

Teaching Multidimensional Ethical Decision-Making through a Role-Play Case Study

Shruti Mehta
Information Sciences and Technology
George Mason University
Fairfax, USA
smehta23@gmu.edu

Ashish Hingle
Information Sciences and Technology
George Mason University
Fairfax, USA
ahingle2@gmu.edu

Aditya Johri
Information Sciences and Technology
George Mason University
Fairfax, USA
johri@gmu.edu

Abstract— In this research-to-practice paper, we present a study examining how role-play case studies can teach technology students multidimensional ethical thinking on broad, everyday uses of algorithms and technology. Given the complexity of most engineering objects and systems, students need to be able to think not only from a technical or social perspective when it comes to ethical and responsible development and use but also to incorporate an awareness of environmental and sustainability concerns. To enable students to think in this multidimensional manner, we developed a role-play case study that explores different aspects of using e-scooters on a college campus. E-scooters are commonly available across the US on many college campuses, and it is not uncommon for students to have experienced using them or being in an environment where they are frequently used. The case study explores aspects of using e-scooters on campuses considering the technical, social, policy, and sustainability issues. The role-play activity encourages students to work collaboratively with their peers to understand the case study, raise concerns, and ultimately reach a consensus on the future use of the technology. The goal is to get students to recognize ethics in play in everyday spaces. To support this goal, open-ended data were collected from six student teams (6-7 students per team) with a total of 39 students and analyzed using a thematic analysis approach. Students learning about the case were supported through the use of academic and industry resources and frameworks. We found that students expressed a range of ethical concerns and were able to identify dilemmas and value tensions that are inherent in technology use. Thematic analysis of student discussions demonstrated students' uptake of ideas about dignity, well-being, sustainability, regulation, and convenience with reflection, among others. The data highlights students developing empathy and ethical perspectives by taking on a role, "being," and negotiating from a character's viewpoint and motivation.

Keywords: *ethical thinking, engineering education, role-play case study*

I. INTRODUCTION

A. Background

The idea of teaching ethics in engineering classrooms stems from the moral complexity that engineering tasks pose. According to Martin & Scherzinger [1], engineering ethics address responsibility, professionalism, codes, safety,

truthfulness, technology, and environmental ethics. The study presented in this paper adds to the work in engineering education that addresses the need for a technical workforce that can understand, address, and mitigate ethical issues arising from advancements in cyber-human systems. Engineers largely work as part of organizations. Consequently, ethical decisions are also strategic and business decisions that shape engineers' ethical mindset. This study uses multidimensional marketing, strategy, and ethical tools to design a case study and facilitate ethical decision-making.

B. Study Aims

In this study, we investigate the effectiveness of a case study designed to teach engineering students a multifaceted approach to ethical decision-making. Specifically, we examine how frameworks related to the ethics of artificial intelligence (AI), such as *TPESTRE* (defined below), can guide the design and use of pedagogical innovations such as a role-play case study.

II. LITERATURE REVIEW

A. Dilemma and decision-making

We live in a digital society that uses innovations from technology. The ubiquitous nature of products and services, scale, and influences have forced unforeseen ethical dilemmas, and both scholars and industry consider and question these ethical and moral consequences [2].

While ethical decision-making and reasoning are important for engineering and computing professionals that design and deal with new technologies, many students find ethical issues abstract [3]. Ethical theories, frameworks, and organizational practice tools have been used in classrooms [4]. Ethical-decision making has also been discussed as a stepwise procedure by making parallels with the engineering design process [5]. This first step is identifying relevant moral factors that understand the concept and claims behind an ethical choice. Next, the ethical dilemmas and conflicting moral responsibilities are identified and understood. This is followed by consideration for moral theories and an alternate course of action. After obtaining alternative perspectives, a final decision is made for a problem. However, while making such decisions, the stance of all stakeholders related to the problem must be considered [5].

B. Role-play case studies to teach ethics

As case studies encapsulate real-world issues and dilemmas, they are often used in ethics, law, and business. In engineering, case studies help focus on problems at the workplace or examine a large-scale project or disaster [6]. Case studies help expand perspectives by investigating sociotechnical aspects of engineering practice through contextualizing students' understanding. Students get to examine real and hypothetical situations and ethical dilemmas while understanding the importance of engineering decisions and their effects on public safety and security [7]. The "Relatability" of case studies makes recognizing ethical issues convenient and facilitates decision-making [8]. Therefore, due to its situated learning element, case studies, particularly role-plays, allow students to explore many sides to a problem and develop multiple perspectives facilitating decision-making through collaboration and consensus with peers [9],[10]. A well-designed case study helps identify morally relevant factors like the principles that govern the situation, long-term and short-term consequences, vices, and virtues of a decision. The skills acquired in the process can be used to identify ethical issues in similar real-life situations [11].

C. Multidimensional framework

Engineering decisions like the implementation of micro-mobility devices are centered around technology. However, their impact extends beyond technical aspects, considering categories of environment, economy, society, and travel behavior [12]. Also, as engineering practice occurs as a part of industry innovations or government resolutions, an inherent strategic component attaches business, political and legal considerations, expanding the scope of engineering practice beyond technical. Therefore, business, and strategic tools, like *PESTEL* and *SWOT*, have been used in engineering classrooms to help engineers develop a multifaceted lens to view technical problems [13],[14].

PESTEL is an acronym that stands for Political, Economic, Social, Technological, Environmental, and Legal [15]. *PESTEL* tools help businesses analyze the viability and impact of new services and technology [13]. Hoople et al. [14] utilized the *PESTEL* framework to teach sociotechnical ideas about energy from a multidisciplinary perspective. *PESTEL* has also been used to conduct a multidimensional analysis to understand the suitability of micro-mobility technology using an e-scooter renting case study. The analysis evaluated the business decision of scattering electric scooters at charging points in the city and offering them on demand for a mobile app [13].

Expanding the scope of *PESTEL*, Gartner [16] developed the 'Tapestry' *TPESTRE* tool, which includes ethics and regulation for strategic planning focusing on technological innovation and research. The need for a new framework comes from considering digital transformations and disruptions that could inform organizations' decisions. The framework consists of 7 trends or categories -- Technical, Political, Economic, Social/Cultural, Trust/Ethics, Regulatory/Legal, and Environmental. The Ethics trend/category deals with ethical expectations, duties, and biases of people and organizations, while the Regulatory

component talks about changes in laws and government policies and regulations to reward behavior.

AI and digital technologies are integral to e-scooter operations and user experience. AI-powered algorithms are used in e-scooter fleet management, collision detection, and speed regulation. Other digital technologies like IoT are used to enhance the user experience by providing real-time information about e-scooter availability, location, and payment. Discussing data privacy, security, and algorithmic bias concerns is essential. "Ethical Framework for Artificial Intelligence and Digital Technologies," developed by Ashok, Madan, Joha & Shivajah [17], discusses the impact of digital ethics implication on society. The authors identify the ethical implications of digital technology archetypes on society, like accountability, fairness, autonomy, and privacy. These implications are grouped under inter-related physical, cognitive, information, and governance domains. These domains impact organizations dealing with digital archetypes and society in general. We adopt ethical themes from the framework that aids in the design of the case study and in assessing students' ethical decision-making.

- Privacy – deals with the implications of access, rights to personal data, consent, and safety. Concerning big data collection, privacy deals with the idea of safety from surveillance under the non-maleficence AI principle [17]
- Safety – is the protection against physical harm from AI-enabled tech [17]. It has implications to mitigate against actions that could cause accidents and physically harm the users.
- Sustainability – With a positive outlook for future generations, sustainability is concerned with the impact of new digital technologies for the environment, public goods, and society in general [17]
- Accountability – Defined as "the ethical sense of who is responsible for the way AI works" [18]. It deals with figuring out who is responsible for algorithmic decisions and discusses ideas of liability and culpability.

Other frameworks like the 'AI ethics guidelines in a global context' identify five ethical principles: transparency, responsibility and privacy, and sustainability [19]. An important theme of transparency can be adopted from this framework.

- Transparency relates to acts of communication and disclosure. The principle relates to dialogue, participation, and principles of democracy. Transparency with the use of AI technologies fosters trust.

III. RESEARCH STUDY

A. Context of the study

The role-play exercise was conducted at the College of Engineering and Computing at a large public university in the United States. The study was conducted in a technology and society course with 39 predominantly junior and senior-level (3rd and 4th year) undergraduate students majoring in technology courses (computer networking, information technology, cybersecurity). Students participated in the role-play in groups of 6-7 students. Students were given the readings based on the case study to prepare for the role-play.

Pre- and post-class assignments helped students prepare for the exercise and helped articulate their learnings, respectively. The research study was approved by the Institutional Review Board (IRB) of the home institution.

B. Use of E-scooters on college campuses- Role-play design and implementation

The case study was aimed at encouraging students to think of an infrastructural decision of whether to favor or not the use of e-scooters on university campuses. E-scooters are motorized stand-up scooters powered using a small electric or internal combustion engine. The scooters are used as means of micro-mobility as a convenient alternative to traditional gas-powered vehicles [20]. However, the real impact and utility of e-scooters is contested. Also, college administrations have recently banned scooters due to safety concerns [21],[22]. The e-scooters case presents ethical dilemmas concerning the supply chain and consumer well-being [23].

TABLE I. CASE STUDY MAPPED TO TPESTRE FRAMEWORK

Role Title	Role Description	Mapping to TPESTRE framework
A, Co-founder and CEO of RideBy, an e-scooter company	A is interested in personal transportation and new forms of energy. A was a chemical engineer, working for alternative fuels, particularly batteries. He believes RideBy could make a difference to the environment.	Technological Environmental Economical
B, Professor of transportation engineering and expert on mobility systems	B studies the use and abuse of e-scooters in urban areas. B also studies the effect of e-scooters on the environment.	Technological Environmental Social
C, Director of Transportation for the local county	Having lived in Germany and the US, C can compare the transportation systems in both countries. C investigates issues of regulations, insurance, and rules relating data sharing by vehicles and apps.	Technological Regulatory /Legal Trust/Ethics Social Political
D, Director of Infrastructure and sustainability on campus	D looks into the space and sustainability dimensions of campus development. She is also concerned with the campus infrastructure, making it an accident-free zone and keeping it off litter.	Technological, Environment, Ethics/Social
E, Heads a student interest group focused on autonomous vehicle development and use	The group members are interested in the technical dimensions of mobile solutions and policy issues surrounding implementation. E is a computer science major.	Technological, Ethics/Trust, Social, Regulatory /Legal
F, Head of accessibility services	F is responsible for technology and infrastructure support for the campus community members.	Social, Trust/Ethical
G, Head of Maintenance and Safety on Campus	G is concerned with accidents and littering on campus.	Social, Regulatory /Legal

The case study is set on a college campus where a reporter who recently witnessed an e-scooter accident wishes to understand and write about using e-scooters on campus grounds. The reporter invites a focus group of representatives from around campus, including students, faculty, staff, and a few external stakeholders. This is followed by a discussion on issues of mobility, convenience, accessibility, data privacy, and pollution, among other things. The case, therefore, presents a multistakeholder approach to discussing a decision that could affect the campus community. (See Table 1)

TABLE II. PRE -CLASS READINGS BASED ON THE TPESTRE FRAMEWORK

References to Readings and Videos Assigned to Students	Mapping to TPESTRE framework
Hilty, Lorenz; Lohmann, Wolfgang; Huang, Elaine M (2011). <i>Sustainability and ICT - An overview of the field</i> . <i>Notizie di Politeia</i> , 27(104):13-28.	Environmental, Technological
Johnson, Perry (2019) <i>A Bird's Eye View: How Machine Learning Can Help You Charge Your E-scooters</i> . Towards Data Science. https://towardsdatascience.com/a-birds-eye-view-leveraging-machine-learning-to-generate-nests-30dd2136a839	Technological
Hayat, Shifa & Fast, Victoria (2019) <i>Classifying and Mapping Accessibility on Post-Secondary Campus</i> . <i>Spatial Knowledge and Information Canada</i> , 7(5), 3	Social
Larkins, Kelly; Dunning, Anne & Ridout, John. (2011) <i>Accessible Transportation and the Built Environment on College Campuses</i> . <i>Transportation Research Record: Journal of the Transportation Research Board</i> . 2218. 88-97. 10.3141/2218-10.	Environmental, Social
Johnson, Jeremiah (2019) <i>Are Shared e-scooters good for the planet? Only if they replace car trips</i> . The Conversation. https://theconversation.com/are-shared-e-scooters-good-for-the-planet-only-if-they-replace-car-trips-121166	Environmental, Technological
Daniel Schellong; Philipp Sadek; Carsten Schaezberger, & Tyler Barrack. (2019). <i>The Promise and Pitfalls of E-scooter sharing</i> . BCG. https://www.bcg.com/publications/2019/promise-pitfalls-e-scooter-sharing	Economical
Namiri, Nikan; Lee, Austin; Amend, Gregory ;Vargo, Jason & Breyer, Benjamin. (2021). <i>Impact of alcohol and drug use on bicycle and electric scooter injuries and hospital admissions in the United States</i> . <i>Trauma</i> . 1-9. 10.1177/14604086211044353	Regulatory/ Legal
Rabino-Neira, Maria. (2019) <i>E-scooters and human rights: What are the ethical dilemmas in their supply chain and in consumers' wellbeing?</i> <i>Business & Economics, Referee</i> University of Auckland	Economical, Environmental, Regulatory/Legal, Trust/Ethics, Social
Lekach, Sasha (2018) <i>E-scooters aren't getting stolen, the real issue is sidewalk litter</i> <i>Mashable</i> . https://mashable.com/article/electric-scooters-sidewalk-litter	Regulatory/Legal
Bradshaw, Tim (2019) <i>Electric scooters battle to prove 'green' worth</i> . https://www.ft.com/content/cd6fcae8-28a6-11e9-9222-7024d72222be	Environmental
Penalosa, Enrique (2023) <i>Why buses represent democracy</i> TEDCity2.0 https://www.ted.com/talks/enrique_penalosa_why_buses_represent_democracy_in_action	Political Environmental

The roles were planned to include one or more components of the TPESTRE framework. The readings and preparation material for the case study were also based on the TPESTRE framework to develop a multidimensional viewpoint about the case study. In this way, students were primed to think about TPESTRE elements through roles and readings. (See Table 2).

C. Assessing students' understanding of multidimensional ethics and decision-making

Students understanding of ethics and their decisions for the case study were analyzed qualitatively using thematic analysis of responses to pre and post-class assessments [24]. Themes were drawn inductively and deductively using the literature review.

Students' responses were coded to identify ethical themes, identify dilemmas in the case study, and demonstrate a multidimensional approach to making decisions about an ethical dilemma.

Identification of ethical themes is an important step toward ethical decision-making [5]. Students were given a list to choose the ethical theme(s) that they identified from the case study. It must be noted that literature that informed the themes had already been discussed with students in introductory sessions of the course [17],[19].

Responses were coded for the identification of dilemmas presented by the case study. Conflicts around the environment, data privacy, regulation, and well-being were integral to the case study. So, the identification of dilemmas indicates a successful understanding of the role-play.

The case study's central conflict was the decision to favor the use of e-scooters. Students were required to deliberate on the central dilemma in groups and report their decisions. Responses were coded to observe the approach to reach the decision and argument behind the collective answers given by the groups.

IV. FINDINGS

A. Identification of ethical themes

All students identified ethical themes in response to the question- "Which of these ethical themes did you identify from the e-scooter role-play case study? Explain with examples from the case study-Transparency, Privacy, Bias/Discrimination, Inclusion, None of the others." (See Fig. 1).

Transparency, inclusion, and privacy were the most identified themes, followed by sustainability, accessibility, and responsibility. For each identified theme, students were able to reason their choices and explain the relevance to the case study.

"The main theme of the e- scooter case study was transparency. This is because companies of these - scooters need to be open about their products, such as the risks levels and dangers that can affect students on campus. This would help students become aware and minimize injuries and accidents. It would be important to

enforce safety regulations and policies which would include transparency." - Student 1

"Sustainability was the theme for this case study. E-vehicles have some merit in this, but we do not have long-term data if they really do enough to positively affect the planet. It is much easier to point out their cons at the moment due to how their production and end of lifespan negatively add to CO2 emissions." - Student 2

"The case study dealt with the theme of including all opinions and perspectives of the students, faculty, and the general public." - Student 3



Fig. 1 Students were able to identify ethical themes.

B. Identification of dilemmas and conflicts

28 out of 39 students were able to find dilemmas associated with the case during discussions. While some students identified more than one dilemma, some did not identify any. (See Fig. 2 and Table 3)

Many students (11 of 39) found that the case highlights the conflict between 'Convenience and Safety' in using e-scooter on campus. The 'short-term impact on reduction in CO2' by using electric micro-mobility devices and the 'long-term pollution' caused by the disposal of batteries was also identified by nine students. Another dilemma was whether to choose the 'regulation of the e-scooter or to ban the device.' Mobility of students or taking care of accessibility needs for people that may need the scooters beyond just convenience was recognized as well. Tracking data for safety or data privacy, giving precedence to rider rights or commuter rights, as well as conflict between rider regulation or manufacturer responsibility, was also highlighted.

The case study presents the dilemma of whether to favor using e-scooter on campus or not. Some students were successful in identifying this conflict. A student generalized the dilemma in the case study to arguments for and against emergent AI and their implications. The conflict between what dimension- environmental or ethical to give importance to while making the decision for the case study was elicited in responses.

“This is a very difficult subject because both sides are easily defendable”- Student 4

“As such, the decision of whether Eva should write in favor or against the use of e-scooters on campus is a small portion of the broader arguments for or against innovative technologies being implemented in society without official legislation or rulesets governing their use.”- Student 5

“Our group agreed that e-scooters do have a place on the university campus but not without regulations. My group was considering the safety of the students above all things. The environmental aspect felt secondary, but I think that this was realistic as safety regulations will have a more visible impact than waiting to see the impact that e-scooters will have on the Earth.”- Student 6

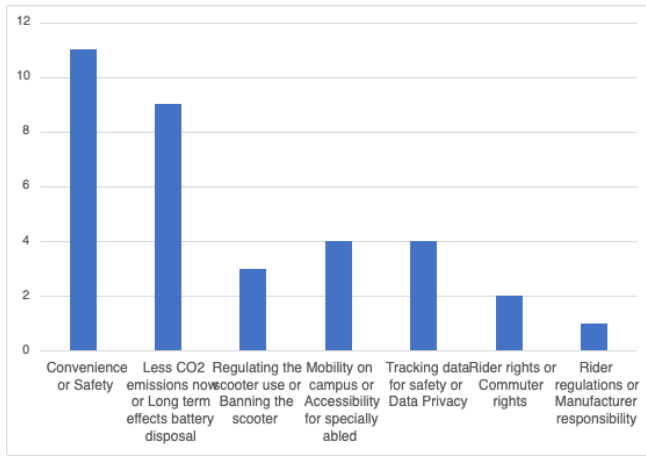


Fig. 2 Students were able to identify dilemmas.

C. Regulation, accessibility, and multidimensional approach to decision-making

The use of multidimensional frameworks in the design of the case study, especially the TEPESTRE framework, reflected in how students interpreted the case study and the decisions reached. The need for rules and regulations before and while implementing the case study was a running theme in students' responses. Ideas around access, safety, and sustainability were also articulated.

“E-scooters, especially on a university campus, could implicate multiple concerns that were discussed to their own extent. Environmental implications, safety measures and concerns, energy efficiency, etc., all pertain to usage of these electric vehicles, and the implementation of that to a public setting could lead to numerous disadvantages.”- Student 15

“When it comes to tech, rarely does its impact affect only the area associated with the intended use. All angles must be reviewed and taken into consideration”- Student 5

“Our group agreed that e-scooters do have a place on the university campus but not without regulations.”- Student 6

TABLE III: DILEMMAS IDENTIFIED BY STUDENTS

Dilemma	No. of Students	Examples
Convenience or Safety	11	“E-scooters will assist students in arriving on time and avoiding any tardiness. Concerns have been raised about the use of scooters, which some say has resulted in a large number of campus accidents. This dilemma may be managed and resolved if heads establish regulations for its use” - Std 7
Fewer CO2 emissions now or Long term effects of battery disposal	9	“E-vehicles have some merit in this, but we do not have long-term data if they really do enough to affect the planet positively. It is much easier to point out their cons at the moment due to how their production and end of lifespan add to CO2 emissions.” - Std 8 “Electrifying things versus gas operated is a huge part of improving the environment. However, the batteries may be an issue in the long run” - Std 9
Regulating scooter use or Banning the scooter	3	“They were not focused on creating laws and regulations to improve the situation. They only cared about the space of the campus and banning the scooters” - Std 10
Mobility and accessibility on campus or accessibility	4	“These scooters are very helpful for those students trying to get around campus, but those who are in a wheelchair find it hard to really get around.” - Std 11
Tracking student data for Safety or Data Privacy	4	“We discussed tracking which students are using the bikes, who uses them properly, and tracking the location of these bikes and limiting them to certain locations on campus. However, after all the other role-plays, I just could not justify this. That information is necessary for the safety of everyone on campus, and it is more ethical to keep that information rather than be negligent and not. That information could prevent accidents from happening again and improving the overall situation on campus” -Std 12
Rider or Commuter rights	2	“Commuters need to be sure they are being mindful of the way they drive.” - Std 13
Rider regulations or Manufacturer Responsibility	1	“This is not the fault of the e-scooter but rather the person using it.” -Std 14

V. DISCUSSION AND CONCLUSION

As the complexity of engineering continues to increase, especially with the amalgamation of physical and digital objects and services, many additional dimensions have come into play concerning ethical and responsible design and implementation of technology. In this paper, we present a study that evaluates the efficacy of a role-play case study in scaffolding student learning about different elements related to ethical thinking. Primed by readings that cut across a range of factors, informed by the PESTEL/TEPESTRE frameworks, students prepared for the discussion and brought to the table different perspectives. These were reflected in the post-discussion assignments submitted by the students.

Overall, this study provides lessons on how to prepare students for complex ethical issues, consistent with other

work in using role-plays to discuss relevant ethical principles [25],[26]. It also confirms the effectiveness of role-play case studies for teaching ethics. Finally, the study points to the usefulness of using different frameworks in the PESTEL/TEPESTRE family of work in teaching about ethics. Increasingly, scholars and practitioners are using these frameworks to guide their work, and through this study, we showcase their usefulness for teaching and assessment as well. Finally, our work demonstrates the ability of students to identify dilemmas and value tensions inherent in the use of technology through their discussion.

ACKNOWLEDGMENT

This work was partially supported by US National Science Foundation Awards #1954556, 1937950, 1939105; and USDA/NIFA Award #2021-67021-35329. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the funding agencies.

REFERENCES

- [1] M.W. Martin and Schinzinger, R. "Introduction to Engineering Ethics", 2nd ed. Boston, MA, USA: McGraw-Hill Higher Education, 2000.
- [2] P. H. Silverglate, J. Kosmowski, H. Hilary, and D. Jarvis, "Beyond good intentions: Navigating the ethical dilemmas facing the technology industry," Deloitte Insights, 2021. [Online]. Available: <https://www2.deloitte.com/us/en/insights/industry/technology/ethical-dilemmas-in-technology.html>. [Accessed: May 15, 2023].
- [3] S.Abraham, A.D. Knies, K.L. Kukral, and T.E. Wills, "Experiences in discussing ethics with undergraduate engineering," *Journal of Engineering Education*, vol.86, no.4, pp.305-307, 1997.
- [4] D. A. Martin and G. Bombaerts, "Exploring ethical decision-making in group settings with real-life case studies," 2021 IEEE International Symposium on Ethics in Engineering, Science and Technology (ETHICS), Waterloo, ON, Canada, 2021, pp. 1-1, doi: 10.1109/ETHICS53270.2021.9632713.
- [5] B. Bero and A. Kuhlman, "Teaching ethics to engineers: ethical decision making parallels the engineering design process," *Science and Engineering Ethics*, vol. 17, no. 3, pp. 597-605, 2011.
- [6] A. Johri and A. Hingle, "Learning to Link Micro, Meso, and Macro Ethical Concerns Through Role-Play Discussions," 2022 IEEE Frontiers in Education Conference (FIE), Uppsala, Sweden, 2022, pp. 1-8, doi: 10.1109/FIE56618.2022.9962560.
- [7] W. T. Lynch and R. Kline, "Engineering Practice and Engineering Ethics," *Science, Technology, & Human Values*, vol. 25, no. 2, pp. 195-225, 2000. [Online]. Available: <https://doi.org/10.1177/016224390002500203> [Accessed: May 15, 2023].
- [8] A. Hedayati-Mehdiabadi, "How do computer science students make decisions in ethical situations? Implications for teaching computing ethics based on a grounded theory study," *Organization, Information & Learning Sciences*, University of New Mexico, 2021.
- [9] Q. Zhu and B. K. Jesiek, "A Pragmatic Approach to Ethical Decision-Making in Engineering Practice: Characteristics, Evaluation Criteria, and Implications for Instruction and Assessment," *Science and Engineering Ethics*, vol. 23, no. 3, pp. 663-679, 2016. Doi: <https://doi.org/10.1007/s11948-016-9826-6>
- [10] A. Hingle, A. Johri, H. Rangwala, and A. Monea, "Using the Boeing Max Air Disaster as A Role-play Scenario for Teaching Ethical Thinking," presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference, Jul. 2021. [Online]. Available: <https://peer.asee.org/38001>.
- [11] C. Bertha, "How to Teach an Engineering Ethics Course with Case Studies," in *American Society for Engineering Education*, 2010. [Online]. Available: <https://peer.asee.org/how-to-teach-an-engineering-ethics-course-with-case-studies>. [Accessed: May 15, 2023].
- [12] A. Roukouni and G. Homem de Almeida Correia, "Evaluation Methods for the Impacts of Shared Mobility: Classification and Critical Review," *Sustainability*, vol. 12, no. 24, p. 10504, Dec. 2020, doi: 10.3390/su122410504
- [13] M. J. Casan, M. Alier, and A. Llorens, "Teaching ethics and sustainability to informatics engineering students, an almost 30 years' experience," *Sustainability*, vol. 12, no. 14, pp. 5499, 2020, doi: 10.3390/su12145499.
- [14] G. D. Hoople, D. A. Chen, S. M. Lord, L. A. Gelles, F. Bilow, and J. A. Mejia, "An integrated approach to energy education in engineering," *Sustainability*, vol. 12, no. 21, pp. 9145, 2020. doi: 10.3390/su12219145.
- [15] Washington State University, "What is PESTEL analysis?" [Online]. Available: <https://libguides.libraries.wsu.edu/c.php?g=294263&p=4358409>. [Accessed: May 15, 2023].
- [16] Gartner, "A Tapestry (TPESTRE) of Trends for Strategic Planning," Gartner, 2021. [Online]. Available: <https://www.gartner.com/en/documents/4000751>. [Accessed: May 15, 2023]
- [17] M. Ashok, R. Madan, A. Joha, and U. Sivarajah, "Ethical framework for artificial intelligence and digital technologies," *International Journal of Information Management*, vol. 62, p. 102466, 2021, Available:<https://doi.org/10.1016/j.ijinfomgt.2021.102433>. [Accessed: May 15, 2023]
- [18] L. Floridi and J. Cowls, "A Unified Framework of Five Principles for AI in Society," *Harvard Data Science Review*, vol. 1, no. 1, pp. 1-30, 2019, doi: 10.1162/99608f92.8cd550d1.
- [19] A. Jobin, M. Ienca, and E. Vayena, "The global landscape of AI ethics guidelines," *Nat. Mach. Intell.*, vol. 1, pp. 389–399, Sep. 2019. Doi: [10.1038/s42256-019-0088-2](https://doi.org/10.1038/s42256-019-0088-2)
- [20] A. Eggert, "E is for Environment, Unpacking the benefits of e-scooters," *Forbes.com*, Mar. 5, 2020. [Online]. Available: <https://www.forbes.com/sites/anthonyeggert/2020/03/05/e-is-for-environment-unpacking-the-benefits-of-e-scooters/?sh=6567918161c3>. [Accessed: Apr. 28, 2023].
- [21] S. Abdulahi, "E-scooters spark new safety concerns across campuses," *Inside Higher Ed*, Dec. 16, 2022. [Online]. Available: <https://www.insidehighered.com/news/2022/12/16/e-scooters-spark-safety-concerns-across-campuses>. [Accessed: May 15, 2023].
- [22] L. Spitalniak, "Are college e-scooter bans an overreaction to safety concerns?," *Higher Ed. Drive*, Jan. 2023. [Online]. Available: <https://www.highereddrive.com/news/banning-electric-scooters-on-campus/639633/>. [Accessed: May 15, 2023].
- [23] C. Rabino-Neira, "E-scooters and human rights: What are the ethical dilemmas in their supply chain and in consumers' wellbeing?," University of Auckland, 2019. Available: <https://www.thebigq.org/2019/11/20/e-scooters-and-human-rights-what-are-the-ethical-dilemmas-in-their-supply-chain-and-in-consumers-wellbeing/> [Accessed: May 15, 2023]
- [24] V. Braun and V. Clarke, "Thematic analysis," in *APA Handbook of Research Methods in Psychology*, H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, and K. J. Sher, Eds. American Psychological Association, vol. 2, 2012, pp. 57-71, doi: 10.1037/13620-004.
- [25] A. Hingle and A. Johri, "Assessing Engineering Student's Representation and Identification of Ethical Dilemmas through Concept Maps and Role-Plays." *Proceedings of ASEE (2022)*, Minneapolis, USA.
- [26] A. Hingle, H. Rangwala, A. Johri and A. Monea. "Using Role-Plays to Improve Ethical Understanding of Algorithms Among Computing Students." *Proceedings of IEEE/ERM Frontiers in Education (2021)*.