User vs. Engineer: Student Perceptions of Responsibility in Social Media

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Users and Engineers: Student Perceptions of Responsibility in the Context of Social Media

Abstract

This paper analyzes qualitative interview data from a study on engineering students' perceptions of engineering ethics and social responsibility to answer the following research question: How do engineering students view engineers' social and professional responsibilities in the context of social media? In this study, a total of 33 students from three U.S. universities were interviewed longitudinally, once in the first year of their degree and again in the fourth year. In the interviews, the students were asked about their views on the social and professional duties engineers have for the technologies they create, framed in the context of social media. Analysis of student responses involved open and axial coding of relevant interview portions performed by two researchers to identify common themes and longitudinal changes between student interviews. These themes included: communication between the engineer and user, collective responsibility, reduction in potential harm, high quality engineering, and misinformation. While students typically maintained elements of their views across both interviews, it was also common to see students change their responses in the second interview to include new themes or exclude themes present in their initial interview.

Our findings show that mentioning social media as a specific application of engineering ethics rendered visible the relationship between engineers, users, and technology that students then utilized to address the broader question about engineers' responsibility to the technologies they create. The students tended to believe that engineers have a responsibility to think through potential uses (or misuses) of their technology, but also believe that the users share some responsibility to use the technology appropriately. When social media was mentioned specifically, some students believed that the users were entirely responsible for how the technology is used, occasionally contradicting their views of engineering ethics when probed without the context of social media. This paper highlights the central tension between user responsibility and engineer responsibility. By illuminating students' views, it will support educators in opening a dialogue with their students about who is ultimately responsible for the design and use of new technologies.

Introduction

Engineers bear responsibilities to many stakeholders, including the public, their employers, and the users of their products. One such responsibility is considering and accounting for the potential impacts and risks associated with a technology that they create. A relatively new, and potentially risky, technology that has become pervasive over the past two decades is social media. In recent years, social media has been linked to the rise in misinformation [1], increased political polarization in the United States [2], negative impacts on users' self-perceptions [3], and election interference [4]. The advent of social media, including platforms such as Facebook and Twitter, and its integration into our daily lives raises questions about the duty engineers bear for

its responsible usage and design and the responsibilities users have as they interact with the technology.

In 2015, our research team launched a project to use quantitative and qualitative research methods to longitudinally explore how engineering students view ethics and social responsibility and how those views change over time [5]. We have since expanded this project to include the perspectives of early-career professional engineers [6]. In this paper, we analyze the student interviews carried out for this project to answer the following research question:

> How do engineering students view engineers' social and professional responsibilities in the context of social media?

To answer this question, we used qualitative methods to analyze first- and fourth-year engineering students' responses to a series of interview questions focused on social responsibility in engineering, including a question focused on emerging technologies such as social media. In the sections that follow, we describe both the larger research project and the methods used in the analysis highlighted in this paper. We then describe the themes that emerged from our analysis and discuss their implications.

This paper aims to expand our knowledge of how engineering students understand and allocate the responsibilities associated with one specific emerging technology, social media. By doing so, it contributes to the growing body of work focused on how engineering students perceive engineering ethics and social responsibility in the context of novel applications. This understanding will enable engineering educators to better prepare students for the ethical questions and responsibilities that they will encounter in their future professional practice.

Background

Engineering education has seen increased calls for the incorporation of ethics into engineering curricula over the past few decades [7], [8]. In response, engineering education researchers have explored how engineering students perceive engineering ethics and related concepts such as social responsibility (see, for example, Zoltowski et al. [5]). To measure students' commitment to social responsibility, Bielefeldt and colleagues have used both quantitative survey instruments [9], [10] and qualitative interviews [11]. Their work identified four "types" of social responsibility that encapsulated the varied ways that engineering students connected social responsibility to their choice of an engineering major or career [12]. Increasingly, researchers have explored how engineering students understand and respond to the unique ethical questions raised by emerging technologies [13], [14]. Debs et al. found that students most frequently cited privacy, security and balance of power in discussions of responsibility for emerging technologies [14].

Separately, researchers have described multiple ethical issues with respect to social media. Studies show that social media has been a primary source of spreading misinformation [15], contributing to an echo chamber effect and political polarization [16]. Though social media usage can be advantageous, people can suffer adverse effects if it is not used moderately [17]. Increasingly, students heavily rely on the internet and social networking sites for information. As a result, their ability to learn and conduct research has been shown to be negatively impacted

[18]. Online users tend to seek out information that aligns with their worldviews and ignore information that they disagree with, which can then lead to polarization around shared narratives. As a result, misinformation spreads quickly when these polarized groups increase [16]. Due to the unique ethical challenges of software systems in general (as compared to the ethics of other engineering applications, such as hardware products or infrastructure), educators have proposed developing ethics educational resources that are responsive specifically to the needs of software engineering students [19].

The study described in this paper adds to these bodies of work by exploring how engineering students perceive the responsibilities tied to the creation and use of one specific emerging technology, social media.

Methods

This paper uses data collected as part of a large longitudinal, mixed-methods study that examined engineering students' perception of ethics and social responsibility [5]. The study employed a quantitative survey administered to engineering students at three U.S. universities in their first, third and fourth years of their studies. During their first and fourth years, these surveys were followed by interviews with some participants, resulting in pairs of longitudinal interviews from 33 participants. The interviews were semi-structured and included questions about students' definitions of engineering ethics and ethics in general, their perceptions of the ethical climate at their universities, and their beliefs about the responsibilities of engineers. The interviews also prompted students to explain some of their answers to particular survey questions. All of the participant names presented in this paper are pseudonyms assigned to the student for anonymity and ease of longitudinal tracking.

The interview question that we focused on for this study probed the students to explain their responses to an initial survey question which asked them to indicate how much they agreed or disagreed with the statement: "Surprising and risky uses or new technologies, such as social networking websites, are completely the responsibility of people who use them." The options on the survey ranged from strongly disagree to strongly agree.

To analyze these data, an initial round of open coding was performed by two members of our research team with the goal of identifying themes that were immediately present in the data, such as "improvement of society" and "helping people." These codes were rooted in the participant language to ensure accuracy of representation. A second round of axial coding was then performed by the same researchers to find similarities between some of the initial codes with the intent to consolidate the themes. For example, the initial codes mentioned previously, "improvement of society" and "helping people," became part of the final code, "reduce potential harm." The development of the final codebook was done collaboratively by the two researchers. Although the majority of codes selected to be presented in this paper were based on their prevalence within the data, the code of "misinformation" only appeared in two student responses but was included due to the relevance of misinformation to the discussion of social media responsibility.

It should be noted that the terminology surrounding social media has evolved since the beginning of this study. In 2016, when the first round of interviews was completed, "social networking"

was the commonly used term as opposed to "social media." Since then, social networking has fallen out of common use and the term social media has become more common. For the purposes of this paper, we use social networking and social media interchangeably.

Findings

There were five major themes that were apparent in the data: collective responsibility, communication between the engineer and user, misinformation, high-quality work, and reduction in potential harm. These themes were present in both the initial (T1) interviews and the follow-up (T2) interviews, but individual participants lacked the consistency between interviews to adequately assess longitudinal changes. Instead, we focus on the content and quality of the response rather than how participants' answers change over time. Findings connected to each of these five themes are presented below.

Collective responsibility

Collective responsibility was a consistent theme that appeared in 62% of answers (41 of 66) given by the students across both T1 and T2 groups. This code was assigned when the student indicated that the responsibility for social media lies with both the user and the engineer. One student, Bagheera, referenced user agreements in his T1 interview as one example of this collective responsibility:

> That one's tricky. I would say that the engineers, or the developers of the technology are kind of opening a can of worms. It's a tool that a lot of people can use. In designing their terms of use agreements, they have to be careful to make sure that it's written in such a way that users can't use it in detrimental ways. Facebook doesn't allow sexual content or bullying or excessive profanity, which I think is a good example of […] fulfilling their part. Users obviously have the obligation to abide by those terms and conditions and to use it within its intended realm.

Here, Bagheera described the user agreement as an example to illustrate how the responsibility of social media lies between both the engineer and the user. He saw the engineer as having the role of preventing malicious uses of the technology while the user has the role of promising to abide by the terms and to not attempt such actions. To students like Bagheera, the user agreement is the document that outlines the shared responsibility of both parties and how the expectations will be upheld.

The theme of collective responsibility was also identified outside the context of user agreements. Palano shared the same sentiment as Bagheera, but without the framework of the user agreements. Palano's response instead focused on the dual responsibility of the consumers and the company creating the technology. He explained this by focusing on the topic of Facebook and clickbait posts: "There were completely fake websites being posted and shared. That is the consumer to some degree, but it also should be the responsibility of the company that it's being shared on to help sift through that and find falsities." Like Bagheera, Palano shared this view of a collective responsibility – that both the consumer and the engineer are responsible for the actions taken in social media like Facebook. There is a give and take from both sides such that, if a fault

were to occur, the blame would not solely lie on one side. In essence, the idea of collective responsibility is a widely shared concept that focuses on both the engineer and the consumer that was emphasized heavily by the students.

While a sense of shared responsibility was far more common, a minority of participants (7 of 66) believed that the use or misuse of social media was entirely the responsibility of the user. One example came from Carlos in the context of Facebook data leaks.

> [P]eople go ahead and put all their stuff on the internet. They put their credit cards and stuff on Facebook. They put all their personal pictures and all their personal thoughts and feelings and emotions on Facebook and then they get so offended when it's hacked. I was like, "What else did you expect?"

Despite personal information being leaked by security flaws, Carlos believed that the users were foolish to trust the platform with that sort of personal information in the first place. The user needs to understand there is a risk associated with the use of social media platforms and that if something goes awry, that is part of the risk the user accepted when they agreed to use the platform. This sentiment of accepting the risk of use was echoed by other participants, though many of the students still held the view that the social media company needs to provide some level of protection from potentially dangerous materials. Cody described how Facebook has a responsibility to remove extremely violent material, but not necessarily everything that can be perceived as negative.

> [T]he designers have just, created a platform for people to use, and I don't think they really have that much of a responsibility for how people use that platform, unless they [pause] I will say that if it goes into the realm of actually inciting violence or something like that, like an ISIS page on Facebook, that goes too far. But if people want to argue all the time and call each other names online, I don't think it's really the responsibility of the people who made it.

Cody claimed that social media platforms do have a responsibility to remove content that can lead to real-world harm while he simultaneously claimed the platform has no responsibility to police less severe negative content. His response highlights how engineers may not have a responsibility for each individual action taken on their social media platform, but they do have a responsibility for making their product safe in a broad sense.

Communication between the engineer and user

Communication between the engineer and user is another prominent code in the students' responses, appearing in 44% (29 out of 66) of responses. To the students, this included the values of honesty and transparency between the engineer and the user. Petunia specifically highlighted honesty when discussing the promises social media companies make: "They're promising to offer you a protective, safe service, and if you're not getting that service from their end, that's the company's fault for making false claims that what they made is safe and good for use." As Petunia pointed out, truth is expected from companies and their engineers when they advertise specific services. When there is a lack of honesty, the trust between the consumer and the

engineer is broken. Students like Petunia value the clear communication that flows from the engineer and the user, emphasizing it when technology like social media is in use.

With regards to transparency in social media usage, user agreements came up again, as mentioned by the student Cameron, when he highlighted the importance of transparency for both entities.

> …When one signs up for a social media website, they have an idea what they're getting into and ideally, they read the terms and conditions and whatnot. In that aspect, I believe the consumer should be aware of what they're doing, why they're doing it, and the effects on themselves…The engineers who designed it should not be trying to sell your information, purposely sabotage you into believing [things] that aren't true or whatnot.

Cameron illustrated the importance of transparency in the usage of consumer information and trust. Here, Cameron focused on how the communication should be clearly defined. He believes that the consumer should expect some transparency in the terms and conditions of the platform regarding user expectations and their data privacy. In their responses, both Petunia and Cameron valued the honesty of engineers' and the clear communication of information.

Misinformation

Misinformation is a topic that was described briefly by two students but only named by one student. The student who explicitly mentioned it, Corvin, was previously the focus of another case study analysis (Claussen et al., 2020). During one of his interviews, Corvin highlighted Facebook and Instagram and their responsibility to maintain truth in social media: "I believe Facebook, Instagram, all those social networking sites, I do believe that they have some responsibility to basically show that what's being put out there is truthful and not harmful to the general public, like misinformation, things like that." This responsibility to prevent or stop misinformation relates to the previous code, when students emphasized the importance of communication between social media's users and engineers. As a result, the engineers are expected to prevent falsities from spreading on their technology.

Despite the low number of participants that mentioned misinformation, we felt it was important to include because it does tie deeply into the conversation about engineer and user responsibility. The central question of this paper is exemplified by the debate over the engineer's role in curtailing misinformation. Are users responsible for not posting or believing misinformation, or are engineers responsible for the moderation of misinformation on their platform? This question becomes especially relevant when discussing issues of censorship and internet safety, which are beyond the scope of this paper.

High-quality work

Quality in the technology made by the engineer is a theme that appeared in 47% (31 out of 66) of the interviews. This theme mainly emphasizes the quality of the work done by the engineer, such as the assurance that the end product will work as intended and do so safely. The quality of work as defined here is also related to the effort engineers put into their creations. Christiano summed

up this idea well when asked about an engineer's responsibility to their technology in the context of social media:

> [Engineers] have the responsibility of making sure that everything's fine, it's not going to malfunction, simple stuff like that that should happen, should be taken accounted for, and I feel like that's what makes a good engineer, like they can account for what's good and what's bad and what they develop.

For students like Christiano, the quality of the work that the engineers bring to the public is what is the most important. The engineers are to uphold a high standard and as a result, their work is expected to be of top quality. This focus on quality continues to be a prevalent topic even in the later years for students as exemplified by student Beverly who echoed Christiano's thoughts in her second interview when she stated:

> Responsibilities [pause] I think it's our responsibility to be [pause] to come up with or develop the best product we can to do a task. As I said, it's not [pause] we're not always gonna see it start to finish, but if we did our best then that's good. I mean, it might not have been the best that somebody else can do, but if we put forth our best, I think that's our responsibility.

Here, Beverley equated quality with the effort the engineer puts into their technology. For Beverly, doing one's "best" is most important. These students focused less on who bears the responsibility or the hidden messages in user agreements, and more on the quality of effort put forth by the engineers and the excellence of the product. They emphasized that high-quality technologies can only be created when sufficient energy and effort has been placed onto the product.

Reduce potential harm

One of the most frequently used codes focused on the idea of reducing the potential harm done by a technology, appearing in 44% (29 out of 66) of responses. Students stated an expectation that engineers ensure that their work has as few negative impacts as possible while also providing the benefit that the technology was initially intended to produce. They expected engineers to be aware of how much their creations may affect those around them, which relates to the "high quality" code described below. They also expected engineers to find solutions to problems that arise in their technical work. For example, Bosco emphasized the importance of considering the impacts of a technology when he described an engineer's responsibility on social media:

> If an engineer is developing something, and they know it can negatively impact someone in such a way, and they just send it out there, someone might naively use this product, not aware of that. So I think that is the engineer's responsibility to make sure these [negative impacts] are either made aware of [*sic*] by the people that are using them, that there's this risk of this happening, or not develop something if it [pause] especially if it's not something necessary.

In this instance, Bosco highlighted the importance of engineers working to prevent negative impacts to users, with a focus on making the users aware of potential downsides to a technology. There is a distinction to make here between preventing negative impacts to users and creating a benefit to them. The relationship between the two is close, but Bosco discussed the reduction in potential harm. He claimed that engineers have a responsibility to their technology to understand and predict the negative impacts before it reaches the end user.

The participant Paulina focused on engineers continually bettering their technology as a means of helping their community. Paulina mentioned specifically how feedback is the key to the advancement of technology and the importance of such feedback to the public when discussing the role of engineers in social media: "I don't think anybody expects the first iteration of anything to be perfect. And that's why we always have updates and that's why we always have new versions to point out. Use that feedback to make things better." In contrast to Bosco, Paulina did not expect engineers to be prepared for everything, but she did expect them to be continuously improving and to adjust based on past failures. Paulina's focus was on using learning from previous creations to develop better, more efficient technologies. This combination of efforts to prevent negative impacts and a readiness to improve create a responsibility beyond simply harm reduction, but to actual ensure the technology is benefitting the user.

Discussion

Overall, many participants described a sense of shared responsibility in the use social networking websites. The engineers were expected to anticipate potential misuse, such as misinformation, as well as work towards creating a quality product that benefits the users. There was also an expectation that communication between the engineer and users is transparent. This could be done through means such as making the terms of service for social networking websites written in a clear and understandable manner. In return, users are expected to abide by those terms and conditions, as well as not contribute to the misuse of the technology, such as the spreading of misinformation. Despite the focus on shared responsibility, most of the examples provided by students focused on the engineers' responsibility. This could be a result of the framing of the interview question, which asked if the participant agreed or disagreed that surprising uses of new technologies are entirely the responsibility of the people who use them. This framing may have potentially led the participants to think of reasons it is not *entirely* the responsibility of the people who use them.

The themes present in student responses remained fairly consistent between the first and second interview, but there was a notable lack of connection with individuals' first and second interview responses. Some participants mentioned similar themes in both interviews while others did not address the same themes from their initial responses. The inconsistency of which themes were present in student responses suggests the longitudinal data did not show individual change, but rather highlighted aspects of how the participant thought about the question in that particular moment. For example, Cameron mentioned that engineers would should not cut corners to save money in his first interview, coded as related to high-quality engineering work in this study, but in his second interview, he focused on transparency and ensuring the product is limited in its negative impacts. The quality of the product and clear communication and intentions are not mutually exclusive, so it does not demonstrate that Cameron had a significant change in

perspective. Most likely, the disparities between the interviews are based on how the student was feeling at that particular instant, and thus has no clear pattern of change.

When discussing the collective responsibility that was a major theme for most of the participants, who bears part of that collective responsibility is an important factor. There is an interesting dynamic in the participant responses with how they viewed the relationship between the engineer and the user versus the engineer, company, and user. For some students, the responsibility relationship was between the individual engineer and the end user of their product. For others, the company was a third party that the engineers also had to interact with. This dynamic of engineer and employer is especially relevant with social networking websites that are created by companies with thousands of employees and provide little opportunity for an individual engineer to make sweeping changes across the platform.

The age of the participants and the timing of the interviews could also play a major role in how the participants responded to the interview questions. All of the participants come from a generation of people that have been exposed to social media throughout their teenage years. This could foster a sense of familiarity with the concept of social networking and how it is used in daily life. Had the participants been older and not used social media until they were adults, their responses may have been different. Similarly, if the participants had used social media from an even younger age, they may have different perspectives. The first round of interviews occurred in 2016 and the second round in 2019. Changes in social media culture may have impacted student responses and framed how they perceive social media responsibility. The social media landscape is always changing and evolving as users change, new social networking websites appear, and legacy social networking websites adjust their practices.

The work of Debs et al. (2022) on students' perspectives about the ethics of emerging technologies is relevant to this work, with some notable differences between our results and theirs. A key difference is that Debs et al. focused on ethical reasoning processes and connecting new technology usage to the student participants' professional lives, while we were more focused on identifying themes related to responsible engineering of social networking specifically. We defined social networking websites as a risky and new technology in the interview question, but in Debs et al., participants would mention social media companies in the context of broader themes like the relationship between corporate profits and engineering work. A shared theme between both papers, however, is the role of users in responsible usage of technology. Our participants focused on topics such as terms of service and shared responsibility when discussing user responsibility. The participants in Debs et al. also mentioned terms and conditions, but their data suggests that participants were more aligned with corporate interests than the end users [14].

Conclusion

This paper shows that students are have an understanding of how engineers and users share responsibility for the use of new or risky technology, especially in regards to the use of social media websites. In addition to the sense of shared responsibility, the students also expressed the importance of clear communication with the users, high-quality engineering work, reduction of the potential for harm, and how misinformation is managed. While longitudinal changes were

not clear enough to present in this study, the consistent presence of the themes in both T1 and T2 interviews show the consistency of the types of ethical concerns associated with new and risky technology.

One of the limitations of this study is that it was primarily focused on social networking websites. Social networking websites primarily host user-generated content, such as text posts and video uploads. The engineers provide the platform, but ultimately the users are the people creating most of the content on the websites. The user/engineer relationship present in social networks is more fluid than the physical goods that other engineers might create because of their constant interaction. Social media is also a controversial and politicized topic. A research participant's political ideology around topics such as free speech could have affected how they viewed responsibility specifically in the context of social media. Alternatively, the newness of social media as a technology could be the reason behind the contention between engineer and user responsibility.

One potential way to determine if the shared responsibility described by students is unique to social media is to see if participants' responses during the interviews changed before and after social media was mentioned. Our interview question included social media into the phrasing, which primed the participants to think about risky and new technologies in the frame of social media. While social media can be seen as risky and new when the study first began in 2016, the technology has since become a part of our daily lives. There is currently an analogous discussion that can be made around algorithms and artificial intelligence (AI) and how what responsibility the developers have in its use. Martin (2019) argues that algorithms have become so ubiquitous in our lives that their value-laden nature has real-world moral consequences [20]. In a future study, participants could be asked about responsibility for emerging technology in a general sense, then as follow-up ask in the context of social media to see if their answer changes. Additionally, the participants could be asked about risky technologies outside of the realm of social media to see if their responses change because of the specific technology in question, such as algorithms, AI, or a technology related to their engineering discipline.

There is an opportunity to connect this paper to real world application in teaching ethics to engineers, specifically software engineering in the context of social media. Some of the challenges in teaching software engineering ethics highlighted by Grubb (2021) are the disconnected nature of examples and how vignettes limit exploration [19]. Social media provides a concrete area where software engineering and engineering ethics intersect. The concept of user versus engineer responsibility could be used in a teaching application to encourage students to think about these issues from a variety of viewpoints and to understand how their work impacts the real-world.

Acknowledgements

References:

[1]   H. Allcott and M. Gentzkow, "Social Media and Fake News in the 2016 Election," vol. 31, no. 2, pp. 211–236, 2017.

[2]   J. A. Tucker, A. Guess, and C. Vaccari, "Social Media , Political Polarization , and Political Disinformation : A Review of the Scientific Literature," no. March, 2018.

[3]   J. Fardouly and L. R. Vartanian, "Social Media and Body Image Concerns : Current Research and Future Directions," *Curr. Opin. Psychol.*, vol. 9, pp. 1–5, 2016, doi: 10.1016/j.copsyc.2015.09.005.

[4]   G. Eady, T. Paskhalis, J. Zilinsky, J. A. Tucker, and R. Bonneau, "Exposure to the Russian Internet Research Agency foreign in fl uence campaign on Twitter in the 2016 US election and its relationship to attitudes and voting behavior," *Nat. Commun.*, vol. 14, no. 62, 2023, doi: 10.1038/s41467-022-35576-9.

[5]   C. B. Zoltowski, B. K. Jesiek, S. Claussen, S. J. Howland, D. Kim, and S. Nittala, "Foundations of Social and Ethical Responsibility Among Undergraduate Engineering Students : Overview of Results Foundations of Social and Ethical Responsibility Among Undergraduate Engineering Students : Overview of Results Introduction," *ASEE Virtual Conf.*, 2020.

[6]   S. Claussen, S. J. Howland, S. Nittala, B. K. Jesiek, and C. B. Zoltowski, "Longitudinal Qualitative Case Study of One Engineering Student's Perceptions of Ethics and Social Responsibility: Corvin's Story," *ASEE Annu. Conf. Expo. Conf. Proc.*, 2021.

[7]   A. Colby and W. M. Sullivan, "Ethics teaching in undergraduate engineering education," *J. Eng. Educ.*, vol. 97, no. 3, pp. 327–338, 2008, doi: 10.1002/j.2168-9830.2008.tb00982.x.

[8]   J. L. Hess and G. Fore, "A Systematic Literature Review of US Engineering Ethics Interventions," *Sci. Eng. Ethics*, vol. 24, no. 2, pp. 551–583, 2018, doi: 10.1007/s11948-017-9910-6.

[9]   N. Canney and A. Bielefeldt, "A framework for the development of social responsibility in engineers," *Int. J. Eng. Educ.*, vol. 31, no. 1, pp. 414–424, 2015.

[10]   A. R. Bielefeldt and N. E. Canney, "Changes in the Social Responsibility Attitudes of Engineering Students Over Time," *Sci. Eng. Ethics*, vol. 22, no. 5, pp. 1535–1551, 2016, doi: 10.1007/s11948-015-9706-5.

[11]   G. Rulifson and A. R. Bielefeldt, "Evolution of Students' Varied Conceptualizations About Socially Responsible Engineering: A Four Year Longitudinal Study," *Sci. Eng. Ethics*, vol. 25, no. 3, pp. 939–974, 2019, doi: 10.1007/s11948-018-0042-4.

[12]   G. Rulifson, A. R. Bielefeldt, and W. Thomas, "Understanding of social responsibility by first year engineering students: Ethical foundations and courses," *ASEE Annu. Conf. Expo. Conf. Proc.*, 2014.

[13]   P. de Vries, "The Ethical Dimension of Emerging Technologies in Enigneering Education," *Educ. Sci.*, vol. 12, no. 754, 2022.

[14]   L. Debs, C. M. Gray, and P. A. Asunda, "Students' perceptions and reasoning patterns about the ethics of emerging technology," *Int. J. Technol. Des. Educ.*, vol. 33, pp. 143–163, 2021, doi: 10.1007/s10798-021-09719-w.

[15]   K. S. Lee, H. Wei, and K. S. Lee, "Design Factors of Ethics and Responsibility in Social Media : A Systematic Review of Literature and Expert Review of Guiding Principles Design Factors of Ethics and Responsibility in Social Media : Principles," *J. Media Ethics*,

vol. 37, no. 3, pp. 156–178, 2022, doi: 10.1080/23736992.2022.2107524.

[16]   M. Cinelli, G. De Francisci, A. Galeazzi, and W. Quattrociocchi, "The echo chamber effect on social media," *PNAS*, vol. 118, no. 9, 2021, doi: 10.1073/pnas.2023301118/-/DCSupplemental.y.

[17]   S. Siddiqui, "Social Media its Impact with Positive and Negative Aspects," *Int. J. Comput. Appl. Technol. Res.*, vol. 5, no. 2, pp. 71–75, 2016.

[18]   W. Akram and R. Kumar, "A study on positive and nagative effects of social media on society," *Int. J. Comput. Sci. Eng. Open Access*, vol. 5, no. 10, pp. 347–354, 2018, doi: 10.26438/ijcse/v5i10.351354.

[19]   A. M. Grubb, "Four Opportunities for SE Ethics Education Four Opportunities for SE Ethics Education," *Comput. Sci. Fac. Publ. Smith Coll.*, 2021.

[20]   K. Martin, 'Ethical Implications and Accountability of Algorithms', Journal of Business Ethics, vol. 160, pp. 835–850, 12 2019, doi: 10.1007/s10551-018-3921-3