

# An Analysis on Ethical Competency and Self-Efficacy Among Freshman Students in Engineering\*

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Ethical education during high school plays a pivotal role in shaping students' ethical self-efficacy and ethical and professional responsibility, particularly for those pursuing careers in engineering. Understanding the impact of early exposure to ethics on students' confidence in professional decision-making and their understanding of ethical responsibilities is critical for developing effective educational interventions. This study aims to examine the influence of high school ethics education on the ethical self-efficacy and ethical and professional responsibility of freshman engineering students. Additionally, the study explores how demographic factors such as being a first-generation student, ethnicity, and gender further impact these attributes and how the attributes impact each other. A comprehensive survey consisting of questions assessing high school ethics exposure, ethical self-efficacy, and ethical and professional responsibility of freshman engineering students was administered. The analysis revealed that university students whose high school experiences emphasized ethics, collaboration, and respect reported higher self-efficacy in professional decision-making and a clearer understanding of engineering roles. Additionally, being a first-generation student and having taken an Engineering Ethics Course were found to significantly impact both ethical self-efficacy and ethical and professional responsibility.

**Keywords:** ethics education; ethical self-efficacy; ethical and professional responsibility; engineering ethics education; high school ethics education; demographic factors

## 1. Introduction

The absence of ethical engineering practices can have catastrophic impacts beyond one's professional sphere, such as financial losses, environmental disasters, structural failures and even loss of life. One example of the devastating effects of inadequate ethical considerations in decision-making is the Deepwater Horizon oil spill. Reports suggest that engineers working at BP did not fully observe safety protocols. This led to one of the worst environmental disasters, claiming 11 lives [1]. Similarly, in the Ford Pinto case, the production tooling was created before the completion of crash tests [2]. This hindered the ability to make necessary design changes and contributed to critical safety defects.

Unethical practices have also been witnessed in other areas, such as academia and the pharmaceutical industry. The Tuskegee Syphilis Study [3] and

the Vioxx scandal are examples of such instances. Vioxx was initially marketed as a safe solution for pain relief. However, it was later associated with an increased risk of cardiovascular disease. This led to its withdrawal and legal claims were filed by nearly 30,000 people [4]. In academia, the case of Marc Hauser is an example of how a lapse in research integrity can damage the credibility of scientific work. An investigation by the U.S. Department of Health and Human Services Office of Research Integrity (ORI) found gaps in the data and methods used in his research [5]. This led to serious repercussions. These examples highlight the importance of ethical decision-making where the stakes often involve public safety and wellbeing.

One can think of ethics in engineering as having two levels. The immediate level is ethical competence, which requires awareness (the ability to identify ethical concerns present in a particular

situation), moral and professional knowledge (knowledge about ethical concepts and frameworks that aid in evaluating an ethical situation, e.g., knowledge about honesty or conflicts of interest situations, and a historical knowledge of what has been acceptable for similar events in the past, knowledge about professional codes of ethics), and moral reasoning (the ability to think from premises to conclusions in a logical and cogent manner, to understand the strengths and weaknesses of the steps of one's thinking, and to determine which line of thought is best for a particular situation). Properly exercising these competences requires commitment [6]. The second level is ethical self-efficacy [7], which denotes a person's belief in their ability to successfully perform a task. Studies have shown that factors such as self-awareness, ethical awareness, global competence, creativity, and teamwork skills contribute to self-efficacy, which in turn affects leadership abilities [7]. Ethical self-efficacy refers to an individual's confidence in being able to make ethical decisions, particularly when dealing with moral dilemmas under pressure [8]. Cultivating this confidence is crucial as it enables individuals to stand firm in their judgments and justify decisions prioritizing ethics over other interests. It helps ensure that the individual adheres to both personal and professional ethical standards.

The present study investigates two of these ideas, ethical and professional responsibility, and self-efficacy. Ethical and professional responsibility refers to an individual's ethical competence, involving an understanding of and commitment to the standards set by their professional community [9]. Engineers often possess poor risk and responsibility awareness, which can lead to unethical decisions [10]. For example, the financial details of the Ford Pinto case were presented to a group of students for analysis. The study [2] revealed that 56.8% of the students chose to pay for the wrongful death lawsuits instead of repairing the defective cars. The study demonstrates the lack of ethical awareness among the students and highlights the need to equip future engineers with moral reasoning abilities. Cultivation of ethical and professional responsibility in engineering education has also been studied by several other researchers. Case-based and problem-based approaches have been suggested [11] to help prepare students for practical application of ethical principles. Additionally, ethical discussions and reflections are seen to be effective at cultivating a natural sense of ethics [12].

Researchers also emphasize the need to inculcate ethical awareness at an early stage as unethical practices often take root in academic settings [13]. Starting in the form of plagiarism and cheating in educational environments, such unethical behav-

iors can erode integrity. Studies [14–16] reveal that a student's tendency to act unethically in academic settings can influence their professional behavior. A similar pattern has been observed by Harding [14], where survey results of 388 students from three Midwestern U.S. universities are studied using regression analysis. Students who cheated in high school are observed to be more likely to resort to unethical practices in college, which could subsequently extend to their professional lives.

This study explores the impact of high school ethics education on the ethical self-efficacy and ethical and professional responsibility of freshman engineering students. Additionally, the effects of demographic factors such as first-generation college education, ethnicity and gender are studied. The findings will help suggest improvements to ethics education at both high school and post secondary levels. Quantitative analysis methods like *t*-test and correlation tests are used to assess these factors. In the next section, we will review related work with a focus on past quantitative research. In the subsequent sections, we discuss the research design, survey results and its analysis.

## 2. Literature Review

Ethical self-efficacy, ethical and professional responsibility, and demographic factors have been studied by several researchers using a variety of quantitative techniques. Some commonly used techniques include surveys, regression analysis, factor analysis, and experimental methods. Studies utilize Likert scale and scenario-based surveys to study students' attitudes toward ethical practices and academic ethical awareness [17–19]. Though surveys remain the most commonly used method, experimental approaches and longitudinal studies can also provide valuable insights. Studies on ethical perceptions [20] and moral disengagement [21] are a few examples of longitudinal studies in this domain. Howland [20] found that students showed improvements in their ethical knowledge over time, though social considerations were consistently perceived as less important than the other factors. Kim [21] reported that, while the overall levels of moral disengagement remained stable over time, students exhibited an increase in the displacement of responsibility and a decrease in attribution of blame. A controlled experiment, performed by Stenmark [22], analyzes the impact of self-efficacy on ethical decision-making by examining 170 students. The study reveals that self-efficacy does not affect ethical cognition but influences ethical perception.

A variety of instruments and tools have been developed to measure self-efficacy and ethical and professional responsibility. PACES-2 [23] was

designed to assess the cheating behavior of students in college and was tested by evaluating academic dishonesty. Defining Issues Test, Version 2 [6] or DIT-2, a well-established tool based on Kohlberg's theory of moral development, measures moral judgment. Within engineering contexts, specific instruments have been developed to evaluate ethical decision-making. The Engineering and Science Issues Test (ESIT) assesses technical dilemmas in science and engineering [24], while the Engineering Ethical Reasoning Instrument (EERI) measures an individual's ethical decision-making in a project-based setting [25]. Additionally, the Ethical Decision Making in Engineering Model [26], integrates descriptive and normative approaches to assess how students approach ethical dilemmas individually and in teams. The study found that teamwork improves decision-making in less complex ethical cases but does not significantly impact complex dilemmas.

In the context of ethical and professional responsibility, the IDEALS Professional Responsibility Assessment was developed to evaluate students' understanding of professional responsibility in capstone projects [27]. Findings suggest that while students recognize work competence as essential, they often overlook sustainability and social responsibility. Canney [28] created the Engineering Professional Responsibility Assessment (EPRA), a tool to measure social responsibility attitudes among engineering students. Similarly, Binani [29] created a survey instrument to measure the ethical preparedness, challenges and self-efficacy of students. The instrument was validated using exploratory factor analysis and proved helpful in measuring students' ethical competencies. Many research studies [30–33] have used a combination of EERI and DIT-2 to assess general and engineering specific ethical reasoning.

These instruments have been widely used to study the impact of various factors, such as ethics education and demographics, on ethical behavior. Extensive research has been conducted on the effect of college-level ethics courses on moral judgment and ethical and professional responsibility, yielding mixed results. May [34] analyzed the impact of embedded and stand-alone ethics courses on students and found both courses to enhance ethical sensitivity and moral courage. On the other hand, Simha [35] concluded that business ethics education did not have an effect on the cheating tendencies of students. The study by Li [36] revealed that students without prior ethics education had stronger ethical views. These studies highlight the complexity in the relationship between ethics education and ethical behavior, necessitating further research in this aspect.

In addition to educational interventions, demographic factors also play an important role in shaping ethical perceptions, as studied by Drake [37]. The research focuses on the impact of educational level, course major, gender, religious beliefs, political beliefs on ethical reasoning abilities of students. Gender was observed to have a low impact, whereas educational level was seen to have a significant impact. Juniors and seniors displayed better reception to ethical instruction in comparison to freshman and sophomore. A similar observation was made by Polmear [38] on the impact of gender on ethical standards. However, differences in ethical values were seen among racial and ethnic groups. Black and Hispanic students exhibited stronger ethical values compared to their peers. Furthermore, Kuczenski [39] identified that factors such as whether the student attended a private or a public institution played an important role. Students at private institutions reported higher rates of unethical behavior compared to those at public institutions, likely due to the higher levels of pressure at the private institutions. Rodzalan and Saat [40], noticed that engineering students exhibited lower levels of ethics, especially in plagiarism and whistleblowing, compared to students from other disciplines.

Several studies have employed statistical techniques to analyze the relationships between ethics and influencing factors. Commonly used methods are *t*-tests [28, 41], correlation analysis [42] and ANOVA [40, 43]. Collectively, these studies form a quantitative foundation for our research. Our study builds on this foundation by specifically examining the impact of high school ethics education and demographic variables on freshman students.

### 3. Research Method

This paper uses a quantitative survey method to assess the ethical self-efficacy and ethical and professional responsibility of freshman engineering students. By assessing the exposure to ethics education and ethical best practices in high school, this study aims to understand their influence in ethical decision-making and ethical and professional responsibility as college students. In addition, the study examines the role of demographic attributes such as gender, ethnicity and first-generation college students in shaping these competencies. The survey responses are then analyzed using statistical measures such as *t*-tests and correlation analysis to test the formulated hypotheses. The research is guided by the following key questions:

**RQ1:** *To what extent does exposure to ethical best practices/education in high school impact the for-*

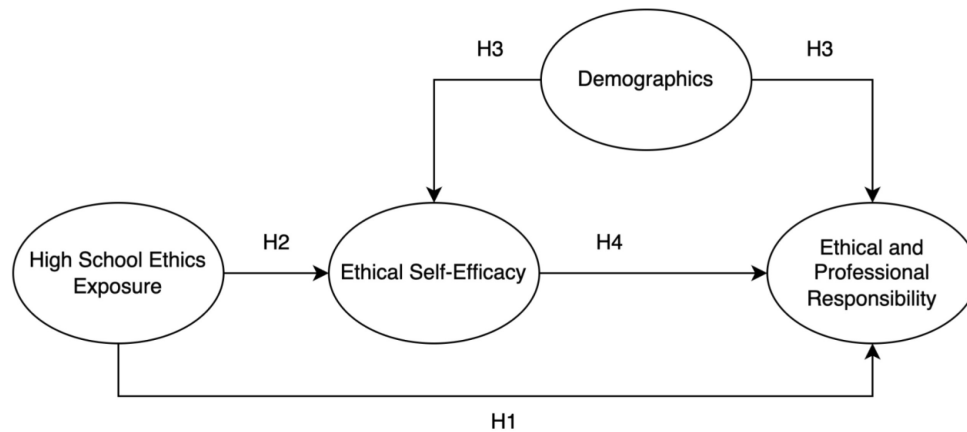


Fig. 1. Research Design.

mation of students' sense of ethical and professional responsibility and ethical self-efficacy in college?

**RQ2:** Do demographic attributes explain the variability in students' levels of ethical and professional responsibility and ethical self-efficacy?

**RQ3:** Is there a correlation between students' ethical self-efficacy and their understanding of ethical and professional responsibility in engineering practice?

Building on the research questions, the following hypotheses have been formulated to empirically investigate the influence of the factors. These hypotheses will be tested using a comprehensive research design that integrates these factors and guides the investigation.

**H1:** Students who were exposed to ethics in high school education will have a better understanding of their ethical and professional responsibilities as engineers compared to those without such exposure (**RQ1**)

**H2:** Students with high school exposure to ethics will exhibit higher levels of ethical self-efficacy compared to those without such exposure (**RQ1**)

**H3:** Ethical self-efficacy levels and ethical and professional responsibility will have no bearing on demographic attributes of students such as gender and ethnicity. (**RQ2**)

**H4:** Higher levels of ethical self-efficacy are positively associated with a better understanding of ethical and professional responsibility in engineering. (**RQ3**)

In quantitative research, an independent variable (IV) affects the outcome of the experiment, while a dependent variable (DV) is influenced by the IV [44]. For Hypotheses 1 (H1) and 2 (H2), the IV is high school ethics exposure, with ethical and professional responsibility, and ethical self-efficacy serves as the DVs, respectively. For Hypothesis 3 (H3), the IVs are demographic factors, and the DVs

are ethical self-efficacy and ethical and professional responsibility. To assess Hypothesis 4 (H4), ethical self-efficacy acts as the IV and ethical and professional responsibility is the DV. The research design, depicted in Fig. 1, illustrates the relationships between these variables.

To test these hypotheses, we use *t*-tests for H1, H2, and H3, and Pearson's correlation for H4. *t*-tests compare the means of the dependent variable across groups defined by the independent variable. For H1 and H2, the groups are based on low and high levels of ethics exposure in high school. In H3, the groups correspond to the different categories of each demographic attribute. We perform Levene's test to assess the equality of variances [45], and apply Welch's *t*-test when variances are unequal. Pearson's correlation is used in H4 to explore the relationship between ethical self-efficacy and ethical and professional responsibility.

### 3.1 Survey Instrument

A comprehensive questionnaire consisting of 40 questions was distributed to freshman students. The questions were designed to assess the students' high school exposure to ethics, level of ethical self-efficacy, and sense of ethical and professional responsibility. The high school-related questions covered adherence to ethical academic practices, consideration of the broader impact of decisions, and individual and collaborative responsibility of the students. The self-efficacy questions focused on assessing their confidence in making professional decisions despite personal financial benefits, working with people from different backgrounds, managing conflicts, and balancing one's interests with those of the employer and the public. Similarly, the questions regarding ethical and professional responsibility centered on values related to the understanding of engineering responsibilities, career success, impact of academic quality, attitude towards personal growth and ethical behavior in

**Table 1.** Survey Questions and Associated Statistics

| #                                                         | Cronbach's Alpha Measure for Survey Data ( $\alpha = 0.836$ )                                                           | Mean | Variance |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------|----------|
| <i>High School Experiences</i>                            |                                                                                                                         |      |          |
| HS1                                                       | Emphasized to follow accepted procedures in experiments                                                                 | 5.66 | 1.31     |
| HS2                                                       | Encourages to accurately report results regardless of outcome                                                           | 5.98 | 1.21     |
| HS3                                                       | Emphasized importance of doing own work and acknowledging contributions                                                 | 6.11 | 1.11     |
| HS4                                                       | Group work grade depended on individual contribution                                                                    | 4.91 | 1.65     |
| HS5                                                       | Taught to work with people from different backgrounds                                                                   | 4.91 | 1.86     |
| HS6                                                       | Teachers interested in student's development and growth                                                                 | 5.2  | 1.51     |
| HS7                                                       | Teachers treated students with respect                                                                                  | 5.78 | 1.15     |
| HS8                                                       | Taught to think about making a decision against personal interests                                                      | 3.88 | 1.97     |
| HS9                                                       | Taught to think how individual actions affect the community                                                             | 4.91 | 1.66     |
| HS10                                                      | Taught to think how choices made affect the environment                                                                 | 5.05 | 1.63     |
| <i>Self-Efficacy Assessment</i>                           |                                                                                                                         |      |          |
| SE1                                                       | I am certain about being able to make correct professional decision given the chance of personal financial benefits     | 5.48 | 1.16     |
| SE2                                                       | Concerned about responding effectively when forced to accept a flawed solution                                          | 3.71 | 1.7      |
| SE3                                                       | Feel prepared to work with people from different backgrounds                                                            | 6.23 | 0.98     |
| SE4                                                       | I am sure about responding correctly when told to perform a task outside my expertise                                   | 5.37 | 1.17     |
| SE5                                                       | Feel prepared to address interpersonal tensions                                                                         | 4.95 | 1.41     |
| SE6                                                       | I know how to balance interests of self, employer and public and justify my decisions                                   | 5.25 | 1.29     |
| <i>Ethical and Professional Responsibility Assessment</i> |                                                                                                                         |      |          |
| PR1                                                       | Career success means a great deal to me                                                                                 | 6.41 | 0.89     |
| PR2                                                       | My quality of work in academics will have a major impact on my career success                                           | 5.78 | 1.13     |
| PR3                                                       | I know what matters most to me                                                                                          | 5.75 | 1.21     |
| PR4                                                       | Being efficient is more important than considering many viewpoints                                                      | 4.01 | 1.42     |
| PR5                                                       | I'd rather get along than always tell people the truth                                                                  | 3.65 | 1.5      |
| PR6                                                       | I have a good understanding of the opportunities an engineering degree provides                                         | 5.57 | 1.18     |
| PR7                                                       | I can explain how what matters most to me aligns with my aims as an engineer                                            | 5.45 | 1.22     |
| PR8                                                       | It is okay to mislead if it seems that no one will be harmed                                                            | 2.77 | 1.37     |
| PR9                                                       | Improving ability to communicate is as important as improving technical skills                                          | 6.05 | 1.07     |
| PR10                                                      | I know the characteristics and skills that make engineers successful                                                    | 5.2  | 1.19     |
| PR11                                                      | I would tell my friend to do his or her own work if he or she were thinking of copying                                  | 5.83 | 1.17     |
| PR12                                                      | I feel confident expressing my opinions when people disagree with me                                                    | 5.37 | 1.28     |
| PR13                                                      | I have a good sense my engineering career will contribute to society                                                    | 5.42 | 1.34     |
| PR14                                                      | I tend to become frustrated when there is ambiguity and uncertainty                                                     | 5.05 | 1.49     |
| PR15                                                      | I have a good understanding of the kinds of responsibilities of engineers                                               | 5.28 | 1.2      |
| PR16                                                      | I compliment someone if I thought it would help my career regardless of whether I believed it                           | 4.3  | 1.6      |
| PR17                                                      | Engineering is a career that offers far more than just a paycheck                                                       | 5.79 | 1.12     |
| PR18                                                      | If a store charges me less, I try to correct them                                                                       | 4.52 | 1.68     |
| PR19                                                      | I find it interesting to learn why people think the way they do                                                         | 5.95 | 1.1      |
| PR20                                                      | I am pursuing engineering primarily because it is challenging or interesting work                                       | 5.52 | 1.24     |
| PR21                                                      | Almost all of my friends in college are studying engineering                                                            | 4.34 | 1.87     |
| PR22                                                      | I would feel bad if I received credit for something I did not do                                                        | 5.56 | 1.25     |
| PR23                                                      | I am pursuing engineering primarily because it leads to a well-paid career or will be instrumental in some other career | 5.14 | 1.53     |
| PR24                                                      | My success depends on what my colleagues do                                                                             | 3.98 | 1.51     |

professional situations. A detailed list of the questions under each category are presented in Table 1.

A 7-point Likert scale, spanning from 'strongly disagree' to 'strongly agree', was employed for the respondents to express their opinions. To assess the respondents' attentiveness, a few questions with instructions to select a specific answer were added to the questionnaire.

### 3.2 Data Analysis

The questionnaire was distributed to nearly 2100 freshman students, out of which 26% of the participants responded to the survey. The gender distribution, racial diversity, and other demographic information of the participants, presented in Table 2, reflect the overall demographic distribution at the university.

**Table 2.** Demographic characteristics of the participants

| Category          |                                           | n   | %      |
|-------------------|-------------------------------------------|-----|--------|
| Total             |                                           | 552 | 100%   |
| Gender            | Female                                    | 166 | 30.10% |
|                   | Male                                      | 371 | 67.20% |
|                   | Other                                     | 2   | 0.40%  |
|                   | Do not wish to specify                    | 13  | 2.40%  |
| Hispanic/Latino   | Yes                                       | 119 | 21.60% |
|                   | No                                        | 417 | 75.50% |
|                   | Do not wish to specify                    | 16  | 2.90%  |
| Race              | American Indian or Alaska Native          | 4   | 0.70%  |
|                   | Asian                                     | 127 | 23.00% |
|                   | Black or African American                 | 14  | 2.50%  |
|                   | Native Hawaiian or Other Pacific Islander | 3   | 0.50%  |
|                   | White                                     | 364 | 66.00% |
|                   | Do not wish to specify                    | 40  | 7.20%  |
| First Gen Student | Yes                                       | 71  | 12.90% |
|                   | No                                        | 472 | 85.50% |
|                   | Do not wish to specify                    | 9   | 1.60%  |
| Career Choice     | Industry                                  | 548 | 99.30% |
|                   | Academia                                  | 4   | 0.70%  |
| Disability        | Yes                                       | 98  | 17.80% |
|                   | No                                        | 413 | 74.80% |
|                   | Do not wish to specify                    | 41  | 7.40%  |

Two test questions were added to the questionnaire with instructions to select ‘agree’ and ‘strongly disagree’, respectively to check the validity of the responses. All rows with incorrect answers to either of the test questions were discarded. The responses were recorded using a 7-point scale with ‘strongly agree’ and ‘strongly disagree’ mapped to numeric values of 7 and 1 respectively. The internal consistency reliability coefficient (Cronbach’s  $\alpha$ ) was 0.836, indicating strong reliability of the measure.

## 4. Results

The mean and standard deviation of each question are listed in Table 1. Among the high school experience questions, majority of students reported exposure to the importance of doing one’s own work and acknowledging others’ contributions. Among the self-efficacy questions, most students either agreed or strongly agreed about feeling prepared to work with people from different backgrounds. Additionally, most of the students give priority to career success and consider communication skills essential.

### 4.1 Impact of High School Exposure

To calculate the impact of high school ethics education on ethical self-efficacy and ethical and professional responsibility, a *t*-test was performed for each combination of high school and SE/PR ques-

tions. The dataset was split into two samples based on the responses to the high school-related questions. Values from 1–4 were marked as low exposure, and 5–7 were marked as high exposure. The average response for each question at the two levels of ethics exposure in high school is tabulated in Table 3 and Table 4. Responses with higher values for low exposure and lower values for high exposure to high school ethics are highlighted in gray.

The *p*-values for all self-efficacy related questions are listed in Table 5, with values less than 0.05 shaded in gray. It can be observed that most of the values under SE1, SE3, SE4, SE5, and SE6 are below the threshold, indicating a significant impact of high school ethics exposure on self-efficacy. However, as most *p*-values are higher than the threshold for SE2, it indicates that there are no significant relationships. A similar pattern can be observed in Table 3, where the average self-efficacy response for SE2 is lower for students with a good high school ethics exposure. This implies that most high school experiences are not strongly linked to concerns about responding to flawed solutions.

Table 6 shows the *p*-values for all ethical and professional responsibility questions. It is observed that very few aspects of high school exposure strongly affect PR1, PR4, PR6, and PR18. Most other questions have majority of *p*-values below the threshold. Ethical and professional responsibility aspects like Professional Integrity (PR2, PR3,

**Table 3.** Impact of high school ethics exposure on self-efficacy (mean scores)

|      | Exposure | SE1   | SE2   | SE3   | SE4   | SE5   | SE6   |
|------|----------|-------|-------|-------|-------|-------|-------|
| HS1  | Low      | 4.985 | 3.712 | 5.788 | 5.015 | 4.530 | 5.015 |
|      | High     | 5.556 | 3.715 | 6.294 | 5.421 | 5.006 | 5.281 |
| HS2  | Low      | 4.814 | 3.907 | 5.395 | 4.628 | 4.070 | 4.558 |
|      | High     | 5.544 | 3.697 | 6.305 | 5.436 | 5.025 | 5.309 |
| HS3  | Low      | 4.844 | 4.094 | 5.438 | 4.875 | 4.406 | 4.875 |
|      | High     | 5.526 | 3.690 | 6.282 | 5.402 | 4.982 | 5.272 |
| HS4  | Low      | 5.309 | 3.556 | 5.983 | 5.017 | 4.579 | 4.927 |
|      | High     | 5.573 | 3.794 | 6.356 | 5.548 | 5.133 | 5.410 |
| HS5  | Low      | 5.290 | 3.760 | 5.929 | 5.219 | 4.426 | 4.940 |
|      | High     | 5.587 | 3.691 | 6.390 | 5.450 | 5.221 | 5.410 |
| HS6  | Low      | 5.364 | 3.868 | 6.020 | 5.126 | 4.642 | 4.927 |
|      | High     | 5.533 | 3.654 | 6.315 | 5.467 | 5.068 | 5.375 |
| HS7  | Low      | 5.382 | 3.855 | 5.727 | 4.945 | 4.655 | 4.800 |
|      | High     | 5.497 | 3.698 | 6.289 | 5.419 | 4.981 | 5.300 |
| HS8  | Low      | 5.341 | 3.569 | 6.194 | 5.275 | 4.716 | 5.016 |
|      | High     | 5.703 | 3.934 | 6.288 | 5.514 | 5.297 | 5.599 |
| HS9  | Low      | 5.203 | 3.785 | 5.955 | 5.034 | 4.492 | 4.740 |
|      | High     | 5.625 | 3.679 | 6.369 | 5.538 | 5.175 | 5.501 |
| HS10 | Low      | 5.174 | 3.738 | 5.913 | 5.029 | 4.483 | 4.785 |
|      | High     | 5.633 | 3.703 | 6.383 | 5.533 | 5.169 | 5.469 |

Note: Shaded cells denote negative correlation. Scores range from 1 (lowest self-efficacy) to 7 (highest self-efficacy).

**Table 4.** Impact of high school ethics exposure on ethical and professional responsibility (mean scores)

|      | Exposure | PR1   | PR2   | PR3   | PR4   | PR5   | PR6   | PR7   | PR8   | PR9   | PR10  | PR11  | PR12  | PR13  | PR14  | PR15  | PR16  | PR17  | PR18  | PR19  | PR20  | PR21  | PR22  | PR23  | PR24  |
|------|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| HS1  | Low      | 6.076 | 5.409 | 5.348 | 4.015 | 3.045 | 5.409 | 5.288 | 4.227 | 5.758 | 4.924 | 5.424 | 5.152 | 4.97  | 4.788 | 5.045 | 2.879 | 5.333 | 4.561 | 5.606 | 5.515 | 4.485 | 5.348 | 4.879 | 3.561 |
|      | High     | 6.457 | 5.833 | 5.803 | 4.006 | 3.397 | 5.592 | 5.479 | 4.236 | 6.086 | 5.234 | 5.884 | 5.397 | 5.487 | 5.092 | 5.313 | 2.674 | 5.85  | 4.519 | 5.996 | 5.526 | 4.318 | 5.586 | 5.182 | 4.043 |
| HS2  | Low      | 6     | 5.116 | 5.279 | 4     | 2.907 | 5.256 | 5.233 | 3.953 | 5.791 | 4.93  | 5.256 | 4.837 | 4.884 | 4.767 | 4.907 | 2.628 | 5.186 | 4.302 | 5.326 | 5.372 | 4.419 | 5.256 | 4.837 | 3.93  |
|      | High     | 6.446 | 5.838 | 5.787 | 4.008 | 3.393 | 5.597 | 5.474 | 4.26  | 6.067 | 5.219 | 5.877 | 5.413 | 5.47  | 5.08  | 5.313 | 2.706 | 5.838 | 4.544 | 6.002 | 5.538 | 4.331 | 5.583 | 5.172 | 3.988 |
| HS3  | Low      | 5.812 | 5.094 | 5.469 | 4.125 | 2.844 | 5.5   | 5.094 | 3.594 | 5.719 | 4.969 | 4.938 | 4.594 | 4.562 | 4.656 | 4.75  | 2.875 | 5.094 | 4.031 | 5.344 | 5     | 4.5   | 5.094 | 4.5   | 3.844 |
|      | High     | 6.448 | 5.824 | 5.764 | 4     | 3.386 | 5.574 | 5.478 | 4.276 | 6.066 | 5.21  | 5.884 | 5.416 | 5.478 | 5.08  | 5.314 | 2.688 | 5.83  | 4.556 | 5.986 | 5.558 | 4.328 | 5.586 | 5.186 | 3.992 |
| HS4  | Low      | 6.331 | 5.539 | 5.551 | 3.933 | 3.331 | 5.483 | 5.258 | 4.27  | 5.927 | 4.955 | 5.624 | 5.303 | 5.152 | 5.039 | 5.067 | 2.742 | 5.556 | 4.208 | 5.899 | 5.438 | 4.404 | 5.455 | 5.18  | 3.871 |
|      | High     | 6.449 | 5.901 | 5.845 | 4.045 | 3.364 | 5.613 | 5.554 | 4.218 | 6.105 | 5.316 | 5.929 | 5.398 | 5.559 | 5.062 | 5.387 | 2.678 | 5.901 | 4.684 | 5.972 | 5.568 | 4.305 | 5.607 | 5.127 | 4.04  |
| HS5  | Low      | 6.339 | 5.585 | 5.421 | 3.94  | 3.426 | 5.317 | 5.197 | 4.12  | 5.934 | 4.847 | 5.656 | 5.164 | 5.191 | 5.066 | 4.995 | 2.694 | 5.639 | 4.24  | 5.754 | 5.59  | 4.454 | 5.415 | 5.158 | 3.825 |
|      | High     | 6.447 | 5.883 | 5.917 | 4.043 | 3.315 | 5.702 | 5.59  | 4.295 | 6.103 | 5.378 | 5.917 | 5.473 | 5.544 | 5.049 | 5.43  | 2.702 | 5.862 | 4.673 | 6.049 | 5.49  | 4.278 | 5.63  | 5.138 | 4.066 |
| HS6  | Low      | 6.391 | 5.596 | 5.609 | 4.013 | 3.199 | 5.417 | 5.278 | 4.119 | 5.98  | 5.007 | 5.748 | 5.238 | 5.212 | 5.099 | 5.066 | 2.609 | 5.629 | 4.139 | 5.828 | 5.417 | 4.291 | 5.377 | 5.152 | 3.887 |
|      | High     | 6.417 | 5.853 | 5.801 | 4.005 | 3.415 | 5.63  | 5.525 | 4.281 | 6.071 | 5.27  | 5.858 | 5.417 | 5.507 | 5.037 | 5.365 | 2.735 | 5.848 | 4.677 | 5.995 | 5.567 | 4.357 | 5.627 | 5.142 | 4.021 |
| HS7  | Low      | 6.273 | 5.545 | 5.6   | 3.891 | 3.109 | 5.473 | 5.291 | 4.073 | 5.691 | 5     | 5.436 | 5.073 | 5.2   | 5.164 | 5.127 | 2.691 | 5.291 | 4.436 | 5.582 | 5.291 | 4.418 | 5.145 | 5.309 | 3.927 |
|      | High     | 6.426 | 5.807 | 5.763 | 4.021 | 3.382 | 5.581 | 5.474 | 4.254 | 6.086 | 5.218 | 5.872 | 5.4   | 5.449 | 5.042 | 5.298 | 2.7   | 5.843 | 4.535 | 5.99  | 5.551 | 4.329 | 5.604 | 5.126 | 3.99  |
| HS8  | Low      | 6.394 | 5.688 | 5.644 | 3.819 | 3.45  | 5.494 | 5.341 | 4.359 | 6.047 | 5.019 | 5.816 | 5.309 | 5.35  | 5.075 | 5.119 | 2.819 | 5.728 | 4.403 | 5.894 | 5.528 | 4.294 | 5.522 | 5.15  | 3.859 |
|      | High     | 6.434 | 5.92  | 5.901 | 4.292 | 3.208 | 5.684 | 5.627 | 4.047 | 6.042 | 5.462 | 5.844 | 5.453 | 5.533 | 5.024 | 5.524 | 2.519 | 5.873 | 4.708 | 6.028 | 5.519 | 4.406 | 5.608 | 5.137 | 4.17  |
| HS9  | Low      | 6.322 | 5.508 | 5.463 | 3.938 | 3.328 | 5.362 | 5.175 | 4.124 | 5.881 | 4.831 | 5.655 | 5.192 | 5.175 | 5.04  | 4.944 | 2.864 | 5.548 | 4.356 | 5.729 | 5.446 | 4.362 | 5.367 | 5.085 | 3.847 |
|      | High     | 6.454 | 5.915 | 5.887 | 4.042 | 3.366 | 5.673 | 5.594 | 4.29  | 6.127 | 5.377 | 5.913 | 5.454 | 5.546 | 5.062 | 5.448 | 2.617 | 5.904 | 4.608 | 6.056 | 5.563 | 4.327 | 5.651 | 5.175 | 4.051 |
| HS10 | Low      | 6.221 | 5.488 | 5.43  | 3.89  | 3.401 | 5.355 | 5.052 | 4.285 | 5.953 | 4.86  | 5.709 | 5.145 | 5.064 | 5.041 | 4.895 | 2.855 | 5.535 | 4.395 | 5.756 | 5.541 | 4.308 | 5.302 | 5.064 | 3.82  |
|      | High     | 6.5   | 5.919 | 5.897 | 4.064 | 3.331 | 5.672 | 5.647 | 4.211 | 6.089 | 5.356 | 5.883 | 5.472 | 5.594 | 5.061 | 5.464 | 2.625 | 5.906 | 4.586 | 6.039 | 5.517 | 4.353 | 5.678 | 5.183 | 4.061 |

Note: Shaded cells denote negative correlation.

PR22), Understanding of Engineering Roles (PR7, PR10, PR15), Communication and Collaboration (PR12, PR19), and Ethical Decision-Making and Responsibility (PR11, PR13, PR17) are strongly influenced by high school experience. Similar results are observed in Table 4, where PR questions with high *p*-values have lower averages for the category of students with high exposure.

#### 4.2 Correlation between Ethical and Professional Responsibility and Ethical Self-Efficacy

The correlation between self-efficacy and ethical and professional responsibility is presented in Table 7. Pearson's correlation coefficient was calculated for each combination of questions. Combinations with *p*-values < 0.05 are shaded gray. Several key correlations emerge between ethical

**Table 5.** Impact of high school exposure on self-efficacy (*p*-value)

| HS Education Experience | Self-Efficacy |      |        |        |        |        |
|-------------------------|---------------|------|--------|--------|--------|--------|
|                         | SE1           | SE2  | SE3    | SE4    | SE5    | SE6    |
| HS1                     | <0.001        | 0.99 | <0.001 | 0.01   | 0.01   | 0.12   |
| HS2                     | <0.001        | 0.33 | <0.001 | <0.001 | <0.001 | <0.001 |
| HS3                     | <0.001        | 0.06 | <0.001 | 0.01   | 0.03   | 0.09   |
| HS4                     | 0.01          | 0.11 | <0.001 | <0.001 | <0.001 | <0.001 |
| HS5                     | 0.01          | 0.66 | <0.001 | 0.03   | <0.001 | <0.001 |
| HS6                     | 0.13          | 0.19 | <0.001 | <0.001 | <0.001 | <0.001 |
| HS7                     | 0.49          | 0.52 | <0.001 | <0.001 | 0.1    | 0.01   |
| HS8                     | <0.001        | 0.01 | 0.28   | 0.02   | <0.001 | <0.001 |
| HS9                     | <0.001        | 0.5  | <0.001 | <0.001 | <0.001 | <0.001 |
| HS10                    | <0.001        | 0.81 | <0.001 | <0.001 | <0.001 | <0.001 |

Note: Shaded cells denote *p*-value <0.05.

**Table 6.** Impact of high school exposure on ethical and professional responsibility (*p*-value)

| HS Education Experience | Ethical and Professional Responsibility |       |       |       |      |       |       |      |      |       |       |       |       |      |       |      |       |       |       |      |      |       |      |      |
|-------------------------|-----------------------------------------|-------|-------|-------|------|-------|-------|------|------|-------|-------|-------|-------|------|-------|------|-------|-------|-------|------|------|-------|------|------|
|                         | PR1                                     | PR2   | PR3   | PR4   | PR5  | PR6   | PR7   | PR8  | PR9  | PR10  | PR11  | PR12  | PR13  | PR14 | PR15  | PR16 | PR17  | PR18  | PR19  | PR20 | PR21 | PR22  | PR23 | PR24 |
| HS1                     | 0.02                                    | 0.02  | 0.01  | 0.96  | 0.07 | 0.24  | 0.24  | 0.96 | 0.06 | 0.05  | 0.02  | 0.14  | <0.01 | 0.12 | 0.09  | 0.33 | <0.01 | 0.85  | 0.03  | 0.95 | 0.5  | 0.15  | 0.13 | 0.01 |
| HS2                     | 0.04                                    | <0.01 | 0.01  | 0.97  | 0.04 | 0.07  | 0.21  | 0.16 | 0.1  | 0.13  | 0.02  | <0.01 | 0.01  | 0.19 | 0.03  | 0.76 | <0.01 | 0.37  | <0.01 | 0.4  | 0.77 | 0.1   | 0.17 | 0.77 |
| HS3                     | <0.01                                   | 0.01  | 0.18  | 0.63  | 0.05 | 0.73  | 0.08  | 0.01 | 0.08 | 0.27  | <0.01 | <0.01 | <0.01 | 0.12 | 0.01  | 0.4  | <0.01 | 0.05  | <0.01 | 0.01 | 0.52 | 0.03  | 0.01 | 0.52 |
| HS4                     | 0.15                                    | <0.01 | 0.01  | 0.39  | 0.81 | 0.23  | 0.01  | 0.68 | 0.07 | <0.01 | <0.01 | 0.42  | <0.01 | 0.87 | <0.01 | 0.67 | <0.01 | <0.01 | 0.47  | 0.25 | 0.56 | 0.19  | 0.71 | 0.22 |
| HS5                     | 0.19                                    | <0.01 | <0.01 | 0.43  | 0.42 | <0.01 | <0.01 | 0.16 | 0.08 | <0.01 | 0.01  | 0.01  | <0.01 | 0.9  | <0.01 | 0.96 | 0.03  | <0.01 | 0.01  | 0.34 | 0.31 | 0.06  | 0.88 | 0.08 |
| HS6                     | 0.76                                    | 0.02  | 0.1   | 0.95  | 0.13 | 0.06  | 0.04  | 0.22 | 0.38 | 0.02  | 0.33  | 0.14  | 0.02  | 0.66 | 0.01  | 0.41 | 0.04  | <0.01 | 0.11  | 0.21 | 0.72 | 0.04  | 0.94 | 0.36 |
| HS7                     | 0.23                                    | 0.1   | 0.35  | 0.52  | 0.2  | 0.52  | 0.29  | 0.35 | 0.01 | 0.2   | 0.01  | 0.07  | 0.19  | 0.57 | 0.32  | 0.97 | 0     | 0.68  | 0.04  | 0.14 | 0.74 | 0.01  | 0.4  | 0.77 |
| HS8                     | 0.61                                    | 0.02  | 0.02  | <0.01 | 0.07 | 0.07  | 0.01  | 0.01 | 0.96 | <0.01 | 0.78  | 0.2   | 0.12  | 0.7  | <0.01 | 0.03 | 0.14  | 0.04  | 0.17  | 0.93 | 0.5  | 0.43  | 0.92 | 0.02 |
| HS9                     | 0.11                                    | <0.01 | <0.01 | 0.41  | 0.78 | <0.01 | <0.01 | 0.19 | 0.01 | <0.01 | 0.02  | 0.03  | <0.01 | 0.87 | <0.01 | 0.09 | <0.01 | 0.1   | <0.01 | 0.3  | 0.84 | 0.01  | 0.52 | 0.13 |
| HS10                    | <0.01                                   | <0.01 | <0.01 | 0.19  | 0.61 | <0.01 | <0.01 | 0.56 | 0.17 | <0.01 | 0.11  | 0.01  | <0.01 | 0.88 | <0.01 | 0.12 | <0.01 | 0.22  | 0.01  | 0.83 | 0.8  | <0.01 | 0.4  | 0.08 |

Note: Shaded cells denote *p*-value <0.05.

**Table 7.** Correlation between ethical and professional responsibility and self-efficacy (Pearson's Correlation Coefficient)

| Ethical and Professional Responsibility | Self-Efficacy |        |       |       |        |        |
|-----------------------------------------|---------------|--------|-------|-------|--------|--------|
|                                         | SE1           | SE2    | SE3   | SE4   | SE5    | SE6    |
| PR1                                     | 0.2           | -0.05  | 0.21  | 0.12  | 0.16   | 0.16   |
| PR2                                     | 0.13          | -0.01  | 0.22  | 0.15  | 0.15   | 0.25   |
| PR3                                     | 0.25          | -0.09  | 0.21  | 0.25  | 0.32   | 0.39   |
| PR4                                     | 0.13          | 0.07   | -0.04 | -0.01 | 0.09   | 0.1    |
| PR5                                     | 0.08          | -0.21  | 0.02  | 0.15  | 0.08   | 0.13   |
| PR6                                     | 0.29          | -0.1   | 0.25  | 0.25  | 0.23   | 0.33   |
| PR7                                     | 0.27          | -0.11  | 0.24  | 0.22  | 0.2    | 0.29   |
| PR8                                     | 0.09          | -0.14  | 0.17  | 0.16  | 0.15   | 0.11   |
| PR9                                     | 0.17          | -0.06  | 0.19  | 0.2   | 0.19   | 0.21   |
| PR10                                    | 0.35          | -0.08  | 0.22  | 0.29  | 0.34   | 0.42   |
| PR11                                    | 0.09          | <0.001 | 0.13  | 0.16  | 0.1    | 0.14   |
| PR12                                    | 0.25          | -0.18  | 0.2   | 0.2   | 0.3    | 0.37   |
| PR13                                    | 0.29          | -0.12  | 0.27  | 0.26  | 0.23   | 0.32   |
| PR14                                    | -0.02         | 0.18   | -0.04 | -0.09 | -0.04  | -0.13  |
| PR15                                    | 0.37          | -0.07  | 0.27  | 0.22  | 0.25   | 0.36   |
| PR16                                    | 0.01          | -0.1   | 0.08  | 0.07  | -0.04  | 0.02   |
| PR17                                    | 0.23          | -0.07  | 0.24  | 0.23  | 0.15   | 0.25   |
| PR18                                    | 0.14          | 0.01   | 0.1   | 0.18  | 0.27   | 0.2    |
| PR19                                    | 0.23          | -0.08  | 0.27  | 0.2   | 0.23   | 0.17   |
| PR20                                    | 0.12          | 0.02   | 0.14  | 0.16  | 0.07   | 0.17   |
| PR21                                    | <0.001        | 0.05   | -0.03 | -0.02 | -0.03  | -0.04  |
| PR22                                    | 0.11          | -0.02  | 0.2   | 0.16  | 0.1    | 0.16   |
| PR23                                    | 0.09          | 0.06   | -0.05 | 0.02  | 0.05   | 0.01   |
| PR24                                    | 0.08          | 0.26   | -0.05 | -0.02 | <0.001 | <0.001 |

Note: Shaded cells denote *p*-value < 0.05.

**Table 8.** Impact of demographics on self-efficacy (*p*-values)

|                           | Self-Efficacy |      |        |        |      |      |
|---------------------------|---------------|------|--------|--------|------|------|
|                           | SE1           | SE2  | SE3    | SE4    | SE5  | SE6  |
| Multiple AP courses       | 0.39          | 0.3  | 0.3    | 0.4    | 0.38 | 0.86 |
| Career Choice             | 0.65          | 0.7  | <0.001 | 0.82   | 0.25 | 0.12 |
| Disability                | 0.56          | 0.8  | 0.25   | 0.31   | 0.96 | 0.34 |
| Engineering Ethics Course | 0.47          | 0.02 | 0.67   | 0.18   | 0.04 | 0.14 |
| FE Ethics Course taken    | 0.49          | 0.41 | 0.17   | 0.52   | 0.13 | 0.44 |
| First gen Student         | 0.39          | 0.58 | 1      | <0.001 | 0.17 | 0.07 |
| Gender                    | 0.07          | 0.72 | 0.68   | 0.76   | 0.07 | 0.21 |
| Hispanic/Latino           | 0.18          | 0.87 | 0.64   | 0.26   | 0.73 | 0.76 |

Note: Shaded cells denote *p*-value > 0.05.

**Table 9.** Impact of demographics on ethical and professional responsibility (*p*-values)

|                           | Ethical and Professional Responsibility |       |       |       |       |       |       |       |       |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|---------------------------|-----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                           | PRQ 1                                   | PRQ 2 | PRQ 3 | PRQ 4 | PRQ 5 | PRQ 6 | PRQ 7 | PRQ 8 | PRQ 9 | PRQ 10 | PRQ 11 | PRQ 12 | PRQ 13 | PRQ 14 | PRQ 15 | PRQ 16 | PRQ 17 | PRQ 18 | PRQ 19 | PRQ 20 | PRQ 21 | PRQ 22 | PRQ 23 | PRQ 24 |
| Multiple AP courses       | 0.35                                    | 0.59  | 0.88  | 0.78  | 0.82  | 0.17  | 0.46  | 0.25  | 0.29  | 0.15   | 0.58   | 0.67   | 0.38   | 0.17   | 0.16   | 0.11   | 0.31   | 0.15   | 0.41   | 0.64   | 0.29   | 0.6    | 0.02   | 0.31   |
| Career Choice             | 0.14                                    | 0.55  | 0.04  | 0.14  | 0.11  | 0.15  | 0.06  | 0.24  | 0.04  | 0.2    | 0.67   | 0.99   | 0.84   | 0.46   | 0.19   | 0.73   | 0.39   | 0.35   | 0.11   | 0.91   | 0.55   | 0.43   | 0.8    | 0.4    |
| Disability                | 0.14                                    | 0.45  | 0.95  | 0.27  | 0.99  | 0.43  | 0.05  | 0.51  | 0.12  | 0.37   | 0.58   | <0.01  | 0.24   | 0.34   | 0.58   | 0.61   | 0.53   | 0.9    | 0.88   | 0.29   | 0.77   | 0.71   | 0.15   | 0.56   |
| Engineering Ethics Course | 0.52                                    | 0.05  | 0.82  | 0.24  | 0.57  | 0.05  | 0.42  | 0.06  | 0.01  | 0.85   | 0.05   | 0.19   | 0.36   | 0.21   | 0.7    | 0.18   | 0.99   | 0.03   | 0.61   | 0.44   | 0.49   | 0.08   | 0.02   | 0.94   |
| FE Ethics Course taken    | 0.99                                    | 0.82  | 0.31  | 0.48  | 0.52  | 0.65  | 0.72  | 0.53  | 0.33  | 0.07   | 0.64   | 0.9    | 0.57   | 0.27   | 0.52   | 0.02   | 0.28   | 0.12   | 0.02   | 0.99   | 0.8    | 0.7    | 0.69   | 0.2    |
| First gen Student         | <0.01                                   | 0.04  | 0.09  | 0.71  | 0.7   | 0.49  | 0.9   | 0.66  | 0.5   | 0.66   | 0.17   | 0.15   | 0.6    | 0.18   | 0.08   | 0.09   | 0.03   | 0.19   | 0.05   | 0.01   | 0.16   | 0.09   | 0.76   | 0.08   |
| Gender                    | 0.2                                     | <0.01 | 0.1   | <0.01 | 0.1   | 0.11  | <0.01 | 0.11  | 0.68  | 0.45   | 0.79   | <0.01  | 0.99   | 0.61   | 0.25   | 0.14   | 0.22   | 0.53   | 0.01   | 0.26   | <0.01  | 0.95   | <0.01  | 0.75   |
| Hispanic/Latino           | 0.06                                    | 0.92  | 0.43  | 0.27  | 0.9   | 0.31  | 0.74  | 0.5   | 0.93  | 0.09   | 0.07   | 0.03   | 0.39   | 0.41   | 0.89   | 0.63   | 0.05   | 0.9    | 0.58   | 0.53   | 0.88   | 0.17   | 0.91   | 0.06   |

Note: Shaded cells denote *p*-value > 0.05.

and professional responsibility (PR) and self-efficacy (SE) measures. PR10 and PR15 show the strongest positive correlations with multiple SE measures, indicating that a strong understanding of engineering success factors and responsibilities is linked to higher self-efficacy. Negative correlations can be observed for PR2 with SE6 and PR14 with SE4 and SE6. This indicates challenges in self-efficacy when facing academic pressure or ambiguity. Some PR items such as PR4, PR5, PR16, PR21 and PR23, show no significant correlation with SE, indicating these aspects may not strongly influence self-efficacy in students.

#### 4.3 Impact of Demographics on Self-Efficacy and Ethical and Professional Responsibility

The SE and PR responses were split into two sets of samples based on demographic attributes for *t*-test analysis. For attributes denoting first-generation students, ethics course exposure, AP course exposure, disability, and Hispanic/Latino identity, the two samples corresponded to YES and NO. For gender, data was classified into male and female, and for career choice, academia and industry were the two classes. Records corresponding to other response options were ignored.

The results of the *t*-test for self-efficacy and

demographics are presented in Table 8. SE4 shows significant correlations with being a first-generation student. SE2 and SE5 are significantly influenced by having taken an Engineering Ethics Course. Other demographic attributes like gender, FE Ethics Course, Hispanic/Latino identity, career choice, and disability show no significant impact on self-efficacy.

The impact of demographics on ethical and professional responsibility is tabulated in Table 9. PR1, PR9, PR11, PR12 and PR13 depict significant correlations, indicating that first-generation students have a distinctive sense of ethical and professional responsibility, especially regarding communication, career success and ethical behavior. Significant correlations are found in PR1, PR3, PR9, and PR17, suggesting that Hispanic/Latino students have particular ethical and professional responsibility perspectives, especially in areas like career importance and the ethical aspects of engineering. PR3, PR10, PR16, and PR24 are notably influenced by taking an Engineering Ethics course. Gender shows significant influence on PR4, PR11, PR12, and PR22, suggesting that gender differences impact various aspects of ethical and professional responsibility, particularly in ethical decision-making and the willingness to address misconduct.

## 5. Discussion

These findings suggest that high school ethics education has a significant impact on professional development in areas related to integrity, understanding of professional roles and ethical decision-making. This supports our hypothesis that students exposed to ethics in high school education will better understand their ethical and professional responsibilities as engineers compared to those without such exposure (H1). This contrasts with the findings of Li [36], who conducted a controlled lab experiment and found that students who had participated in ethics education exhibited lesser ethical behavior. Students were seen to prioritize self-interest over ethics in the absence of supervision.

We also observe that high school experiences that emphasize ethics, collaboration, respect, and consideration of broader impacts (community, environment) are significantly associated with higher self-efficacy in professional decision-making, handling interpersonal tensions, and working with diverse groups. This supports our hypothesis that students with high school exposure to ethics will exhibit higher levels of ethical self-efficacy compared to those without such exposure (H2). Some aspects, like concern about flawed solutions, show weaker or no significant relationships with high school experiences, indicating that these concerns might be influenced by factors outside of the high school ethics exposure.

Certain attributes, such as being a first-generation student and taking an Engineering Ethics course, significantly impact students' self-efficacy in specific areas, supporting hypothesis H3. Other socioeconomic attributes did not show a significant impact on self-efficacy. Gender is observed to have some influence on ethical self-efficacy. Since the impact is less consistent, we need to explore the effect of gender dynamics further.

It is also observed that demographic attributes such as being a first-generation student, Hispanic/Latino identity, and gender significantly shape students' perspectives on ethical and professional responsibility. Students who identified as Hispanic/Latino had higher ethical and professional responsibility scores than other students. A similar pattern was observed in another research [38], where Black and Hispanic students had a greater perception of ethical standards. These attributes influence how students understand their professional roles, prioritize career goals and how they handle ethical dilemmas. The findings also suggest that taking an Engineering Ethics course influences certain areas of ethical and professional responsibility, supporting hypothesis H3.

The data also suggests a significant relationship between ethical self-efficacy and ethical and professional responsibility (H4), particularly in areas where a strong understanding of engineering roles and responsibilities correlates with higher self-efficacy. It can also be inferred that, students with strong interpersonal skills and high ethical self-efficacy tend to have a better commitment to their ethical and professional responsibilities. However, students who struggle with academic pressure and students who are unclear about their professional roles have lower ethical self-efficacy.

This study expands the scope of ethical self-efficacy research by incorporating high school ethics education as a key factor influencing students' ethical and professional responsibility. A critical contribution of this work is the introduction of ethical self-efficacy scores to quantify students' confidence in handling ethical dilemmas. Furthermore, statistical methods such as *t*-tests and correlation analysis were applied to rigorously evaluate the relationships between high school experiences, demographic factors, and ethical development. By examining the connection between ethics education and professional responsibility, this study provides a more comprehensive perspective on how early exposure to ethics shapes students' ethical decision-making.

## 6. Conclusion and Future Work

The observations from the survey results help us conclude that high school education plays a vital role in shaping the ethical self-efficacy and ethical and professional responsibility of students. It is crucial to prepare students for the ethical challenges they might have to face in their professional careers. The differences in certain ethical perspectives influenced by demographics highlight the importance of targeted educational interventions. The strong correlation between ethical self-efficacy and ethical and professional responsibility underscores the importance of fostering ethical self-efficacy in educational settings. The impact of taking an Engineering Ethics course, observed from the survey results, emphasizes the importance of integrating ethics education into engineering curriculum.

For administrators of university programs in engineering, these results suggest that the appropriate interventions for their students depend in part on the high school experiences their students have had. Institutions may wish to measure the starting point of their students to shape their interventions. One interesting question is whether the programs should be designed based on averages or median performance, or based off of what lower percentiles report. Institutions whose students, or a

significant number of them, have had limited exposure to these elements should consider interventions early in the students' programs.

More broadly, our research was not designed to determine when engineering ethics interventions are best imparted. Students who receive it at the beginning of their studies are often more open to ethical concerns, and their university experience and all of their engineering internships are shaped by what they have learned. Interventions closer to graduation can be designed for students who have a better understanding of what engineers do in their desired industry, often gained in part through internship

experience. These students, further along in their studies, are also more mature thinkers, and the intervention takes place closer to the start of their careers.

A potential path for future work could be to conduct a longitudinal study by tracking students from freshman to their capstone project. This study will help us understand the long-term effects of ethics education. We can also investigate changes in students' ethical perceptions and ethical and professional responsibilities that may occur with experience and exposure to more complex situations.

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