

BOARD # 368: ER2 & RFE: Experiences of Ethics and Equity in Engineering Practice: A National Survey of Early-Career Engineers as they Transition to the Workforce

Chika Winnifred Agha, Colorado State University

Chika Winnifred Agha is a Ph.D. candidate in the Civil and Environmental Engineering department at Colorado State University. She holds both a bachelor's and a master's degree in civil engineering. She employs both qualitative and quantitative research methods to examine how early-career engineers navigate ethics and equity as they transition into professional practice.

Her research interests center on engineering education, with a strong emphasis on ethics, equity, diversity, and inclusion. She studies the experiences of early-career engineers, professional development, and workforce preparation, aiming to foster a more equitable and ethical engineering profession.

She was a fellow at the Colorado Water Center during the Fall 2023 and Spring 2024 semesters. She has also been selected as a Colorado State University Vice President for Research Fellow for the Fall 2024 and Spring 2025 semesters.

Dr. Rebecca A Atadero, Colorado State University

Rebecca Atadero is a professor in the Department of Civil and Environmental Engineering at Colorado State University, specializing in structural engineering. She conducts research on the inspection, management and renewal of existing structures, social equity in civil engineering work, and diversity, equity and inclusion in engineering education settings.

Dr. Amir Hedayati Mehdiabadi, University of New Mexico

Amir Hedayati is an Associate Professor at Organization, Information & Learning Sciences program at College of University Libraries & Learning Sciences at University of New Mexico. His research seeks to answer how we can enhance ethical decision-making among professionals, including engineers and computer scientists, by understanding their ethical judgment processes.

ER2 & RFE: Experiences of Ethics and Equity in Engineering Practice: A National Survey of Early-Career Engineers as they Transition to the Workforce

Abstract

The transition from academic training to professional practice often exposes engineers to real-world ethical dilemmas and equity concerns that may not have been fully addressed during their formal education. As engineering education evolves to address not only technical competencies but also the broader social responsibilities of engineers, the knowledge of how early-career engineers grapple with these issues in real-world settings becomes increasingly important. The primary purpose of this NSF-funded project is to gain insight into the professional experiences of early-career engineers regarding ethics and equity. This poster will share findings from a national survey. The survey will focus on early-career engineers with five years or less of experience in the field to obtain approximately 250 completed responses. To recruit participants from various engineering disciplines, we will utilize various approaches, including outreach through social media platforms like LinkedIn, as well as engagement with professional organizations specific to different engineering fields. Using a quantitative research approach to examine the data collected from these surveys, we will employ both inferential and descriptive statistical methods.

This study reports how early-career engineers perceive and apply their academic preparation, on-the-job learning, and available resources related to equity and ethics in their professional work, as well as how their social identities and experiences shape these perceptions and motivations. The findings will inform a subsequent round of interviews to further illuminate the early career experiences of engineers and help develop learning tools to help better prepare students and recently hired engineers for the transition to practice.

Keywords: survey, engineering ethics, equity, early-career engineers, engineering education

Introduction

Engineers are entrusted with a fundamental responsibility to uphold honesty, integrity, and social accountability, protecting both human life and the environment from harm [1, 2, 3]. As such, the ethical obligations of engineers encompass a commitment to maintaining public welfare and societal trust, often requiring them to navigate competing interests and challenging situations in the workplace [2].

Transitioning from academic training to professional practice is a crucial period in the development of early-career engineers, during which they apply their theoretical knowledge in real-world scenarios and gain the practical experience needed to refine their professional skills [4]. This phase is significantly influenced by both educational and organizational environments, which shape engineers' awareness of public welfare and enhance their responsiveness to ethical issues [5]. Engineers work within a variety of organizations and across different levels, making them an ideal example for examining ethical behavior and the influence of organizations in either fostering or impeding ethical practices [6].

Hess and colleagues' [7] review of literature underscores the need to integrate ethics, diversity, equity, and inclusion (DEI) into engineering education and practice to create a more inclusive and equitable professional culture. This approach has the potential to contribute to a socially just world, with an engineering community that meets the diverse needs and values of its members. Yet, despite these potential benefits, the engineering workforce continues to reflect inequalities, including gender imbalances and career disadvantages for underrepresented groups [8, 9]. Studies indicate that these disparities often impact career trajectories, with underrepresented engineers experiencing barriers to advancement and persistent inequalities in leadership roles [10]. To support the integration of ethics and diversity, equity, and inclusion in engineering education and practice, this study seeks to understand the current experiences of engineers transitioning from school to the workplace, providing a basis for recommendations for change.

Summary of the Complete Research Project

This National Science Foundation (NSF)-funded project employs a sequential mixed-methods approach to study the experiences of early-career engineers with ethics and equity in the workplace. The approach comprises three phases, the first phase is Qualitative (qual), the second phase is Quantitative (QUAN), and the third phase is Qualitative (QUAL).

The first phase, a basic qualitative interview study, has been completed, and its findings were presented at the ASEE Annual Conference in 2024. A summary of the overall NSF research project plan was shared in a poster presentation [11]. Moreover, the preliminary findings from the first phase based on the analysis of workplace stories from early-career engineers on ethical and equity-related issues were presented in the ethics division of ASEE [12]. Topics raised by research participants included quality control, safety, doing work beyond one's expertise, equity in pay and promotion, the ethical environment of the organization, and conflicts of interest involving the desires of different stakeholders. The findings revealed overlaps between ethical and equity concerns in participants' responses, with equity-related stories focusing on (1) inequitable or discriminatory allocation of resources or opportunities, and (2) discriminatory comments, uncivil behavior, and uncomfortable situations. These insights provide a foundational understanding of the ethical and equity challenges early-career engineers face. In addition, a paper analyzing a selection of ethical dilemmas shared in the interviews as case studies with discussion questions was presented in the Civil Engineering Education division [13]. The goal was to help engineering ethics educators foster meaningful classroom discussions and prepare students for real-world challenges.

The current poster will present preliminary results from the second phase of this NSF-funded project, the quantitative (QUAN) phase, which involves conducting a national survey to collect approximately 250 complete responses from early-career engineers. The survey was informed by the findings from the interviews from the first phase of the project. With guidance from advisory board members, the survey questions were refined to align with the research questions and objectives. To recruit participants from diverse engineering disciplines, we employ strategies such as personal outreach, leveraging social media platforms like LinkedIn, and sending emails to professional organizations within specific engineering fields. Participants are also asked about

their willingness to partake in a follow-up interview in preparation for the third phase of the overall project. As an incentive, each participant who completes the survey receives a \$25 Amazon gift card.

The third phase of the project, Qualitative (QUAL), will involve a second round of interviews. The interview questions will be developed using the findings from the second phase of the study. The research team will use purposive sampling to ensure diversity.

Project Research Questions (RQ)

RQ 1: What aspects of their academic preparation and exposure to issues of equity and ethics do early career engineers find relevant and use in their professional work?

RQ 2: What are early-career engineers' experiences of on-the-job learning related to equity and ethics, and what resources are available and useful to support these learning experiences?

RQ 3: What are the perceptions of early-career engineers about equity and ethics and their importance in interpersonal interactions in the work environment? In addition, what experiences or situations have contributed to these perceptions?

RQ 4: What are the perceptions of early-career engineers about equity and ethics and their importance in the professional work of engineers? In addition, what experiences or situations have contributed to these perceptions?

RQ 5: To what extent and in what ways do early-career engineers with different social identities have differing views and motivations to act on issues of equity and ethics in engineering?

RQ 6: What are early career engineers' understanding and perceptions of ethics in relation to equity?

Research Method

This study uses quantitative survey design. The data from the survey will be analyzed using both descriptive statistics (e.g., frequency, percentile, etc.) and inferential (e.g., regression analysis) to address the research questions [14]. Table 1 describes the sections of the survey, provides sample questions from each section, and indicates the alignment between the survey items and the project research questions.

Table 1. *Survey Structure, Example Questions, and Correspondence to Research Questions*

Survey Sections	Sample Survey Questions	Research Question (RQ)
Demographics	How would you describe your race? What is your gender identity?	RQ 5

Workplace context	Where do or did you work most often in your current or most recent engineering organization? What is the overall size of your current or most recent engineering organization?	RQ 5
The importance of ethics and equity to engineering professional practices	In your view, how important is ethics to the work you do as an engineer?	RQ 3 and 4
Your preparation for professional engineering practice	My academic experiences prepared me for ethical practice in engineering. (Rating scale from Strongly disagree to Strongly agree).	RQ 1
Connections between ethics and equity	In my view, when it comes to engineering practice, ethics and equity are: (Rating scale: Not related, Are related but distinct, Are closely related, and One is part of the other)	RQ 6
Your workplace experiences	How helpful are each of the resources below in helping you navigate Ethics and/or equity and inclusion dilemmas at work?	RQ 1,2, and 3

The survey will collect responses during the first quarter of 2025, and preliminary findings will be shared in the poster at the ASEE Annual Conference.

Conclusion and Next Steps

The insights from this study can inform how educational programs are designed and adapted to better equip early career engineers for the ethical and equity-related issues they may face in professional practice. Also, it provides organizations with information about the kind of ethical issues young engineers are likely to face.

The next step of this project is to conduct a second round of interviews informed by the results of the survey.

Acknowledgment

This research is based upon work supported by the National Science Foundation under Grant No. 2135328 and 2135329. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

1. Canney, N. E., & Bielefeldt, A. R. (2016). Validity and reliability evidence of the engineering professional responsibility assessment tool. *Journal of engineering education*, 105(3), 452-477.
2. Murthy, J. N., Lavanya, C., & Kosaraju, S. (2020). Ethics in engineering profession: Pedagogy and practices. In K. Kumar & J. P. Davim (Eds.), *Methodologies and outcomes*

of engineering and technological pedagogy (pp. 296-318). IGI Global.
<https://doi.org/10.4018/978-1-7998-2245-5.ch014>

3. Niles, S., Contreras, S., Roudbari, S., Kaminsky, J., & Harrison, J. L. (2020). Resisting and assisting engagement with public welfare in engineering education. *Journal of Engineering Education*, 109(3), 491–507. <https://doi.org/10.1002/jee.2032>
4. Brunhaver, S. R., Jesiek, B. K., Korte, R. F., & Strong, A. C. (2021). The early career years of engineering: Crossing the threshold between education and practice. *Engineering Studies*, 13(2), 79-85. <https://doi.org/10.1080/19378629.2021.1961570>
5. Cech, E. A., & Finelli, C. J. (2024). Learning to prioritize the public good: Does training in classes, workplaces, and professional societies shape engineers' understanding of their public welfare responsibilities?. *Journal of Engineering Education*, 113(2), 407-438.
6. Adams, T. L. (2020). 'This happens all the time': Organizations, rationalization and ethical dilemmas in engineering. *Work, Employment and Society*, 34(6), 985-1003.
7. Hess, J. L., Lin, A., Whitehead, A., & Katz, A. (2024). How do ethics and diversity, equity, and inclusion relate in engineering? A systematic review. *Journal of Engineering Education*, 113(1), 143-163. <https://doi.org/10.1002/jee.20571>
8. Ayre, M., Mills, J., & Gill, J. (2013). 'Yes, I do belong': the women who stay in engineering. *Engineering studies*, 5(3), 216-232.
9. Adams, T. L., & Flores, J. (2022). Marginalized Inclusion: The Experiences of Visible Minority Engineers in Ontario, Canada. *Canadian Ethnic Studies*, 54(2), 23-45.
10. Gilmartin, S. K., Brunhaver, S. R., Jordan-Bloch, S., Gall Rosa, G., Simard, C., & Sheppard, S. D. (2024). Early-Career Assignments and Workforce Inequality in Engineering. *Engineering Studies*, 16(1), 8-32.
11. Agha, C. W., Hedayati Mehdiabadi, A., Atadero, R. A., Omur-Ozbek, P., & Duenninger, C. (2024). Board 246: Early-Career Engineers' Experiences with Equity and Ethics in the Workplace. In *2024 ASEE Annual Conference & Exposition*. <https://doi.org/10.18260/1-2--46817>
12. Hedayati Mehdiabadi, A., Agha, C. W., Atadero, R. A., Omur-Ozbek, P., & Duenninger, C. (2024). Early-Career Engineers' Stories of Ethics and Equity in the Workplace: A Thematic Analysis. In *2024 ASEE Annual Conference & Exposition*. <https://doi.org/10.18260/1-2--47211>
13. Omur-Ozbek, P., Atadero, R. A., Hedayati Mehdiabadi, A., Agha, C. W., & Duenninger, C. (2024). Navigating Ethical Dilemmas in Civil and Environmental Engineering: Ethical Case Studies Based on Experiences of Early-Career Engineers. In *2024 ASEE Annual Conference & Exposition*. <https://doi.org/10.18260/1-2--47793>
14. Creswell, J. W., & Guetterman, T. C. (2019). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (6th ed.). Pearson.