

# DESCRIBING STEM STUDENTS' PATTERNS OF ETHICAL CONCERN

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## ABSTRACT

Technological systems are increasingly pervasive, impacting both our everyday lives and the current and future states of many STEM professions. Trends in technology present security and privacy concerns, threatening to disrupt individual control over data collection and use. Virtually all areas of STEM study are impacted by these challenges and opportunities, yet many struggle to identify ethical considerations to guide their practice.

In this interview study, we explore opportunities to enhance the preparation of STEM students by documenting current and emerging areas of ethical concern. We interviewed 20 undergraduate and graduate STEM students using a critical interview approach, asking about ethical concerns in everyday and professional interactions with technology. We iteratively conducted a thematic analysis to identify the ethical concerns shared by STEM students, revealing the patterns of ethical reasoning that they use to justify or avoid their use of technologies.

We identified multiple themes relating to matters of ethical concern, including drivers for unethical behavior, beliefs regarding responsibility for ethical technologies, means of engaging with matters of ethical concern, and reactions to unethical technology experiences. The participants' examples revealed ethical awareness manifest in privacy concerns. However, the locus of responsibility for these concerns varied widely. Participants consistently stated that their educational preparation to engage in ethical argumentation within their discipline was lacking. Based on these early results, we posit that our participants' lack of professional ethics capability will be problematic for the future of many technological fields, and should be addressed through new ethics education experiences.

## BACKGROUND

As modern technologies are developed at a rapid speed, ethical guidelines for utilization of new technologies develop at a slower speed [4]. Therefore, many ethical issues are occurring continuously in various areas. However, it is still unclear how individuals, specifically STEM students, determine the ethicality of a technology. To better understand the space, we have identified a few key journals to aid in our understanding, including the Science and Engineering Ethics journal, the International Journal of Technology and Design Education, as well as the Journal of Engineering Education.

**Technologists and technological skills are beginning to have roles of ever-increasing importance and complexity in both the everyday life and professional practices of individuals around the world. With these new roles come new opportunities for growth but also opportunities for abuse and harm. Preparing both the technologists of both the present and of the future is a direct and necessary path forward towards the establishment of a strong sense of ethics. [1] [3] [6]**

To focus on these issues, we conducted interviews with STEM students at Purdue. We have two goals for this study: 1) To research the lived experiences of students in the ethics of new technologies; and 2) Understanding students' use of ethics in their professional disciplines.

## METHOD

In this interview study, we conceptually and pragmatically explore opportunities to enhance the ethical preparation of technology students by documenting current and emerging areas of students' ethical concern. We recruited 21 undergraduate and graduate STEM students by putting flyers across our school campus, e-mailing advisors, and reaching out to current summer class professors etc. Of 21 participants, 11 were female and 10 were male. Of all participants, 8 were Juniors, 7 were Seniors and 6 were graduate students. Each participant had to fill out a set of screener questions as part of their recruitment.

Participants were engaged in a 30-60 minute interview, asked questions regarding ethical concerns in their everyday interactions with technology, followed by ethical concerns in relation to technology in their future profession. After interviews were finished, we started coding for common themes and interesting differences between interviews. We iteratively conducted a thematic analysis to gain insight into the ethical concerns shared by STEM students, as well as the patterns of ethical reasoning that they use to justify or avoid their use of technologies. [2]

## FINDINGS

After further analysis of our interview data, we identified multiple themes relating to matters of ethical concern for STEM students, including drivers for unethical behavior, beliefs regarding responsibility for ethical technologies, means of engaging with matters of ethical concern, and reactions to unethical technological experiences. The examples shared by students were wide-ranging and revealed patterns of ethical awareness among participants, particularly concerning the everyday use of technology.

Concern for privacy was prevalent across almost all participants, but the locus of responsibility for this privacy varied widely, with participants alternately indicating and prioritizing governmental, corporate, designer, and individual responsibility. Participants consistently stated that their education to prepare them to engage in this ethical argumentation within their discipline was lacking, both regarding current technological issues and future dilemmas in their respective fields.

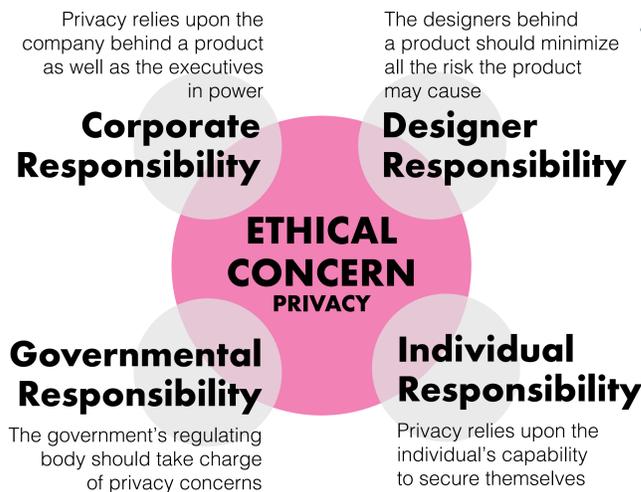


Figure 1: The Locus of Responsibility in Regard to Ethical Concern

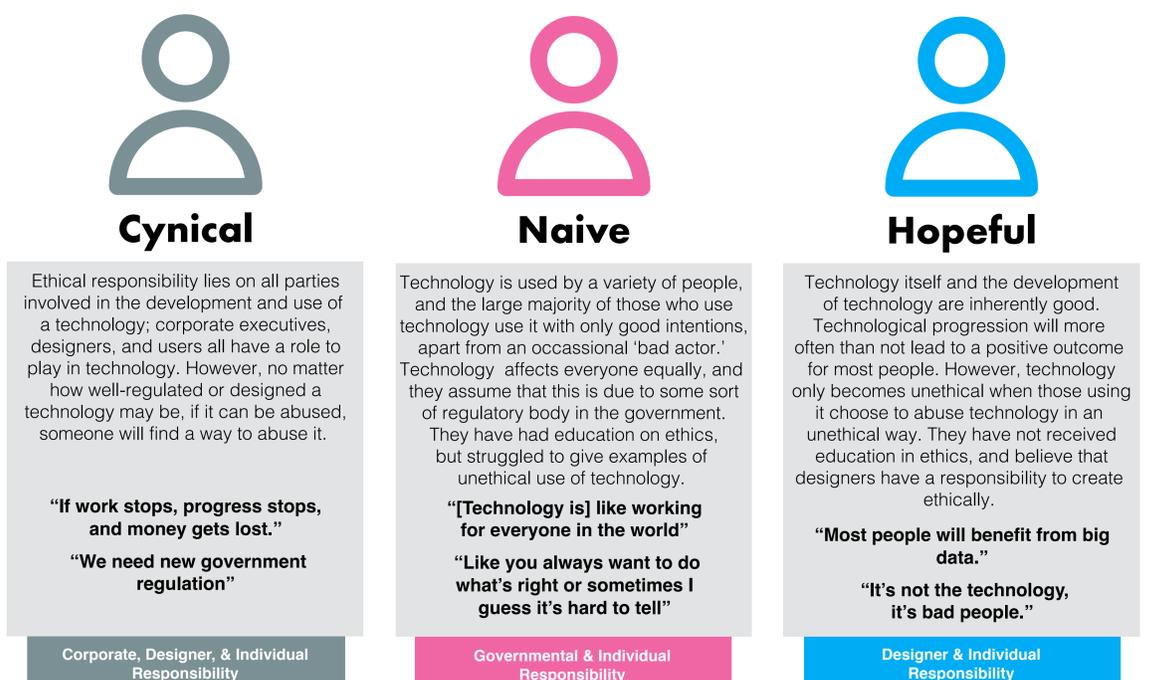


Figure 2: User Profiles based on interview participant responses

## CONCLUSIONS & DISCUSSION

The continuous development of technology present security and privacy concerns, threatening to disrupt individual control over data collection and use. Due to society's ever-increasing reliance on technology, designers and developers of future technologies should be able to take on more demanding responsibilities in order to be able to make ethical judgments in their professional fields. Based on these early results, we posit that our participants' lack of confidence engaging in professional ethics will prove to be problematic for the future of many technological fields. Many of our interviews continually showed an omission of ethical judgment that we believe to be rooted in fear of failure or misjudgment of a situation. Sending students into the professional workforce underprepared to make ethically-grounded judgments and design decisions should be considered a critical concern for the future of ethics in technology and the implementation of explicit ethics education in related curriculums should be highly considered.

**This foundation of establishing a strong sense of technological ethics begins with ethics education. By continually reinforcing and encouraging ethical practice throughout the entirety of an individual's professional education, they can be best prepared to make ethically-sound decisions in fast-paced professional environments and situations.**

To combat a lack of ethical preparedness, the pedagogical experiences relating to ethics education should be reevaluated to better prepare students for the realities of the current and future STEM workforce. Current examples of new approaches to ethics education include Mulhearn et al [5] and Zhu et al [7]. We believe these approaches to be appropriate ways to nurture ethics in STEM students. Our research paves the way for implementational studies seeking to improve ethics education practices and helps to identify areas of need within the field of ethics education.

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## PRIVACY, RESPONSIBILITY & USER PROFILES

Privacy was one of the most mentioned ethical concerns from our interviews. The locus of responsibility in regards to privacy varied between participants, shown to the left in Figure 1. This data informed the creation of user profiles, Figure 2, which aided us in understanding who our research targets as well as what their beliefs are. This relationship might be of interest for further investigation.

## FUTURE WORK

**Continue investigations into STEM students' ethics education experiences**

**Research contributions to ethics education studies in STEM fields**

**Identify areas of high concern in regards to ethics education and practice for STEM students**

**The extension of the study looks forward to understand the ethical awareness of STEM students and the different ethical dimensions of student responsibility. The impact of this study would help to better connect ethics education and practice for future STEM professionals.**