# Chapter 2
# Social Responsibility and Ethics in STEM Education: The State of the Field


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**Abstract** The relationship between ethics education and recent scholarship on social responsibility is crucial to explore. At times, ethics education has been designed to focus narrowly on compliance with rules and regulations. In contrast, other forms of ethics education emphasize direct attention to social responsibility and the types of obligations that future professionals have to society. In this chapter, we provide an overview of social responsibility, including some of its intellectual foundations, and discuss an important distinction to the realm of ethics education between *personal* and *professional* social responsibility. We also review some of the current social responsibility literature and describe connections between social responsibility and traditional approaches to ethics education. We conclude by highlighting opportunities for future research in the realm of social responsibility, including lessons learned from our own research. In particular, there is a need for further analysis of the long-term development of student social responsibility attitudes and their impact on professional practice.

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## 2.1 Introduction

In the twenty-first century, public perceptions of scientists, engineers, and technology professionals have, to some degree, grown more negative (Kennedy et al. 2022). While many factors can contribute to this, high-profile ethical lapses are an ongoing problem. Tragedies involving flawed implementation of sophisticated technology, such as the Boeing 737 MAX crashes (Herkert et al. 2020), and even intentional wrongdoing by scientists or engineers, including the Volkswagen emissions scandal (Patel 2015) and practices within the blood testing company Theranos (Allyn 2022), have shaken public confidence in STEM professionals. Given these and other troubling incidents, combined with the power that science and technology can exert over our lives, it is an important time to re-examine the ethical and social responsibilities that STEM professionals have to society. This chapter provides an overview of current literature on the topic, including the state of educational interventions to develop responsibility attitudes among STEM students.

Many scholars and policymakers suggest that educational interventions in college are key to addressing deficiencies regarding professional ethics and social responsibility within STEM communities (e.g., NAE 2009, 2016). Ethics education in undergraduate and graduate STEM degree programs is ideally a method for familiarizing students with the obligations that they might have as future professionals. Some envision, for example, that such education will prevent or mitigate the chance that students will engage in unethical behavior in the workplace. However, traditional approaches to ethics education may have too narrow of a focus to address the full scope of the challenges facing STEM professionals.

Historically, ethics education in STEM programs usually highlighted issues at the microethical scale rather than broader, macroethical concerns. This trend is common in traditional approaches to engineering ethics (Herkert 2005). To illustrate the distinction: an issue closer to the microethical domain would be an individual engineer's obligation to tell the truth to a client, whereas a professional organization's stance on the morality of weapons development would be closer to macroethics. Assuming that professional ethics is even mentioned within a STEM degree program (which is not always the case), the focus tends to be on microethics, preventive ethics, and compliance with codes of ethics or the law. In response, some scholars advocate that a greater emphasis should be placed on aspirational ethics (Harris 2013; Huff and Barnard 2009; Pritchard and Pritchard 2006). In other words, the approach would not only involve teaching about harm avoidance, but also about the obligation "to do good" and cases of moral exemplars.

Along these lines, the ethical problems that the public perceives as emerging from STEM professions often go beyond the microethical level and range into the broader impacts that science and engineering have on society. There are many

questions, for example, that the public and other stakeholders have about whether computing and other emerging technologies are being designed responsibly, especially considering the harmful consequences that many experience from such technologies. For instance, claims of harm have been articulated in relation to the use of Facebook in Myanmar (Toh 2021). Public concern about such issues is a key reason to examine the intersection of ethics and social responsibility education.

In this chapter, we highlight recent scholarship examining the concepts of personal and professional social responsibility, connections between conceptions of professional ethics and social responsibility, and a variety of factors that may influence social responsibility development in undergraduate students. Furthermore, we discuss what could comprise a future research agenda on social responsibility education.

## 2.2 A Renewed Interest in Ethics and Social Responsibility Education

There has been a renewed interest in integrating ethics and social responsibility content in STEM education. The reasons for this are varied, but studies indicating that STEM students might not be developing a genuine sense of concern for the public's well-being are a contributing factor. Several years ago, Erin Cech's work drew specific attention to engineering education (Cech 2014). She described a "culture of disengagement" – a widespread mindset that encourages bracketing or compartmentalizing of supposedly "irrelevant" (Cetina 1999) social and ethical issues when engaging in engineering practice in favor of technical concerns alone. What can follow from this is the belief that ethical and social issues are not, by definition, engineering problems. Cech (2014) argues that this mindset is furthered by three ideological concepts common in engineering: depoliticization, sociotechnical dualism, and meritocracy. Collectively, these three concepts, she suggests, contribute to a culture where engineers might dismiss their responsibility to help address societal problems.

This type of "disengagement" from ethical or other societal issues may be visible in other areas of STEM as well. Many academic programs do not require discussion of ethical issues relevant to their discipline and treat ethics as an issue external to their field. Similar attitudes are visible in the realm of Big Tech, where a "move fast and break things" mentality has been pervasive (Lidow 2019). This mentality can include a purposeful ignorance of "externalities" such as the societal impacts emerging from technology's development and implementation. In effect, this mindset and approach can foster a de facto or even active rejection of notions of social responsibility. Intertwined with the notion that social responsibility and ethics are outside of a STEM professional's purview is the commonly held belief that technology is "value neutral" (Morrow 2014), a belief that on many occasions is an attempt to insulate designers or their employers from the consequences of the technology they have created.

In response to these and other related concerns, many scholars, academic institutions, professional organizations, and funders of research are advocating for a sincere dedication to ethics and social responsibility education (Grosz et al. 2019). "Ethics across the curriculum," for instance, is one method tried by academic institutions to introduce students to ethics through multiple courses within their program of study. Professional organizations have responded to recent calls to focus on ethics as well. For instance, the Institute of Electrical and Electronics Engineers (IEEE) has dedicated resources to examining the macroethical dimensions of intelligent systems (Adamson and Herkert 2022), while the Association for Computing Machinery (ACM) revised its ethics code in 2018 and hosts an ongoing conference series on Fairness, Accountability, and Transparency (Gotterbarn et al. 2018). The Mozilla Foundation (2017) has also supported the development of ethics pedagogy for the undergraduate computer science curriculum.

Of course, this is not the first time that STEM communities have drawn attention to the need for ethics education. In prior decades, nanotechnology (Eosco et al. 2014) and the human genome project (Dolan et al. 2022) generated much interest in ethics. Yet, the most recent round of interest in ethics education has emerged due to many factors closely tied to the digital age. This includes growing pessimism about social networks and other computing technologies (e.g., Zuboff 2023), along with questions about the role of STEM professionals who are involved in developing technologies that could harm the public (e.g., Benjamin 2019). During this era, ethics education can play a key role in challenging assumptions about the "value neutrality" of technology, especially considering that individuals and groups can be exploited with relative ease and on a global scale with the computing devices that STEM professionals design. Overlapping with calls for increasing ethics education, scholars have also argued that more attention should be given to the importance of social responsibility (Bird 2014). In fact, this book chapter comes at the conclusion of our research team's multi-year research project examining social responsibility development among undergraduate STEM students.[1] A key motivation underlying social responsibility research, including our own, is to shed light on how students develop – or fail to develop – their personal and professional social responsibility attitudes.

## 2.3 What Is Social Responsibility?

Educators and others have put forward many proposals to bolster education on social responsibility (Gangone 2022). Yet, what exactly does the phrase refer to? While "social responsibility" seems intuitive, it is a difficult concept to define precisely. Also, disentangling it from the related concept of *corporate* social

[1] Project details, publications, and research tools are available at: https://serve-learn-sustain.gatech.edu/institutional-transformation-project

responsibility, which we do not cover here, is crucial, given that the latter concept has a narrower and somewhat different scope. Furthermore, whether and how social responsibility relates to ethics is not always clear. Yet, at the broadest level, social responsibility as a concept can be understood with respect to its constituent terms. Namely, as described by Bobo (1991), who contrasts social responsibility against traditional individualistic American values, it is *social* as opposed to individualistic, implying a collective duty. One social responsibility-oriented psychometric instrument, the Scale of Service-Learning Involvement (SSLI), based on Delve et al.'s (1990) service-learning model, notes the focus on pursuing "the common good rather than…personal advancement" (Olney and Grande 1995).

The concept of social responsibility also implies a sense of obligation to act in certain ways (and perhaps to hold certain beliefs or attitudes) so as to foster the social good. Early approaches to measuring social responsibility, for example, reveal a focus on a "sense of obligation to the group" (Gough et al. 1952). Thus, social responsibility is particularly relevant as both a pedagogical and professional-oriented concept because it is action-guiding. That is, while facets of it pertain to "mere" ethical beliefs and attitudes, it is also tied to behavior. Social responsibility is, therefore, often conceived of as a "value orientation" which "motivates certain actions" including "prosocial, moral, and civic behaviors" (Wray-Lake and Syvertsen 2011).

However, several intricacies reveal that social responsibility is more complicated than it initially appears, both in terms of its grounding and implications. First, a variety of normative ethical frameworks can serve as foundations for social responsibility. Wray-Lake and Syvertsen (2011) describe it as "rooted in democratic relationships...and moral principles of care and justice," invoking theories of both care and justice perhaps influenced by Gilligan (1993) or Rawls (1971). This grounding is also critical to the theoretical foundations of Canney and Bielefeldt's Professional Social Responsibility Development Model (PSRDM) (Canney and Bielefeldt 2015a, b, c). The PSRDM directly influences our own research on social responsibility development of STEM students (Schiff et al. 2021; Kreth et al. 2022). More specifically, the PSRDM delineates three realms that comprise social responsibility: (1) Personal Social Awareness, (2) Professional Development, and (3) Professional Connectedness. These realms influenced our research approach in terms of how we sought to examine connections (or lack thereof) between the development of personal social responsibility and professional social responsibility. Details about the PSRDM and how it influenced our research approach are provided in the "Efforts to Examine Social Responsibility in STEM" section.

Yet, it is possible to ground social responsibility within still other normative ethical frameworks. For instance, consequentialism could serve as its foundation (Skorupski 1995). Alternatively, it could be grounded in deontological thinking under the notion that moral prescriptions should be universalizable to all rational agents, or by virtue ethics as the manifestation of a desirable virtue (Pettit 2000), or in still other frameworks.

These disparate groundings do not necessarily entail incompatibility, as it is possible to align practical ethical considerations without sharing the same normative

grounding. Yet, other considerations of key importance emerge, including *to whom* one is responsible. This question asks who (or what) "has standing" to be morally relevant with respect to one's own social responsibility. Even putting aside purely self-interested or egoistic notions of moral responsibility, a long history of philosophical thought has considered to what extent individuals are responsible for others, potentially including one's family, community, nation, ethnic or religious groups, the entirety of humanity, or non-human animals (e.g., Jaggar 1995; Greene 2014; Singer 1981). Further, if there are special obligations to be partial (or especially interested) with respect to one's family, local community, members of a shared social group or vulnerable sub-population, one's nation, and so on, this may delimit the responsibility to work on behalf of *other* groups (Friedman 1991). Thus, the recipients of one's responsibility, depending on the normative grounding under consideration, can range drastically.

A third key facet is the question, "*For what* am I responsible?" Social responsibility, certainly in the twenty-first century, is often cast with respect to aspects of social, economic, political, or environmental justice and injustice. Looking back, Bobo (1991) describes social responsibility as involving "a cluster of beliefs that endorse limitations to economic inequality, an obligation to meet the basic needs of all people in society, and a duty to redress unfair societal inequality" and to do so as part of "a responsibility of the social collective." Conceptualizations like this might align closely with notions of civic duty, implicitly focusing attention within national borders. A review of even older approaches to understanding social responsibility (for example, the questions developed for Gough et al.'s (1952) Personality Scale for Responsibility instrument) reveal that attitudes and actions associated with social responsibility vary widely. For example, questions in the instrument surround civic activities like voting and paying one's taxes, home-based activities like "taking care of one's aging parents," as well as more preliminary efforts like taking time to "find out about national affairs," and even broader concerns like worrying about "the rest of the world." Further, moral duties may include positive (to seek to actively benefit) and negative (to refrain from doing harm) obligations. As such, there is tremendous variation in the types of emphases and specific prescriptions that could emerge in relation to social responsibility, including variation over time and place.

From our perspective, the components contained within a given usage of "social responsibility," the extent of the implied obligations, and associated trade-offs are not always defined nor justified directly. To a great extent, how scholars define social responsibility depends on the cultural context as well as their underlying theoretical assumptions. Examining the questions in survey instruments that scholars select and the literature they decide to cite can provide a working conceptualization of what social responsibility means to them. Ultimately, though, we do not seek to resolve questions about the nature of social responsibility but note that the concept is dynamic and resists a singular and precise specification.

## 2.4 Personal and Professional Social Responsibility

Adding complexity to social responsibility's definitional challenges are the varying subtypes of the concept, including *personal* and *professional* social responsibility. Notions of personal and professional social responsibility overlap to some degree, but in important ways, they are distinct concepts. While both personal and professional social responsibility have macroethical facets to them, personal social responsibility refers to a general sense and awareness of societal problems. Professional social responsibility involves a context and action specific to one's own vocation and vocational skills.

Providing a definition for *professional social responsibility* may be an easier challenge than the broader root concept, but similar questions to those mentioned previously nevertheless apply. Is one responsible only for their own actions as a professional, those of their organization, or their profession as a whole? Are they responsible only to their clients, their local communities, national and international publics, or, say, the environment? It is worth noting here that at least some professional codes of ethics, a formal but incomplete articulation of one's professional obligations, have recently included obligations tied to macroethical issues. For example, when IEEE revised its Code of Ethics in 2020, it added a new obligation "...to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems" (IEEE 2020). What follows is one's professional social responsibilities can expand and become more complex over time.

Our research examined the distinction between personal and professional social responsibility in terms of which factors may contribute to each of their development in undergraduate students (Schiff et al. 2021). In addition, we mapped on to these two concepts the distinction between microethics and macroethics (see Fig. 2.1). While the connection between the microethical dimensions of personal and professional social responsibility is rather direct and intuitive, the connection between their macroethical counterparts may be more elusive. For example, notions of honesty from one's personal life can straightforwardly carry over to their behavior in the workplace. However, it may be a more difficult intellectual hurdle to determine how one's personal views about their broader ethical obligations to society (e.g., reducing homelessness) translate to professional contexts (e.g., software design). This connection, or lack thereof, between personal and professional social responsibility at the macroscale is something that STEM educators need to pay special attention to, especially since many students will have limited familiarity with the profession they plan to enter.

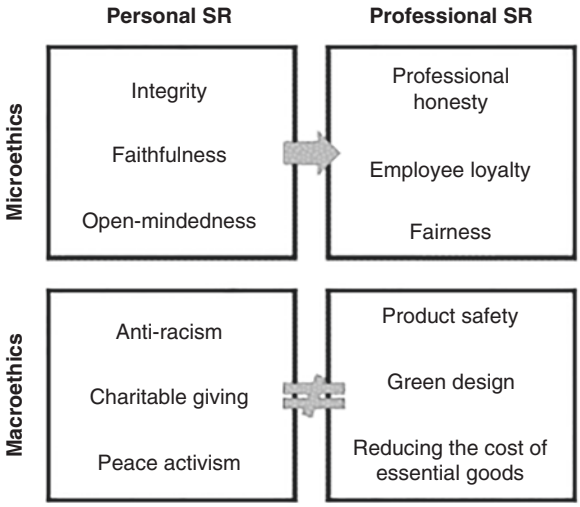


**Fig. 2.1** Mapping social responsibility, microethics, and macroethics. (Adapted from Schiff et al. 2021)

## 2.5 Efforts to Examine Social Responsibility in STEM

While many definitions of social responsibility are possible, the options narrow considerably when the focus is constrained to a specific context. Here, we primarily examine recent work on social responsibility as it pertains to STEM students and professionals. A key advancement in this realm occurred with the development of the PSRDM by Canney and Bielefeldt (2015a, b, c). They describe social responsibility as a sense "of obligation to help others as both a person and a professional, with a special focus on helping disadvantaged or marginalized populations…both a value orientation and as a guiding principle for taking action" (Canney and Bielefeldt 2015a, p. 415). Their theoretical model and associated survey instrument, the Engineering Professional Responsibility Assessment (EPRA), help to assess social responsibility development among engineering students (Canney and Bielefeldt 2016).

The PSRDM emerged through the integration of three preexisting theoretical models: Schwartz's Altruistic Helping Behavior Model (Schwartz 1977; Schwartz and Howard 1982), Ramsey's framework for social responsibility in scientific decision-making (Ramsey 1989, 1993), and the Service-Learning Model (Delve et al. 1990). The Altruistic Helping Behavior Model describes moral development in individuals and its subsequent effect on the willingness to help others, corresponding to personal social responsibility in the PSRDM. Ramsey's work discusses the obligation that scientists have to be conscientious of social needs when making professional decisions. The Service-Learning Model describes a cycle of professionals applying their professional skills to address problems in society, then developing greater conscientiousness and willingness to act; this view draws analogies to physical exercise and is related to concepts of self-efficacy (Bandura 1977).

Canney and Bielefeldt's team has pursued various lines of inquiry at the intersection of engineering and social responsibility. Among their key findings is that engineering students often have lower social responsibility attitudes at graduation than when entering college (Bielefeldt and Canney 2016a). Our research team has been strongly influenced by the PSRDM framework and adapted their EPRA survey instrument to study social responsibility attitudes across STEM fields (Schiff et al. 2021; Kreth et al. 2022). The adapted survey, the Generalized Professional Responsibility Assessment (GPRA), was used to examine social responsibility development in undergraduate students (e.g., Erwin et al. 2018). The GPRA enables cross-disciplinary comparisons; among the goals tied to its use is to better understand the effect of extra-curricular activities on social responsibility development (Schiff et al. 2021).

Within our research, we sought to identify influences and inhibitors within STEM undergraduate education. For example, we found that students pick their field of study largely because of intellectual interest rather than concerns about ethical practice or impact (Schiff et al. 2021). This suggests that educational institutions may have challenges to overcome in order to cultivate student concern about professional social responsibility. That is, if students separate their ethical concerns (e.g., inequality) from their professional development (e.g., building technical skills) and conceive of these aspects of their identity along distinct paths, deliberate efforts may be needed to bridge this personal-professional divide. In addition, our research sought to investigate similarities and differences between the development of personal and professional social responsibility. Mapping that distinction onto the one between microethics and macroethics could be important for working in the realm of ethics and social responsibility education.

## 2.6 Ethics and Social Responsibility Education

Thus far, we have discussed ethics and social responsibility as though they are interrelated concepts. Yet, the connection between them is not always clear, in part because scholars have sharply varying definitions for each respective concept. Of course, the term "ethics" on its own is subject to countless definitions. Similarly, social responsibility, which we sought to highlight previously, has many associated definitional nuances. Some might perceive social responsibility as one type of ethical consideration (i.e., social responsibility as subsumed within ethics), whereas others may think these domains overlap but are in some ways distinct from one another. For instance, under some perspectives, social responsibility might include social and political considerations that go beyond the realm of ethics.

Something that can shed light on the similarities and differences between conceptions of ethics and social responsibility would be delineating what educators envision as the respective learning objectives associated with each topic. Some common goals for ethics education are increased moral sensitivity and improved moral judgment, aims often influenced by the work of Narvaez and Rest (1995) and

Bebeau et al. (1999). Another common goal of ethics education is to lessen the chance that students will perform bad behaviors in their future professional role. More generally, the purpose of ethics education could be to nurture people so that they become virtuous citizens (Narvaez 2005). Moreover, the type of educational offering can be an important factor. For instance, a traditional ethics course focusing on philosophical foundations can have different learning objectives than a professional ethics course. In terms of the latter, Martin et al. (2021) outline the multiplicity of learning objectives in engineering ethics education, including increasing student knowledge of professional codes of ethics or conduct.

Another method for examining overlaps between ethics and social responsibility centers on the particular educational activities or interventions that are intended to foster their development. The use of role playing scenarios is a common approach in ethics courses. For many years, professional ethics courses, including in medical fields and engineering, have embraced case studies as a method for highlighting ethical decision-making complexities. A large variety of interventions have been used in engineering ethics courses (Hess and Fore 2018).

A key goal of social responsibility education is tied to fostering awareness of the particular challenges plaguing society in one's time and context, such as environmental sustainability, social justice, and inequality. Within STEM education, social responsibility themes emerge when examining issues such as privacy and data, the power of technology companies, the role of algorithms in society, and the treatment of underrepresented groups in the workforce. In recent times, social responsibility education is increasingly being tied to learning about and making progress towards the sustainable development goals put forward by the United Nations (2021).

Efforts to nurture social responsibility development frequently seek to connect students to a specific community (Bielefeldt and Canney 2016a, b; Ward and Wolf-Wendel 2000). This can take the form of service learning, or, more broadly, community engagement. That is, such activities often take place in settings outside of a classroom and aim to build relationships with a local group. In that sense, community engagement more likely involves the practice or fulfillment of one's social responsibilities as compared to a more traditional, inwardly focused form of ethics education (Bielefeldt and Canney 2016a, b).

Along these lines, Bielefeldt and Canney (2016a, b) suggest that learning through service, which combines service-learning and co-curricular community service, can be a valuable approach for teaching social responsibility. Some common learning-through-service methods include working with community partners and reflecting on the service experiences. Pedagogical approaches like problem-based learning can involve challenging students to disentangle real-world, ill-structured problems through community engagement and extra-curricular activities (e.g., Engineers Without Borders), which can be accompanied by other educational activities such as mentoring and self-reflection (Hess and Fore 2018; Wittig 2013).

In our own research, we sought to identify, through surveys and interviews, which curricular, co-curricular, and extracurricular community engagement activities students took part in and draw connections between those activities and changes in social responsibility attitudes. The activities included attending a course within or

outside of their primary discipline that contained material on community engagement or social responsibility topics, listening to campus speakers on the topic, and participating in projects that support local communities. Many of the activities had at least some affiliation with the Serve-Learn-Sustain initiative on our campus, which seeks to help students learn how to "create sustainable communities".[2]

During student interviews, we learned about the importance of family upbringing, the influence of peers, current events especially related to politics and racial (in) justice, as well as limitations associated with STEM coursework (Schiff et al. 2021). We found indications that increased community engagement is associated with growth in social responsibility attitudes over time, even controlling for pre-college social responsibility attitudes. Thus, attention to community engagement – whether through coursework or other venues – could increase student social awareness, and when associated with a student's disciplinary focus, may foster professional social responsibility.

## 2.7 Conclusion: Knowledge Gaps and Future Research Opportunities

As research into social responsibility development in STEM is a relatively new field, many knowledge gaps and opportunities for future research are in this realm. For example, it is important to consider what factors could influence the quality of community engagement experiences and their impact on social responsibility development. From our own study findings, reported in Schiff et al. (2021), students' personal and professional social responsibility seem to be strongly influenced by interpersonal interactions, particularly interactions with peers. Other components of quality and impact include the extent to which community engagement activities are collaborative, reflective, and connected to a student's discipline. Drawing from our own research experience and the literature, we identify below key research questions and knowledge gaps that could be examined during future inquiries.

Rather few studies, beyond Cech (2014) and Bielefeldt and Canney's work (Bielefeldt 2021; Bielefeldt and Canney 2016a, 2016b; Canney and Bielefeldt 2015a, b, c), focus on long-term social responsibility development within the education system, let alone after students leave college and enter the workforce. A standard approach to assessing ethical or social responsibility development makes use of a pre-post analysis of an experimental course or module. While such an approach can certainly be worthwhile and provide support for the efficacy of the particular intervention, it rarely answers the question of whether the change within a student persists over time. That is, relatively little is known about the longitudinal effects of ethics-related educational interventions during college. This problem intensifies, given the challenge of disambiguating the many influences students experience within the curriculum from

[2] For more information about Serve-Learn-Sustain at Georgia Tech, refer to: https://sls.gatech.edu/

non-curricular activities and pre-college attitudes. In particular, we suggest that more attention is needed on the extent to which co-curricular and non-curricular activities over the course of undergraduate education work together to shape student perceptions of their professional ethical obligations to the public.

Another key gap, as alluded to above, is that little is known regarding how social responsibility development during undergraduate education influences future professional behavior and practice. In general, research within the realm of ethical and social responsibility development focuses on undergraduate students; a key driving factor being that ethics education requirements are more likely to be in place at the undergraduate level. Yet, one should not assume a strong connection between at-graduation attitudes and future professional behavior. Additional longitudinal studies that follow students after they become working professionals would help close this knowledge gap. Along related lines, future studies could address questions on the extent to which social responsibility attitudes influence career choices post-graduation. Furthermore, whether and how professional social responsibility changes and develops within STEM professionals is another important but underexplored area of inquiry.

We suggest that more of a focus should be placed on whether and how professional social responsibility, especially at the macroethical level, develops within STEM students. Universities may need to take the step of actively encouraging faculty and departments to include in the STEM curriculum discipline-specific education and activities directly tied to cultivating professional social responsibility. Rigorous investigations should continue to evaluate which specific interventions foster social responsibility development. For instance, what (if any) curricular interventions can improve social responsibility attitudes? The same is true for extracurricular activities intended to foster social responsibility. Universities invest significant resources into student organizations, local and international volunteer projects, and many other activities that they hope will contribute to social responsibility development. Yet, the extent to which these activities achieve specific goals tied to ethical and social responsibility development could use the support of a fuller empirical foundation.

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