Are values elicited in engineering capstone design courses?

Zahra Saghafi, University of Guelph
Dr. Julie Vale, University of Guelph

Julie Vale received her Ph.D in Electrical and Computer Engineering from the University of Waterloo. She joined the University of Guelph in 2012 as a teaching focused faculty member and is currently Associate Director Undergraduate Studies for the School of Engineering. Originally trained in electrical engineering as a systems and control theorist, Dr. Vale's current research focuses on engineering education and pedagogy. Her research has two aspects. The first focuses on the development of a tool to assist instructors in building assessments that promote problem solving skills rather than promoting memorization. The second is about how and why values-based learning outcomes should be scaffolded into STEM curricula and capstone experiences.

Dr. Vale believes that building student and faculty appreciation of the intersections between social justice and engineering is crucial to empowering engineers to fulfil their mandate to serve the public. She brings this view to the classroom, to curriculum design and development, and to her research.

Dr. Russell Kirkscey, Pennsylvania State University

Associate Professor of English and Technical and Professional Writing

Jennifer Howcroft, University of Waterloo

Jennifer Howcroft is a Continuing Lecturer in the Department of Systems Design Engineering at the University of Waterloo. Her pedagogical research focuses on engineering design, holistic engineering education, stakeholder interactions, and empathy in engineering education.

Are Values Elicited in Engineering Capstone Design Courses?

Abstract

The engineering profession holds significant societal power, often determining the allocation of resources, opportunities, risks, and harm across various social groups. Capstone design courses, as a cornerstone of Canadian and American engineering curricula, are rich sources of data for accreditation-related graduate attributes. However, societal considerations and values-based outcomes are often overshadowed by a focus on technical skills in these courses. This observation aligns with Cech's (2014) findings on the culture of disengagement in engineering education, which describes three limiting mindsets: the socio-technical divide, depoliticization, and meritocracy. These mindsets conflict with the engineering profession's societal obligations, posing challenges for educators.

This paper is part of a broader study investigating why and how values-based learning outcomes, including DEI and social justice-related outcomes, are (or are not) integrated into the engineering curriculum. Here we examine faculty perceptions of whether values are elicited in Canadian engineering capstone courses.

A survey was conducted across all disciplines and capstone courses at public Canadian engineering universities, resulting in 23 valid responses from a diverse range of institutions and disciplines. The survey focused on three core aspects of values: fairness, human well-being, sustainability, and accountability. Preliminary qualitative findings reveal a disconnect between faculty perceptions of the importance of these values and their integration into capstone design courses. Furthermore, nearly all the respondents who acknowledged the importance of values but reported their absence in capstone courses identified as white males.

Open-text responses highlight themes of leveraging guest speakers and relying on teamwork to implicitly address values, indicating avoidance of directly teaching or assessing them. Faculty with 6–10 years of teaching experience were more likely to express discomfort with teaching values directly, while older and younger faculty appeared more comfortable addressing these outcomes.

1. Introduction

Engineering education occupies a critical role in preparing students for both professional success and societal impact [1]. Engineers hold a position of significant power and privilege in society, influencing the allocation of resources, opportunities, risks, and harms across diverse social groups [2]. This responsibility necessitates an educational approach that extends beyond technical proficiency to include the development of ethical and values-based competencies [3]. In particular, values such as fairness, human well-being, sustainability, and accountability are essential for addressing complex societal challenges. Despite this imperative, engineering curricula, particularly in North America, often prioritize technical skills over societal and ethical considerations [4].

Capstone design courses, as culminating experiences in engineering programs, are uniquely positioned to bridge this gap [5]. These courses integrate technical knowledge with real-world problem-solving and are frequently used to assess graduate attributes [6], such as those defined by the Canadian Engineering Accreditation Board (CEAB) and the National Society of Professional Engineers (NSPE). Attributes like professional ethics, equity, and accountability align with broader societal demands for Diversity, Equity, and Inclusion (DEI) and social justice

outcomes; however, research shows that capstone courses predominantly emphasize technical competencies, leaving limited room for the explicit teaching of values [2], [7], [8]. This misalignment reflects a broader trend within engineering education, often described as the "culture of disengagement."[2]

The culture of disengagement, as articulated by Erin Cech (2014), is rooted in three dominant mindsets. First, the socio-technical divide reinforces the belief that engineering is strictly a technical discipline, relegating social and ethical issues to peripheral concerns. This divide discourages engineers from considering the broader implications of their work. Second, depoliticization frames engineering problems as neutral and apolitical, overlooking how engineering practices intersect with social and political contexts. Finally, the ideology of meritocracy perpetuates the notion that success in engineering is determined solely by individual ability, ignoring systemic inequities that shape access to resources and opportunities. These mindsets collectively limit engineers' capacity to address societal challenges and create significant obstacles for educators seeking to integrate values into the curriculum [2].

Capstone design courses offer an opportunity to counteract these limitations by incorporating explicit values-based learning outcomes [8]. Such outcomes include fairness, which emphasizes equitable decision-making and access; sustainability, which focuses on the long-term impacts of engineering practices; and accountability, which ensures that engineers take responsibility for the societal and environmental consequences of their work [7]. However, the extent to which these outcomes are realized in capstone courses is heavily influenced by faculty perceptions and teaching practices. Faculty members, as the primary architects of course content and delivery, play a crucial role in determining whether and how values are integrated into engineering education [8].

However, research on power dynamics in engineering education suggests that faculty-student interactions are shaped by inherent power imbalances, particularly in design reviews, where instructors often dominate discussions and feedback structures [9]. These power structures influence the extent to which students can engage with values-based learning, as certain feedback mechanisms may restrict student agency or reinforce the prioritization of technical competencies over ethical considerations. Similarly, the concept of 'power over' versus 'power with' in stakeholder interactions highlights the potential for more collaborative, inclusive approaches to engineering education [10].

Efforts to integrate DEI and social justice into engineering education have been met with mixed success. In Canada, for example, the CEAB requires the inclusion of graduate attributes related to ethics and equity. However, these attributes are often insufficiently defined, leaving educators with little guidance on how to operationalize them effectively [8]. Even when values-based topics are included in the curriculum, they are frequently taught in isolation, rather than being integrated into technical and design-focused coursework. This compartmentalization reinforces the socio-technical divide and limits students' ability to connect technical decisions with their broader societal impacts [5], [11].

Theoretical critiques of engineering education highlight the need for systemic reforms. Scholars argue for a more holistic approach that embeds values-based learning throughout the curriculum. This approach would not only address the deficiencies of capstone courses but also challenge the

broader culture of disengagement within the profession. By providing students with opportunities to engage with societal issues in a structured and intentional manner, engineering education can better prepare graduates to navigate the ethical complexities of their work [12].

The present study investigates whether and how values such as fairness, human well-being, sustainability, and accountability are elicited in Canadian engineering capstone design courses. The research draws on a multiple-methods approach, combining quantitative and qualitative data to capture faculty perspectives on the integration of values-based outcomes. Faculty perceptions are critical to understanding the barriers and opportunities for embedding values into the curriculum. This study focuses on identifying the disconnects between the perceived importance of values to the engineering profession and their inclusion in capstone courses.

By examining faculty perceptions and practices, this study contributes to the ongoing discourse on the role of engineering education in fostering socially responsible engineers. It highlights the challenges and opportunities for integrating values into capstone design courses and calls for systemic changes to curricula, accreditation standards, and faculty development. In an era marked by increasing societal and environmental challenges, the need for engineers who can balance technical expertise with ethical responsibility has never been more pressing. This research aims to illuminate pathways for bridging the gap between technical and societal dimensions in engineering education, ensuring that future engineers are equipped to serve the needs of a diverse and interconnected world.

2. Methodology

This study employed a multiple methods approach, incorporating both quantitative and qualitative data collection to explore faculty perceptions of values elicitation in Canadian engineering capstone design courses. The two types of data were collected and analyzed separately, with findings from each method contributing to a broader understanding of the research question This approach was selected to provide both breadth (through Likert scale survey responses) and depth (through qualitative analysis of open-ended responses) in understanding the integration of values such as fairness, human well-being, sustainability, and accountability.

The study focused on faculty members teaching engineering capstone design courses at public universities across Canada. To ensure a diverse and representative sample, purposive sampling was employed, including 25 institutions of varying sizes and geographic locations. Due to the Canadian context, only publicly funded institutions were included in the sample. A total of 23 valid responses were collected from faculty across a broad range of engineering fields and institutions, encompassing both small and large universities and a variety of geographic locations. The sampling process involved a systematic review of all public universities in Canada offering engineering programs. Publicly available information was used to identify capstone design courses and their respective instructors, who were subsequently invited to participate in the survey. Data were collected through an online survey distributed to faculty members via institutional and departmental contacts.

2.1 Survey design

The survey was designed to explore faculty perspectives on the importance and integration of values-based outcomes in engineering capstone courses. It consisted of three primary components:

1. Demographics: Questions gathered information on respondents' institutional affiliation, years of teaching experience, and engineering discipline. This section aimed to provide a comprehensive understanding of the diverse backgrounds and contexts of participating faculty members.
2. Likert-Scale Items: Faculty were asked to rate the importance of core values such as fairness, sustainability, and accountability in engineering education. Additional items assessed whether these values are explicitly addressed within capstone courses and the importance of those values to the engineering profession. The Likert-scale design enabled a structured approach to quantify faculty perceptions and attitudes.
3. Open-Ended Questions: Respondents were invited to provide detailed explanations of their teaching practices, describe challenges faced in incorporating values-based outcomes into capstone courses, and offer suggestions for improving the integration of these outcomes. This qualitative component provided depth and context to the quantitative data.

The survey questions and values were developed based on a thorough review of relevant literature, similar to the approach taken in previous work on this project, including [13], [14]. These concepts informed the structure and content of the survey, ensuring alignment with known challenges in the field. By addressing gaps identified in prior research, the survey design aimed to capture a nuanced understanding of how values-based learning outcomes are perceived and implemented in engineering capstone courses.

2.2 Data analysis

Quantitative data from Likert-scale items [15] were analyzed using descriptive statistics to identify trends in faculty perceptions of the importance and elicitation of values. Qualitative data from open-ended questions were analyzed using thematic analysis. The study employed a systematic qualitative approach to analyze the open-ended survey responses, with the coding process conducted in two distinct phases: preliminary open coding and axial coding. In the first phase, one researcher performed the preliminary open coding by closely examining all open-ended responses. This involved identifying meaningful units of text, such as phrases or sentences, that conveyed significant insights into faculty perceptions of values-based learning. These textual units were tagged with descriptive labels, or codes, that reflected their content and meaning. The goal of this initial phase was to generate a comprehensive set of codes that represented the data without imposing any predefined categories, ensuring that the analysis remained grounded in the responses.

In the second phase, axial coding was undertaken by a second researcher with expertise in qualitative analysis to refine and consolidate the preliminary codes. Similar codes were grouped into broader categories based on their shared characteristics. For example, responses referring to "lack of training" and "discomfort with teaching values" were merged into a category labeled "Discomfort with Direct Instruction on Values." The process of grouping codes into categories was guided by the research questions and theoretical framework, focusing specifically on themes related to the integration of values such as fairness, sustainability, and accountability. Codes were

combined when they reflected similar challenges, opportunities, or practices concerning values elicitation in capstone courses.

3. Results

Table 1 summarizes the demographics of 23 study participants, representing 18 universities and a range of engineering disciplines. Most respondents (over 37%) had 16 or more years of teaching experience, with additional representation from those with 6–15 years, reflecting perspectives from experienced educators. Gender representation included 17 men and 6 women; no participants chose any of the other gender options. Ethnic backgrounds were diverse, with the majority identifying as White/European, alongside smaller representations from Latino/a/x, Arab/West Asian, South Asian, and Southeast Asian identities. This diverse sample allowed the study to capture varied viewpoints on how values are integrated into capstone courses across different institutional and professional contexts.

Table 1. Demographics

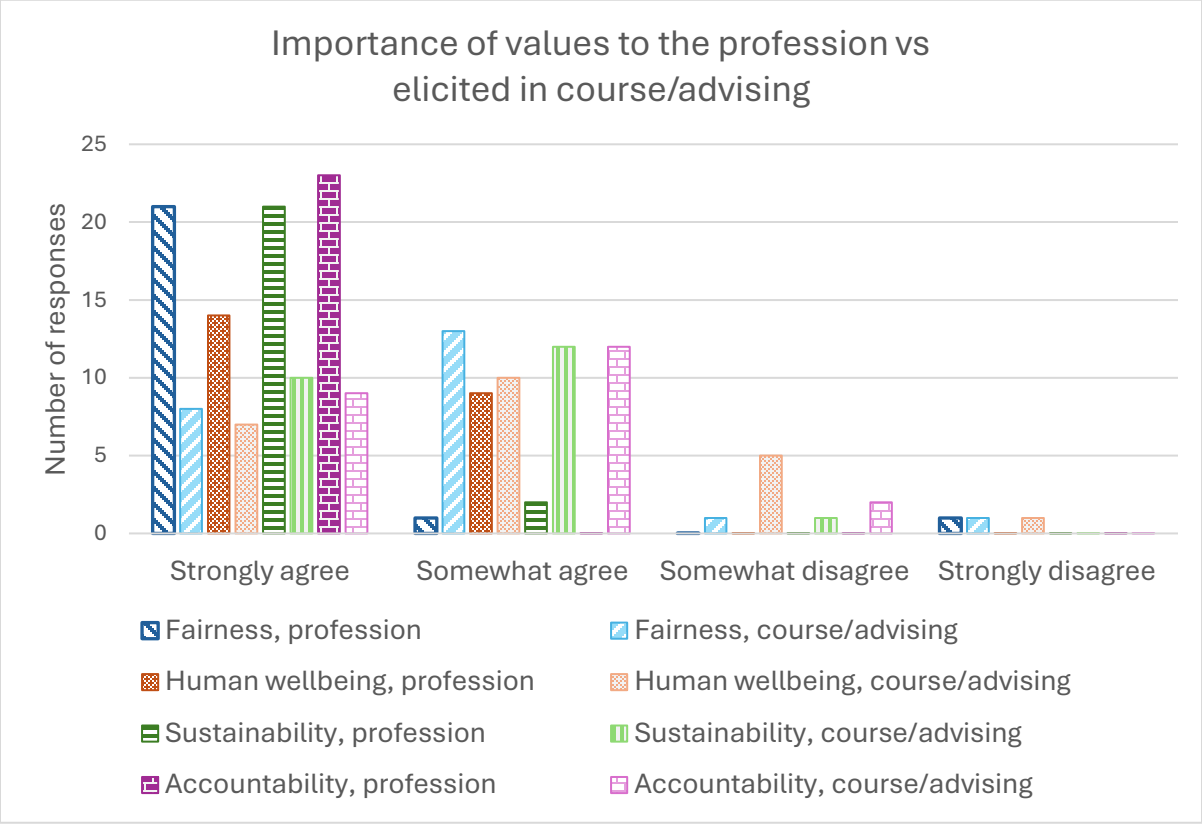
Category	Value	Count
University	Unique Count	18
Gender	Man	17
Gender	Woman	6
Discipline	Civil	5
Discipline	Mechanical	4
Discipline	Chemical	4
Discipline	Biomedical	2
Discipline	Systems	2
Discipline	Computer	2
Discipline	Electrical	2
Discipline	Mechatronics	1
Discipline	It is a general engineering capstone course	1
Years of Teaching Experience	16 or more	9
Years of Teaching Experience	6- 10 years	7
Years of Teaching Experience	11- 15 years	6
Years of Teaching Experience	0-5	1
Ethnicity	White/European (British Isles, French, White-Canadian, etc.)	16
Ethnicity	Latino/a/x (Costa Rican, Guatemalan, Brazilian, Colombian, etc.)	2

Ethnicity	Arab/West Asian/Middle east/North Africa (Afghani, Egyptian, Iranian, Israeli, Libyan, Palestinian, etc.)	2
Ethnicity	South Asian (Bangladeshi, Pakistani, Sri Lankan, etc.)	1
Ethnicity	Southeast Asian (Cambodian, Filipino, Thai, Vietnamese, etc.)	1
Ethnicity	My ethnic background is not listed above (please specify)	1

3.1 Likert scale results: Faculty perceptions of values

The survey data revealed a strong consensus among respondents regarding the importance of values to the profession, with all but one respondent selecting strongly agree or somewhat agree for all 4 factors (Fairness, Human well-being, Sustainability, and Accountability). Notably, accountability was the only factor where all respondents selected 'strongly agree; however, when asked whether these factors are elicited in the capstone course or capstone advising, participants leaned much more heavily toward the somewhat agree or lower (Figure 1).

Figure 1 – Faculty perceptions of values in the capstone (note that no participants selected 'neutral')



3.2 Qualitative Analysis

The qualitative responses provided valuable insights into faculty perceptions of integrating values into Canadian engineering capstone design courses. The analysis highlighted recurring

themes that reflect both the opportunities and challenges associated with embedding values such as fairness, accountability, sustainability, and human well-being into the curriculum.

3.2.1 Capstone Courses as Vehicles for Value Integration

Respondents emphasized the potential of capstone design courses to serve as platforms for instilling professional values in students. Faculty acknowledged that these courses offer unique opportunities for students to engage with real-world problems where ethical considerations and societal impacts are critical: “We have only a limited amount of influence on our students, but capstone is one of the places where we can have a conversation about values, especially with problematic projects.”

3.2.2 Discomfort with Direct Instruction on Values

A significant number of respondents expressed discomfort with directly teaching or assessing values in their courses. This discomfort often stemmed from a perceived lack of expertise or training in addressing values-based outcomes. Faculty frequently relied on indirect methods, such as using guest speakers or case studies, to introduce students to ethical and societal considerations, e.g., one respondent leveraged the open-ended text boxes to identify CEAB outcomes and guest speaker for all of the four values factors. These approaches, while valuable, were often ad hoc and lacked consistency.

3.2.3 Variability in Faculty Approaches

The analysis revealed considerable variability in how faculty approach the integration of values. Female faculty members and those from minority backgrounds were more likely to directly address values, emphasizing the need for equity, diversity, and inclusion: “I feel the values outlined in this survey are very important to the engineering profession. I do a reasonable job of incorporating most of them into my teaching…”

Conversely, male faculty members and faculty with 6–10 years of teaching experience were more likely to rely on indirect methods or assume that teamwork would naturally foster values such as fairness and accountability:

> “Not all are explicitly [Learning Outcomes] in my course, and not all are explicitly taught. But I feel that most are addressed through discussions of the design process and invidiual (sic) team meetings over the course.”

3.2.4 Institutional and Structural Barriers

Respondents highlighted several institutional barriers to embedding values into capstone courses. These included a lack of formal training for faculty and limited time within the curriculum. One respondent said, “I don't have a means for evaluating these important aspects.” and another said, “I am struggling to understand what a values-related outcome means in the context of a capstone course.” Interestingly, all faculty who expressed these types of concerns identified as male.

3.2.5 Faculty Perspectives on Challenges

The qualitative data underscored specific challenges that faculty face in integrating values into capstone design courses. Resource constraints were a recurring issue, with limited lecture time frequently mentioned as barrier to developing comprehensive values-based modules.

Additionally, some faculty noted difficulties in engaging students with values-based topics, particularly when these were presented as abstract concepts rather than practical applications.

That said, some faculty are finding ways to holistically incorporate values despite the barriers and challenges, e.g., “by teaching capstone using a studio model we can include more of these conversations in an organic manner and less in a formal lecture format.”

4. Discussion

The findings of this study reveal important insights into the challenges and opportunities for integrating values-based outcomes in engineering capstone design courses. These results highlight a critical disconnect between faculty recognition of the importance of values such as fairness, sustainability, accountability, and human well-being and their explicit inclusion in course design and assessment [16]. By failing to connect technical problem-solving with societal impacts, capstone design courses miss a critical opportunity to prepare students for the ethical complexities of professional practice. This disconnect underscores the need for a paradigm shift that positions values as central to engineering practice and education [17], [18].

The results align with Cech’s framework and provide empirical evidence of these dynamics in Canadian capstone design courses. The discomfort that some faculty express regarding teaching or assessing values reflects the enduring belief that engineering is strictly technical, relegating societal issues to the periphery. The variability in faculty approaches to teaching values underscores significant challenges and opportunities. Faculty who identified as female or from minority backgrounds were more likely to directly address values such as equity and inclusion, reflecting their lived experiences and perspectives on systemic inequities [19]. Conversely, faculty who identify as male and faculty with 6–10 years of teaching experience exhibited greater discomfort, possibly due to limited institutional support or professional development opportunities. These findings highlight the need for targeted interventions that address faculty-specific barriers to integrating values.

Institutional constraints, including limited lecture time, emerged as significant barriers to embedding values in capstone courses. Accreditation standards, while acknowledging the importance of ethics and societal considerations, often lack specificity and enforceability, leaving faculty without clear guidance [20]. This structural gap perpetuates the marginalization of values-based learning outcomes and reinforces the socio-technical divide. Revising accreditation standards to mandate explicit values-based outcomes is essential for bridging the gap between faculty recognition of values and their implementation. Accreditation bodies like the Canadian Engineering Accreditation Board (CEAB) and the Accreditation Board for Engineering and Technology (ABET) must provide clear guidelines and metrics for assessing values such as fairness, sustainability, and accountability [21]. Institutions, in turn, must allocate resources and create incentives to support faculty in aligning course content with these standards [22].

This study extends Cech’s (2014) framework by exploring how the culture of disengagement manifests in faculty perceptions and teaching practices. It also contributes to the literature on diversity, equity, and inclusion in engineering education by highlighting how faculty demographics influence engagement with values-based outcomes. By situating these findings within broader critiques of engineering education, this study underscores the importance of integrating technical and societal dimensions to prepare engineers for the ethical complexities of their profession. The variability in faculty approaches to teaching values reflects broader

systemic inequities and individual pedagogical preferences, emphasizing the importance of institutional and policy-level reforms to support inclusive and effective education practices [23].

To address the challenges identified in this study, we propose several practical strategies. Institutions should implement professional development programs that equip faculty with the skills and confidence to teach and assess values explicitly [20]. Collaborative workshops, mentoring programs, and interdisciplinary curriculum design sessions can help address faculty discomfort and promote innovative teaching practices [24]. Values-based learning must be systematically embedded into capstone design courses through structured modules, real-world case studies, and team-based projects [25]. Explicit assessment criteria should be developed to ensure consistent implementation. Accreditation bodies should revise their standards to emphasize the integration of value-based outcomes in engineering education. Clear benchmarks and accountability mechanisms are necessary to drive institutional and faculty-level changes [26]. Universities must allocate resources and create supportive environments that prioritize values-based learning. This includes funding for guest speakers, interdisciplinary collaborations, and initiatives that encourage faculty engagement with societal issues.

5. Limitations

While this approach aimed to provide both breadth (through Likert-scale survey responses) and depth (through qualitative analysis of open-ended responses), the quantitative component is not yet fully developed due to a limited sample size, which restricts the use of inferential statistics. This limitation highlights the need for further data collection to enable more robust statistical analysis. Future work will further analyze this data using comparative tools and include an analysis and discussion of co-values associated with each of our four main factors.

6. Conclusion

This study highlights a critical gap between the recognition of values in engineering practice and their explicit integration into capstone design courses. Addressing this disconnect requires systemic reforms that prioritize values-based education, align accreditation standards with societal needs, and provide robust support for faculty [27]. By bridging the socio-technical divide and embedding ethical considerations into the curriculum, engineering education can better prepare graduates to navigate the complexities of a diverse and interconnected world [28].

References

[1] A. Rugarcia, R. M. Felder, D. R. Woods, and J. E. Stice, “The future of engineering education: Part 1. A vision for a new century,” *Chem Eng Educ*, vol. 34, no. 1, pp. 16–25, 2000.

[2] E. A. Cech, “Culture of disengagement in engineering education?,” *Sci. Technol. Human Values*, vol. 39, no. 1, pp. 42–72, 2014, doi: 10.1177/0162243913504305.

[3] G. A. Ngwacho, “Value-based education incorporation in competency-based curriculum-recipe for all-inclusive education for enhanced global citizenship,” *J. Kenya National Commission for UNESCO*, vol. 4, no. 1, pp. 1–13, 2024.

[4] J. Vale, K. Gordon, R. Kirkscey, and J. Hill, “Student and faculty perceptions of capstone purposes: what can engineering learn from other disciplines?,” *Proc. Canadian Eng. Educ. Assoc. Conf.*, Montreal, QC, pp. 1-8, Jun. 2020, doi: 10.24908/pceea.vi0.14149.

[5] R. C. Hauhart and J. E. Grahe, *Designing and Teaching Undergraduate Capstone Courses*. Philadelphia, PA: John Wiley & Sons, 2014.
[6] J. Seniuk Cicek, S. Ingram, D. Mann, and R. D. Renaud, "Investigating the relative importance of the CEAB graduate attributes: Study design and initial findings," in *Proc. Canadian Eng. Educ. Assoc. Conf.: Innovation and Diversity in Eng. Educ.*, Toronto, ON, pp.1-9, June 4–7, 2017. Available: https://ceea.ca/en/publications/
[7] M. C. Paretti, H. Murzi, B. Lutz, M. Menon, And L. Schibelius, "Learning to teach engineering capstone design: An analysis of faculty members' experiences," *Int. J. Eng. Educ.,* vol. 40, no. 2, pp. 440–456, 2024.
[8] J. Vale, R. Kirkscey, J. Weiss, and J. Hill, "Evidence-based pedagogy for values outcomes in capstone experiences," *J. Scholarsh. Teach. Learn.,* vol. 24, no. 4, 2024.
[9] Cieminski and A. C. Strong, "An exploratory study of power dynamics and feedback in design reviews," in *Proc. ASEE Annu. Conf. & Expo.*, Columbus, OH, USA, June 2017. doi: 10.18260/1-2--28661.
[10] C. Schimpf, J. Swenson, and C. Burris, "Power over and power with: Integrating the concept of power into design team and stakeholder interactions," *Front. Educ.*, vol. 9, Jul. 2024, doi: 10.3389/feduc.2024.1371216.
[11] J. Howcroft and J. Vale, "What Do Stakeholders Value? Integrating Value Sensitive Design Techniques into an Impacts-Focused Design Course," *Proc. Canadian Eng. Educ. Assoc. Conf., Edmonton*, AB,2024, doi: 10.24908/pceea.2024.18503.
[12] J. A. Leydens and J. C. Lucena, *Engineering Justice: Transforming Engineering Education and Practice*. John Wiley & Sons, 2017.
[13] J. Howcroft, J. Vale, and R. Kirkscey, "Relationships Among Values, Design, Stakeholders, and Beliefs – A Preliminary Analysis of Student Perceptions," *Proc. Canadian Eng. Educ. Assoc. Conf.*, Edmonton, AB, 2024, doi: 10.24908/pceea.2024.18480.
[14] R. Kirkscey, J. Vale, J. Hill, and J. Weiss, "Capstone experience purposes: An international, multidisciplinary study," *Teaching and Learning Inquiry*, vol. 9, no. 2 SE-Articles, Sep. 2021, doi: 10.20343/teachlearninqu.9.2.19.
[15] J. D. Brown, "Likert items and scales of measurement," *Statistics (Ber)*, vol. 15, no. 1, pp. 10–14, 2011.
[16] J. Leydens, T. K. K. B. Morgan, and J. C. Lucena, "Mechanisms by which indigenous students achieved a sense of belonging and identity in engineering education," in *Proc. 2017 ASEE Annu. Conf. & Expo.*, Columbus, OH, June 2017. doi: 10.18260/1-2--28661.
[17] A. L. Pawley, "Learning from small numbers: Studying ruling relations that gender and race the structure of US engineering education," *J. Eng. Educ.*, vol. 108, no. 1, pp. 13–31, 2019.
[18] D. Riley, *Engineering and Social Justice*. San Rafael, Calif.: Morgan & Claypool, 2008.
[19] K. D. Beddoes, "Feminist scholarship in engineering education: Challenges and tensions," *Eng. Stud.*, vol. 4, no. 3, pp. 205–232, 2012.
[20] J. R. Herkert, "Future directions in engineering ethics research: Microethics, macroethics and the role of professional societies," *Sci Eng Ethics*, vol. 7, pp. 403–414, 2001.
[21] L. J. Shuman, M. Besterfield-Sacre, and J. McGourty, "The ABET 'Professional Skills' — Can They Be Taught? Can They Be Assessed?," *J. Eng. Educ.*, vol. 94, no. 1, pp. 41–55, Jan. 2005, doi: https://doi.org/10.1002/j.2168-9830.2005.tb00828.x.

[22] L. Jamieson and J. Lohmann, “Innovation with Impact,” American Society for Engineering Education, Washington, D.C., 2012. Accessed: Apr. 21, 2025. [Online]. https://monolith.asee.org/member-resources/reports/Innovation-with-Impact/Innovation-With-Impact-Report.pdf
[23] J. L. Hess and G. Fore, “A systematic literature review of US engineering ethics interventions,” *Sci Eng Ethics*, vol. 24, pp. 551–583, 2018.
[24] J. E. Froyd, P. C. Wankat, and K. A. Smith, “Five major shifts in 100 years of engineering education,” *Proc. IEEE*, vol. 100, no. Special Centennial Issue, pp. 1344–1360, 2012.
[25] J. E. Mills and D. F. Treagust, “Engineering education—Is problem-based or project-based learning the answer,” *Australasian J. Eng. Educ.*, vol. 3, no. 2, pp. 2–16, 2003.
[26] L. R. Lattuca, P. T. Terenzini, and J. F. Volkwein, “Panel session-Engineering change: Findings from a study of the impact of EC2000,” in *Proc. IEEE Frontiers in Educ. 36th Annual Conference*, San Diego, CA , 2006, pp. 1–2.
[27] L. L. Bucciarelli, “Ethics and engineering education,” *Eur. J. Eng. Educ.*, vol. 33, no. 2, pp. 141–149, 2008.
[28] A. R. Bielefeldt, “Professional licensure among civil engineering faculty and related educational requirements,” *J. Prof. Issues Eng. Educ. Pract*., vol. 145, no. 3, p. 4019004, 2019.