SECTION 6

Accreditation and engineering ethics education

Shannon Chance

Over time, individuals and entities within the engineering education community have developed a multifaceted strategy to synchronize global educational practices and performance metrics. This comprehensive approach involves conducting and disseminating educational research (evident throughout this handbook) and implementing research-informed pedagogies in the classroom (exemplified by the teaching methods section). It also includes establishing and aligning accreditation standards internationally – to guide the content and delivery of engineering education, including ethics. Although this section focuses on the accreditation of engineering ethics education (EEE), understanding the overall accreditation system is essential for grasping the ethics component.

Alignment across culturally and geographically diverse regions and nations has been facilitated by global accords, fostering a shared understanding of expectations in the engineering profession's globalized landscape. Cohesion is vital, as today's engineering students must possess skills to contribute effectively to international teams and projects, impacting environments and lives around the world.

The primary goal of accreditation is to ensure that graduates from engineering programs possess the necessary skills and competencies for effective engineering practice in a globalized world (Chance et al., 2022; Sthapak, 2012). Much of this standardization occurs in English, reflecting its status as the language of global engineering practice and engineering education research (Klassen, 2018), and is based on values first identified and described in the United States (Anwar & Richards, 2013) via organizations like the Accreditation Board for Engineering and Technology (ABET) and the American Society of Civil Engineers (ASCE). Accreditation frameworks for engineering education developed in the United States by ABET and ASCE included components of ethics; their uptake has expanded internationally over time through agreements such as the Washington, Sydney, and Dublin Accords.

Today, these accords are coordinated by the International Engineering Alliance (IEA) (2024), a non-profit alliance with 29 countries and 41 jurisdictions as members. IEA uses seven international agreements to "establish and enforce internationally bench-marked standards for engineering education and expected competence for engineering practice" (IEA, 2024, ¶ 2). Currently, graduates of accredited engineering programs are expected to demonstrate a comprehensive range of abilities, skills, and knowledge informed and aligned by these agreements – and ethics is a component

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required in most places, yet its definition is often fuzzy and poorly understood by assessors and engineering educators alike (Gywnne-Evans et al., 2021; Martin, 2020).

This handbook section comprises five chapters explaining how engineering education is regulated through a relatively centralized and top-down approach. It explores crucial aspects of the global drive to accredit and align engineering courses and delves into the *who*, *what*, *when*, *where*, *why*, and *how* of engineering education. The set starts by explaining the systems and how they developed over time but then methodically explores regional differences across engineering ethics education; the influence of the accreditation system on engineering licensure worldwide; what topics, ideas, and voices have been getting left out of the conversations that have defined the system; and strategies for ensuring more diverse and holistic representation in the future of EEE accreditation systems. The contributors to these chapters actively engage with professional accreditation systems and contribute to their ongoing evolution (e.g., the recent conference paper by Chance et al., 2024).

Positionality

The editor who has curated this section of the handbook, Shannon Chance, is a Registered Architect who has been active in institutional and architectural accreditation in the United States, having, for instance, served on and chaired multiple visiting teams for the National Architectural Accrediting Board. Shannon's Ph.D. was in higher education policy, planning, and leadership; these activities informed her interest in professional accreditation (you can read about how these topics overlap with EEE in Chance et al., 2022). Shannon's concern for diversity, inclusivity, and decolonization grew from her experience growing up in Virginia and then teaching at a minority-serving institution for 15 years (where ethics, environment, cultural diversity, and social justice were central themes in her teaching). She also led over a dozen international study programs across Africa and Europe for students from underrepresented groups, deepening her commitment to diversity and localized perspectives. As a result, she felt honored to have helped cultivate this handbook section on EEE accreditation; she and the contributing authors endeavored to include diverse voices and critical perspectives.

Chapter topics

The exploration of engineering education accreditation begins in this section from a historical perspective, tracing its origins and evolution to encompass ethical considerations. In the opening chapter, Chapter 32, titled 'Foundational Perspectives on Ethics in Engineering Accreditation,' authors Brent K. Jesiek, Qin Zhu, and Gouri Vinod delve into the formal integration of ethics outcomes into accreditation criteria for engineering graduates. They provide a comprehensive overview of the historical trajectory of accreditation, focusing on pivotal developments in the United States spanning more than a century. This historical analysis sets the stage for discussing the explicit inclusion of *ethics* in accreditation requirements, which emerged as a more recent trend in the 1970s.

Acknowledging the shift from input-based to output-based accreditation models, the chapter examines alternative quality assurance methods and the widespread global impact of the US-style accreditation approach in engineering ethics education. It explores how ethics and related outcomes have been formally incorporated into accreditation requirements across various global contexts, from the United States to Western/Anglo settings like the United Kingdom and Canada, as well as international agreements such as the Washington Accord and EUR-ACE, and cases in East Asian countries like Japan and China. The authors note a contemporary convergence toward a more consistent set of ideals and target outcomes related to ethics in engineering education. This set increasingly emphasizes the importance of engineering graduates recognizing the societal and environmental impacts of their work.

Overall, Jesiek, Zhu, and Vinod synthesize prior scholarship and conduct new analyses of primary source materials, providing valuable insights into areas of convergence and divergence among accreditation documents worldwide. They highlight the incorporation of equity and diversity in some current documents and probe unique emphases in documents from Japan and China. Their chapter underscores the need for additional comparative research across national and cultural groups to further understand the evolving landscape of engineering ethics education and accreditation.

Following up on this historical perspective, the authors of Chapter 33 on 'Contextual Mapping of Ethics Education and Accreditation Nationally and Internationally,' Sarah Junaid, José Fernando Jiménez Mejía, Kenichi Natsume, Madeline Polmear, and Yann Serreau provide such comparative research. They present an analysis of currently enacted accreditation documents from many different parts of the globe. Their chapter shifts from the historical focus of the prior chapter to focus on the present landscape – aiming to discern the similarities and differences in how ethics are addressed within various nations' EEE accreditation documents. As integral members of a larger research team, the authors monitor how various cultural groups perceive and oversee ethics education within their own specific contexts. They pose critical questions about the global and local perspectives embedded in engineering accreditation documents and introduce a framework for cross-cultural comparative analysis.

Specifically, utilizing the Hofstede model (Hofstede, 2011; Hofstede et al., 2010), the chapter evaluates accreditation documents from four major cultural groups: Latin America, Latin Europe, Confucian Asia, and Anglo countries, represented by case studies from Colombia, France, Japan, and the United Kingdom, respectively. The authors conduct comparative analyses involving seven cultural clusters, shedding light on how engineering education systems conceptualize ethics and articulating previously tacit aspects. They identify trends such as the emphasis on 'application' over 'evaluation' in ethics education and recommend a shift towards higher-order skills development. Both this and the prior chapter endeavor to integrate non-English-language documents. Tackling challenges of language translation, their research aims to comprehensively understand and interpret diverse approaches to ethics education and accreditation practices across different cultural and national contexts.

Overall, the chapter provides insights into the current global landscape of ethics education and accreditation, advocating for continued collaborative efforts to broaden the scope and deepen the understanding of ethical considerations in engineering education.

To probe the far-reaching implications of engineering accreditation, particularly its educational requisites and ethical components, Chapter 34, 'Accreditation and Licensure: Processes and Implications' by Angela R. Bielefeldt, Diana Martin, and Madeline Polmear, examines the interplay between accreditation and licensure across diverse engineering subfields, with a focus on civil engineering. This chapter elucidates the intricate legal frameworks governing the formal recognition of individuals as 'engineers,' highlighting the significant variations in credentialing processes across countries and even within regions. It also navigates the complex terrain of licensure, which has become crucial to ensuring public safety and upholding professional standards.

As the chapter underscores the divergent pathways to engineering licensure worldwide, it emphasizes the role of accredited education in helping ensure the technical proficiency and ethical acumen requisite for competent engineering practice. The linkage between education and licensure is particularly pronounced in civil engineering, which has set the tone for accreditation standards across other engineering disciplines in North America and beyond, influencing ethical considerations in accreditation processes. The chapter probes the multifaceted dynamics between education and professional practice, exemplified by the highly regulated relationships within the United States' civil engineering context, governed by diverse stakeholder perspectives and stringent regulations across culturally diverse states.

In exploring the case studies of engineering education and licensure in the United States and Ireland, the chapter elucidates contrasting approaches to ethics integration within accreditation systems. Whereas the United States exemplifies a robust framework underpinned by non-profit organizations like the American Society of Civil Engineers (ASCE) advocating for ethical considerations, Ireland's accrediting body, Engineers Ireland, has spearheaded transformative change by mandating progressive ethics initiatives. However, research conducted by Martin (2020) reveals past discrepancies between stated objectives and actual practices enacted during accreditation evaluations, underscoring the challenges assessors encounter in evaluating ethical curricular components. The findings accentuate the imperative for ongoing dialogue and collaboration to enhance the assessment of engineering ethics education globally.

Chapter 35, 'A Feminist Critical Standpoint Analysis of Engineering Ethics Education and the Powers at Play in Accreditation, Research, and Practice' by Jillian Seniuk Cicek, Robyn Mae Paul, Diana Martin, and Donna Riley, offers critical perspectives on engineering ethics education. The authors probe the dynamics of engineering ethics education within the realms of accreditation and research, interrogating whose voices are privileged and whose are marginalized in the global discourse surrounding engineering accreditation. They challenge the hegemonic structures that dictate the content of engineering ethics education, shedding light on how these structures perpetuate exclusionary practices and uphold Western-centric perspectives.

The Chapter 35 author team raises a number of key points: the Western-centric nature of accreditation standards, such as those outlined in initiatives like the Washington Accord, often disregards local sensitivities, erasing non-Western perspectives. Engineering's technical epistemology tends to overshadow and marginalize alternative disciplinary perspectives, perpetuating a narrow understanding of ethics. The emphasis on micro-ethics and outcome-based assessment in engineering education separates ethics from broader equity and social justice concepts, limiting its transformative potential. The accreditation process in engineering perpetuates a state of "willful ignorance" (Tuana, 2006, p. 10) regarding its own detrimental effects, hindering meaningful progress. By employing critical feminist analyses, the authors critique the complicity of individuals in reinforcing existing power dynamics through engineering accreditation and encourage more conscientious engagement in the formulation and enactment of accreditation policy.

Overall, the authors contend that engineering educators inadvertently impede transformative change in ethics education by conforming to accreditation standards. They advocate incorporating critical perspectives to challenge and resist the exclusionary status quo, urging the transformation of engineering ethics education to embrace authenticity, significance, and inclusivity. This shift, they argue, is essential for engineers to engage in the profound work of addressing the myriad challenges confronting society and the environment.

The final chapter of this section, Chapter 36 on 'Accreditation Processes and Implications for Ethics Education at the Local Level,' written by Helena Kovacs and Stephanie Hladik, also adopts a critical lens. It explores the disjunction between the implementation of ethics education at grassroots levels and its representation in accreditation documents and formal procedural requirements. Kovacs and Hladik highlight the bureaucratic nature of operationalizing ethics education, which often results in abstract descriptions that fail to capture the nuances of ethical practice in engineering. They note the lack of requirements in accreditation policies for students to demonstrate higher-level cognitive skills, arguing that this can hinder the development of critical thinking skills and practices related to engineering ethics.

Kovacs and Hladik argue that the current approach to accreditation is too impersonal – it limits the local community's ability to shape the learning environment to reflect local interpretations and needs, particularly but not exclusively related to ethics. They describe what this impersonal approach implies at institutional, program, instructor, and student levels. The authors explain that institutions may struggle to integrate ethics into technical coursework effectively when they are not allowed enough room for interpretation or 'personalization.' They note that instructors may rely on historical scenarios that do not address systemic oppressions inherent in engineering design work – the type of oppression so vividly described in the previous chapter. For students, the standalone nature of ethics courses may lead to a perception that ethics is tangential to their core program; they may overlook the complex intersections of culture and decision-making.

In response to these challenges, Kovacs and Hladik propose strategies for bridging the gap between abstract accreditation standards and localized ethical practice. They advocate for collaboration among stakeholders within educational environments to develop scenarios that resonate with students' lived experiences, fostering within students essential skills and behaviors for ethical engineering practice. By empowering students to engage critically with ethics in their local contexts, the authors argue, educators can facilitate meaningful and impactful learning experiences that contribute to societal ethical advancement.

Trends and implications

Bookending the compilation of texts within this handbook, this section on engineering ethics accreditation within this *Routledge International Handbook of Engineering Ethics Education* illuminates the intricate landscape of ethics education and its accreditation practices, tracing a journey from disparate national systems towards a network of accords aimed at fostering global alignment. This final section charts the evolution of accreditation, emphasizing the imperative of equipping graduates with the ethical reasoning skills necessary for today's interconnected and mobile engineering profession.

Throughout the section, a discernible shift over time towards a competency-based approach is evident. This competency-based approach emphasizes technical proficiency and, increasingly, non-technical professional skills, ethical consciousness, and social responsibility. Chapters of this section explore the integration of ethics into accreditation standards from multiple perspectives, acknowledging the diverse interpretations of ethical principles across cultures. There is an overarching theme of reflexivity and criticality – the author teams critically examine power dynamics within education, accreditation, and licensure, highlighting the challenges and, at times, questioning the wisdom of implementing uniform ethical standards in diverse contexts.

A central theme across the chapters is the importance of providing localized, meaningful educational experiences that resonate with societal and environmental needs. By infusing engineering ethics education with local cultural perspectives and personal engagement, engineering educators and engineering education researchers can advocate for a balanced approach that fosters meaningful outcomes and cultural relevance. For them to gain legitimacy and become more mainstream and broadly accepted, the alternative ways of implementing engineering ethics education (i.e., localized, personal, and culturally aware perspectives) need to be translated into policy measures. The definitions of what constitutes 'good' engineering education set by accrediting bodies need to be continually informed by critical reflection, and conscientious objection.

Looking forward, we, the contributors to this section, aspire to amplify diverse voices, expand our understandings, and advance engineering practice and education toward greater ethical awareness and contemplation. We seek to build upon established teaching methods, improve assessment practices, and refine accreditation processes to better articulate the ethical aspirations of the engineering profession.

Ultimately, the message resounding throughout this section is a call to treat each other and our planet with ethical regard and respect, celebrate diversity, and continuously strive for improvement. By embracing localized perspectives and fostering global collaboration, we can navigate the complexities of engineering ethics accreditation, charting pathways for progress toward a more ethically conscious engineering profession.

Conclusions from the editor of this section

Shannon Chance, the lead editor for this section, expresses profound gratitude to all the authors who contributed their expertise, insights, and passion to this project. From the outset, the authors played an integral role in shaping the format and content of the chapters, bringing a diverse range of perspectives and experiences to the table. Despite the challenges of language, distance, and time zones, the authors demonstrated perseverance and remarkable collaboration, working in cross-border teams to produce high-quality analyses and generating rigorous research via enthusiastic and thoughtful engagement. We look forward to pushing these ideas and lines of investigation forward and we welcome others to join us in future collaborations.

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32

FOUNDATIONAL PERSPECTIVES ON ETHICS IN ENGINEERING ACCREDITATION

Brent K. Jesiek, Qin Zhu, and Gouri Vinod

This chapter takes a historical approach to examining and contextualizing the formal incorporation of ethics and related learning outcomes in accreditation criteria for engineering graduates. We begin by examining the origins of modern forms of accreditation in higher education, emphasizing key developments in the United States over more than a century. We also note more recent, widespread moves from inputs- to outputs-based frameworks (i.e., shifting focus from curricula and resources to graduates' capabilities), alternate quality assurance methods in some other contexts, and the continued global influence of American-style accreditation models. We then present a series of specific cases to explore when, where, and how ethics and associated concerns have been formally codified in accreditation requirements for engineering graduates. We begin by examining the United States as a particularly well-documented and influential example, followed by two other Western/Anglo settings (the United Kingdom and Canada). We then turn to two international agreements (the Washington Accord and EUR-ACE) and two East Asian cases (Japan and China).

One main goal of this chapter is to historicize attention to ethics in accreditation policies for higher engineering education. By doing so in a cross-national, comparative manner, we identify broader trends such as increasing attention in accreditation guidelines to an ever-wider range of concerns and considerations linked to engineering ethics, professional responsibility, and associated learning outcomes. Yet our efforts also begin to illustrate how local contextual factors (e.g., cultural, organizational, political) likely inflect accreditation criteria and processes, in turn hinting at reverse salients that counteract global convergence trends.

Our approach to developing this chapter involved synthesizing prior scholarship, including other secondary accounts, and performing new analyses of some primary source materials. We took a broad view of ethics when examining accreditation documents, and our choice of specific cases for this chapter was inflected by the authors' expertise, background, and positionality. All three of us hold undergraduate degrees in engineering and graduate degrees in the humanities and/or social sciences. Our team also includes individuals who are from or have lived in the United States, United Kingdom, and mainland China, and the authors have previously conducted other cross-national comparative studies related to engineering education and practice. While the scope of our inquiry is constrained by limitations such as the availability of source materials and our own expertise (language, etc.), we hope this chapter inspires future research efforts focused on other countries and regions.

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Accreditation in higher education: historical origins and US trends

Mechanisms for monitoring the quality and legitimacy of universities can, in part, be traced to the early history of higher education in Europe, from the Middle Ages onward. Historians point to various kinds of oversight, including internal self-governance by student and faculty guilds and external mechanisms such as the formal chartering of institutions by the crown, state, or church (Maassen, 1997; Van Vught & Westerheijden, 1994). Another type of quality assurance emerged much earlier in China, where the Imperial Examination system was used over many millennia to screen candidates for civil-service positions (e.g., Min & Xiuwen, 2001). Yet as Maassen argued, modern accreditation – typically characterized by a focus on quality control mechanisms and the formal recognition of degree programs or entire institutions – "has its roots in American higher education" (1997, p. 124).

Some important early developments in the United States occurred with the establishment of its first colleges. Nine such schools (the 'Colonial Colleges') were operating by the time of the American Revolution, with 'charters' for their establishment usually granted by colonial governors, colonial assemblies, or the British Crown (Stoeckel, 1958). The charters helped establish the legitimacy of these institutions, giving them the formal, legal right to own property and grant degrees. Additional oversight and governance structures started to emerge by the 1780s, such as through the formation of a board of regents in New York to "charter, endow, and control" museums and schools in the state, including colleges (Harcleroad, 1980, p. 15). Nonetheless, historians note that the regulation of US colleges was generally lax into the nineteenth century, even as institutions of widely varying type and quality proliferated (Brittingham, 2019).

In 1847, the first non-profit, voluntary educational association was established in the United States: the National Medical Association, later named the American Medical Association (AMA) (King, 1982). Its founding was partly linked to concerns about the quality of medical education. While initially not very successful in addressing that particular issue, the AMA's efforts to develop a 'Code of Medical Ethics' had lasting impacts (King, 1983). More general calls to regulate US higher education intensified in the latter part of the nineteenth century, especially as new schools proliferated. In response, the late 1800s saw the establishment of regional, non-governmental accreditation bodies, beginning with the New England Association of Schools and Colleges (NEASC) in 1885 (Brittingham, 2009, p. 14). Colleges and universities were members of these voluntary organizations, which were in turn mainly focused on determining "which institutions were legitimately colleges" (Brittingham, 2009, p. 14) and publishing lists of such schools (Harcleroad, 1980, pp. 21–22).

The twentieth century was marked by several trends relevant to this volume. First, new associations focused on specific disciplines and fields multiplied from the 1910s onward. This created a regulatory structure where overall evaluation of universities or colleges was often conducted by regional associations, while discipline-based organizations accredited specific programs. Additionally, key features now associated with the US accreditation model developed during the middle part of the century. Per Brittingham,

> Between 1950 and 1965, the regional accrediting organizations developed and adopted what are considered today's fundamentals in the accreditation process: a mission-based approach, standards, a self-study prepared by the institution, a visit by a team of peers who produced a report, and a decision by a commission overseeing a process of periodic review.
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> *(2009, pp. 14–15)*

Further, the federal government gradually assumed a larger role in higher education, including through new laws and regulations – many from the post-war period – restricting access to federal funding (and especially student aid) to institutions accredited by recognized non-profit associations.

Another development worth noting involves growing emphasis on *results* and *outcomes* in accreditation processes, particularly in relation to student learning. As Nodine (2016) argued, the basic principles of outcomes-based education (OBE) can be "traced back hundreds of years to craft guilds, apprenticeship training programs, technical training programs (in the military, etc.), and licensure programs (for doctors, lawyers, etc.) where established standards for competence and performance have been identified for specific jobs and roles" (p. 6). He noted the resonance between outcomes-based approaches and the concept of mastery-based learning beginning in the 1920s and a turn toward competency-based education (CBE) from the 1960s onward. Nodine observed three key shifts in this confluence of movements, namely moves toward identifying specific learning outcomes, establishing how to assess or measure those outcomes, and developing more flexible and personalized educational pathways (p. 6).

In summary, the US system of accreditation reflects the country's cultural values and styles of governance, including a 'triad' of federal, state, and non-governmental actors, with the latter especially critical for providing a "self-regulatory, peer review system" for higher education institutions and programs (Brittingham, 2009, p. 10). As Akera et al. summarized,

> the highly decentralized system of educational governance within the U.S., and the great diversity of schools that are both the product and reasons for this ecosystem, have given rise to an extremely heterogeneous system. In the United States, accreditation serves as one of the few central mechanisms for shaping learning; it carries the weight of the state to the extent that it contributes to job and federal loan availability as well as licensure in selected fields.
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> *(2019, p. 1)*

Such points are salient in relation to other concerns, including questions about the place of learning outcomes related to ethics in degree programs and the diffusion of American-style accreditation models to other countries.

Further, accreditation is one of many kinds of quality assurance (QA), and alternative approaches like "academic audit and inspection" are more prevalent in some settings (Brittingham, 2009, p. 17). Today, accreditation is often associated with defining features like systematic self-assessment, some kind of external review mechanism, and a forward-looking evaluation philosophy (e.g., as reflected in 'continuous improvement' models). Since at least the late twentieth century, rising accountability pressures in higher education in many parts of the world have been accompanied by more widespread implementation of accreditation systems, albeit with notable local variations (El-Khawas, 2007). The number of foreign universities and degree programs directly accredited by US-based or international organizations has also grown considerably, a trend which has, in turn, been critiqued as a new kind of 'academic colonialism' (Altbach, 2003). As Altbach argued, "American accreditation is designed for the realities of American higher education" and exporting that model could pressure foreign institutions to conform to "American patterns of curricular and academic organization" (p. 6) while disregarding local realities.

Accreditation and ethics in engineering education: detailed cases

We now focus on cases focused on specific countries and international agreements. We begin with three Western/Anglo examples (the United States, the United Kingdom, and Canada), followed by two international agreements (the Washington Accord and EUR-ACE) and two East Asian cases (Japan and China). Readers may also want to consult the appendix of this chapter, as it provides verbatim excerpts of ethics-related outcomes/attributes for many of the accreditation frameworks discussed below.

United States

Early efforts to formally evaluate engineering degree programs in the United States were led by the American Institute of Chemical Engineering's (AIChE) Committee on Chemical Engineering Education starting in 1922, followed by the publication of a list of recognized degree programs at 14 schools in 1925 (Prados, 2008, p. 2). Prados claimed that the subsequent Wickenden report on engineering education helped stimulate broader interest in a new national organization with a similar role across engineering fields. As Wickenden declared, "If protection of standards is needed, the accrediting of engineering schools by their own organization and the national professional societies will probably prove to be much more effective than accrediting by educational bodies of a more general character" (1934, p. 1082). An organization of this sort, the Engineers' Council for Professional Development (ECPD), was established in 1932 with seven professional societies as its founding members (Prados, 2008, p. 6). The organization started accrediting engineering degree programs from 1935–1936 onward (Prados, p. 6).

As Stephan documented, the original ECPD accreditation criteria – unchanged from 1933 to 1950 – offered "virtually no specification of minimum standards, except that all accredited programs had to lead to a degree" (2002, p. 11). Yet in 1955, a new set of 'Additional Criteria' mandated more specific curricular requirements in mathematics, basic science, engineering sciences, engineering analysis and design, and humanistic-social studies (Parker, 1961, p. 14). These were specified as the minimum number of years of study (or fraction thereof) in each designated area. The ASEE's *Summary of the Report on Evaluation of Engineering Education* ('Grinter Report'), published in 1955, reflected this period's shift toward a quantitative view of degree requirements: "The consideration of curricula cannot proceed wholly on a philosophical or qualitative basis but must eventually be approached quantitatively in semester hours or at least in terms of fractional percentages of the total program" (CEEE, 1994, p. 85). Yet these new guidelines did not explicitly refer to 'ethics.' The 1955 criteria, for example, noted very generally that a student's humanistic-social studies coursework "should be selected from fields such as history, economics, government, literature, sociology, philosophy, psychology, or fine arts" (Parker, 1961, p. 14). However, the "qualitative" portion of this same document did mention "safety to life and property" as a relevant consideration for engineers doing design work, alongside economic and functional concerns (Parker, p. 14).

By the early 1970s, the ECPD's curricular requirements for accredited engineering degree programs were only a page long. They called for "the equivalent of one-half year to one full year as the minimum content in the area of the humanities and social sciences" (ECPD, 1971, p. 65), but did not explicitly refer to ethics or related themes. Yet, as the length and specificity of the ABET accreditation guidelines steadily increased from the 1970s onward, ethics and associated concerns became more explicit. For example, revised criteria published in 1973 referred to "the extent to which the program develops an ability to apply pertinent knowledge to the practice of engineering in an effective and professional manner," including "development of a sensitivity to the socially related technical problems which confront the profession" (ECPD, 1973, p. 44). The aforementioned humanities and social sciences requirement was also revised to simply specify "one-half year" as the minimum, while clarifying that such coursework was important for "making the young engineer fully aware of his [*sic*] social responsibilities and better able to consider related factors in the decision-making process" (p. 45). In 1974, a new footnote also clarified the meaning of the ECPD's required one-half year of engineering design "in its broadest sense" noting that "sociological, economic, aesthetic, legal, ethical, etc. considerations can be included" (ECPD, 1974, p. 68). In 1975, this same language was moved from a footnote into the body of the guidelines (ECPD, 1975, p. 75). These appear to be the first direct mentions of ethics in ECPD's accreditation guidelines for engineering programs.

These criteria were relatively stable until 1979 when ethics became even more pronounced in the ECPD guidelines. More specifically, the statement "development of an understanding of the characteristics of the engineering profession and the ethics of engineering practice" was added to the overarching preamble statement introducing the general program guidelines (ECPD, 1979, p. 60). This objective was further underscored in a later passage:

> An understanding of the ethical, social, and economic considerations in engineering practice is essential for a successful engineering career. Coursework may be provided for this purpose, but as a minimum it should be the responsibility of the engineering faculty to infuse professional concepts into all engineering coursework.
>
> *(p. 61)*

As Stephan reported, the latter passage was retained for many years, "substantially unchanged until the issuance of EC 2000" (2002, p. 13).

Ethics and related concerns were also explicit in the general student outcomes presented as part of ABET's Engineering Criteria 2000 (EC2000) framework adopted in 1996 (Lattuca et al., 2006). The new guidelines stipulated that graduates should have "an understanding of professional and ethical responsibility" (Criterion 3.f), "the broad education necessary to understand the impact of engineering solutions in a global and societal context" (3.h), and "a knowledge of contemporary issues" (3.j) (Lattuca et al., pp. 18–19). The most recent version of the Criterion 3 outcomes includes expanded language around graduates having "an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors" (ABET, 2018, I.3.2). It also features a multifaceted outcome focused on ethics, namely: "an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts" (I.3.4). As reported by Matos et al. (2017), earlier drafts did not mention 'professional responsibility' in the ethics outcome, which generated considerable push-back and led to restoration of the phrase. Some of ABET's field-specific program criteria now also include attention to ethics and related concerns. For example, the criteria for "Civil and Similarly Named Engineering Programs" mandate coverage of "principles of sustainability in design" and the ability to "analyze issues in professional ethics" and "explain the importance of professional licensure" (ABET, 2018, III).

There are at least three key points to take from this brief account. First, explicit attention to ethics and related concepts was included in ABET guidelines earlier than previously reported. Both Pritchard (1990) and Stephan (2002) cited 1985 as the year when "understanding of the ethical characteristics of the engineering practice and profession" first appeared in the guidelines. Yet similar language initially surfaced in 1979, and other relevant statements and concepts appeared even earlier. Second, ABET EC2000 is often framed as a key point of transition where concerns over programmatic 'inputs' were replaced by a focus on 'outcomes' in engineering accreditation processes (Lucena et al., 2008). Yet the preceding account shows how ethics, professional responsibility, and related concerns were framed in outcomes-oriented language as early as the 1970s. This tracks well with other accounts regarding a gradual and more general turn toward outcomes- and competency-based approaches to education and training, especially from the 1960s onward (Hodge, 2007).

Finally, it is worth considering why the aforementioned changes were made. Unfortunately, the official accounts from ECPD offer little explanation. Period reports from the ECPD's ethics committee were primarily focused on a major revision of the ECPD Code of Ethics of Engineers, published in 1974 and then championed for more widespread adoption by other professional societies. Nonetheless, it is reasonable to speculate that the incorporation of ethics-related outcomes in the ECPD guidelines reflected broader movements, such as the efforts of engineer activists in the 1960s to critically interrogate the social and environmental effects of technology (Wisnioski, 2016), as well as the 1970s-era establishment of engineering ethics as a distinct scholarly field (Weil, 1984). More research is needed to establish whether and how these historical trends are connected. And, as Stephan (2002) pointed out, changing language in accreditation documents does not necessarily mean that engineering programs, or even accreditors, have historically treated ethics and related outcomes as key concerns.

United Kingdom

The United Kingdom was an important point of origin for engineering as a modern profession with roots going back to the eighteenth century. Yet fragmentation has been a hallmark of British engineering over this long history, in part reflected in the proliferation of engineering professional societies – and numerous calls to unify the profession (Klassen, 2018, pp. 78–84). As Klassen explained, accreditation of engineering programs in the United Kingdom has historically involved a complex assortment of policies and actors, including individual disciplinary professional societies, and with the Engineering Council providing additional coordination and oversight, especially from the 1980s onward. The United Kingdom's enduring tradition of apprenticeship-based training adds further complexity to this milieu.

Early efforts to unify the profession and improve coordination across the institutes are reflected in the creation of the Joint Council of Engineering Institutions in 1965 (called the Engineering Council since 1981) (Chapman & Levy, 2004). In 1984, the Council's *Standards and Routes to Registration* (SARTOR) established common training pathways and requirements for the three main professional grades recognized in the United Kingdom (Chartered Engineers, Incorporated Engineers, and Engineering Technicians). Second and third editions were published in 1990 and 1997. The latter (SARTOR3) is notable for specifying – like period documents from other countries – five specific outcome areas for each professional grade. One of these areas was specifically dedicated to "Professional Conduct" and declared that qualifying candidates for registration should "Make a personal commitment to live by the appropriate code of professional conduct, recognising obligations to society, the profession and the environment" (UKEC, 1998, p. 3), followed by four precepts that expanded on and clarified aspects of this general statement.

Concerns about the Engineering Council's influence over the accreditation of degree programs – including its efforts in SARTOR3 to raise standards – led to new reforms in the late 1990s and early 2000s. This included the promulgation of a new UK Standard for Professional Engineering Competence and Commitment (UK-SPEC) in 2003 to replace SARTOR. The new UK-SPEC placed greater emphasis on outcomes and eliminated earlier 'input-based' considerations like the quality of students entering degree programs (Temple, 2005). In 2004, the Engineering Council released its Accreditation of Higher Education Programmes (AHEP) policy and stated that it would share the responsibility for regulating engineering education standards with an independent non-profit, namely the Quality Assurance Agency for Higher Education (QAA) (EC, 2004). Additionally, the Engineering Council and Royal Academy of Engineering issued a common "Statement of Ethical Principles" for the engineering profession in 2005 (UKEC, 2017). As the most recent (4th) AHEP document notes, more than 40 engineering institutions are licensed by the Engineering Council to accredit degree programs in their respective fields (UKEC, 2020).

All four versions of the AHEP policy published to date include ethics requirements for engineers seeking registration at the incorporated and chartered levels. The first edition (AHEP1) stated that graduates should have an "Understanding of the need for a high level of professional and ethical conduct in engineering" and "Understanding of appropriate codes of practice and industry standards" and elsewhere repeatedly referred to the importance of health, safety, and risk issues, as well as environmental and sustainability concerns (UKEC, 2004, pp. 11–12). And although the next two editions (AHEP2 in 2013 and AHEP3 in 2014) showed little change in ethics-related outcomes, the most recent AHEP4 (released in 2020 and set to take effect in 2024) includes some notable revisions. First, it featured increasingly nuanced language to distinguish learning outcomes for incorporated and chartered grades, including for three distinct educational pathways associated with each. And while it retains five main outcome categories, it includes an "Engineering and society" category in place of "Economic, legal, social, ethical and environmental context" in AHEP3 (UKEC, 2014) and the even earlier "Economic, social and environmental context" in AHEP1 and AHEP2 (UKEC, 2004; UKEC, 2013). This category of outcomes also featured a revised preamble stating:

> Engineering activity can have a significant societal impact and engineers must operate in a responsible and ethical manner, recognise the importance of diversity, and help ensure that the benefits of innovation and progress are shared equitably and do not compromise the natural environment or deplete natural resources to the detriment of future generations.
>
> *(UKEC, 2020, p. 30)*

As this statement suggests, the new standard incorporates wide-ranging outcomes that refer to ethical conduct, risk management, sensitivity to the broader impacts of engineered solutions, and attention to diversity and equity concerns. Indeed, among educators interviewed by Xavier et al. (2023), "AHEP4 was believed to constitute a step change that encouraged the inclusion of [the] 'social'" (p. 4) in engineering programs.

As a final development worth noting, the Engineering Professors' Council (EPC) and Royal Academy of Engineering released an Engineering Ethics toolkit in 2021 "to help engineering educators integrate ethics content into their teaching" (EPC, 2022). As background, they note "growing advocacy for bringing engineering ethics to the fore in engineering programmes – alongside technical skills," including as reflected in current AHEP and UK-SPEC standards.

Canada

Since the early decades of the twentieth century, engineering has been legally regulated as a profession in Canada, mainly at the provincial/territorial level but with national co-ordination (Klassen, 2018, pp. 33–34). Oversight of engineering degree programs originated with establishment of the Canadian Accreditation Board (CAB) in 1965 as a standing committee of the Canadian Council of Professional Engineers (or Engineers Canada from 2007 onward), with the first assessments of undergraduate degree programs occurring in 1969 (CAB, 1975, p. 4). By 1975, the CAB's accreditation criteria specified required program content in five main areas, including "a minimum of one-half year of appropriate humanities and social sciences" (CAB, 1975, p. 15). While this document did not explicitly mention ethics, it did note the need for students to develop "social consciousness" and receive a "sufficient liberal education" (p. 12).

In 1976, a revised set of "specific objectives" included a section (B-1.7) stating that "Students must be made aware of the vital role of the professional engineer in society and the interaction of engineering work with the economic, social and human goals of the nation" (CAB, 1976, p. 10). The document went on to explain that students in accredited programs must understand:

a) the quality of the natural and human environment and the impact of technology;
b) the function and activities of our society, business and government in shaping our society and its values;
c) the legal responsibilities and ethical guidelines and constraints applied to the profession.

(CAB, 1976, p. 10)

As the report emphasized, "Every opportunity should be seized to weave into the fabric of engineering education an awareness of such matters through course material and through liaison with practicing engineers and other groups outside of the educational establishments" (p. 10). Another stipulation regarding a "minimum one half year of appropriate humanities, social sciences and administrative studies" clarified that the aim of such coursework was to "develop a social awareness as related to the philosophy of section B-1.7" (p. 14).

Similar language was retained until 1986 (under the renamed Canadian Engineering Accreditation Board, or CEAB), when a streamlined version of the accreditation criteria removed any direct mention of ethics. A new section of the guidelines (2.1.4) instead simply stated: "The criteria are intended to ensure that students are made aware of the role of the professional engineer in society and the impact that engineering in all its forms makes on the environmental, economic, social and cultural aspirations of society" (CEAB, 1987, p. 14). In the CEAB's 1989–1990 annual report, this statement was revised to refer to the "role *and responsibilities* [emphasis added] of the professional engineer" (CEAB, 1990, p. 14). Requirements published in 1993 also added language in the "Engineering Design" area to acknowledge "constraints which may be governed by standards or legislation to varying degrees depending upon the discipline. These constraints may relate to economic, health, safety, environmental, social or other pertinent factors" (CEAB, 1993, p. 17). In 1996, a new criterion was added (2.2.8) stipulating that "Each program must ensure that students are made aware of the role and responsibilities of the professional engineer in society. Appropriate exposure to ethics, equity, public and worker safety and health considerations and concepts of sustainable development and environmental stewardship must be an integral component of the engineering curriculum" (CEAB, 1996, p. 14).

The preceding language was retained verbatim until 2008 when it was replaced by a new set of 12 "Graduate Attributes" (CEAB, 2008, pp. 12–13). Four of the attributes refer to ethics or related concerns, namely (1) design, (2) professionalism, (3) impact of engineering on society and the environment, and (4) ethics and equity. This same document also retained quantitative requirements for curricular coverage in specific areas, including a stated expectation that all programs include studies of "The impact of technology on society," "Health and safety," "Professional ethics, equity and law," and "Sustainable development and environmental stewardship" (CEAB, 2008, p. 18). These requirements were subjected to only minor editorial changes in more recent versions of the CEAB guidelines. As this overview suggests, the current CEAB framework includes a fairly comprehensive set of ethics-related attributes similar to what can be found in policy documents promulgated in many other contexts.

Washington Accord

Western nations have had deep and lasting impacts on engineering education and professional practice around the world, both through colonial legacies and other influences. As a more specific example, the US-based ABET describes how it engages globally through four mechanisms: "1) accreditation of academic programs; 2) mutual recognition of accreditation organizations; 3) Memoranda of Understanding with accreditation/quality assurance organizations; and 4) engagement in global STEM education organizations" (ABET, n.d.). The third mechanism (regarding MOUs) includes specific cross-national agreements (e.g., between the United States and Canada concerning the accreditation of engineering degree programs, first signed in 1979) and more general agreements like the Washington Accord.

The latter is a multilateral framework that sets standards for mutual recognition of engineering degree programs and professional mobility among signatories, including six countries when initially signed in 1989 (Australia, Canada, Ireland, New Zealand, the United States, and the United Kingdom). Founded in 2007, the associated International Engineering Alliance (IEA) is a global non-profit organization that manages seven such agreements among members representing 41 jurisdictions in 29 countries (IEA, 2015). The IEA also maintains a set of "Graduate Attributes and Competency Profiles" developed from 2001 to 2005 by signatories of the Washington Accord (the preceding six countries, plus Hong Kong and South Africa). "Ethics" was one of 13 attributes in Version 1.1 of this framework ("Understand and commit to professional ethics, responsibilities, and norms of engineering practice"), along with other relevant concerns listed under "The Engineer and Society" and "Environment and Sustainability" (ABET, 2006). Similar categories and language were retained in later revisions (e.g., see IEA, 2013). Today, the Washington Accord has 23 full signatories and seven provisional ones (IEA, n.d.). As this overview suggests, a relatively small group of actors – primarily representing Western, anglophone nations or former colonies thereof – have spearheaded the development of global standards for accrediting engineering programs using outcomes-based approaches. As discussed in more detail below, Japan and China are contrasting examples of Washington Accord adoption, each likely inflected by distinct cultural and ideological factors.

European Accredited Engineer (EUR-ACE)

Beginning in the late 1990s, the intergovernmental initiative known as the 'Bologna Declaration' stimulated efforts to harmonize higher education programs across Europe (Augusti, 2007). Field-specific initiatives like the EUR-ACE (European Accredited Engineer) standard grew out of this larger trend. They became linked to a desire to increase the global mobility of engineering graduates, establish minimum quality standards for engineering degree programs, and encourage quality improvements (Augusti, 2007; Sánchez-Chaparro et al., 2022). EUR-ACE is a comprehensive standard with multifaceted attention to physical facilities; staff qualifications; program management; teaching, learning, and assessment practices; and so on (ENAEE, 2021).

Like other contemporary frameworks, EUR-ACE, from the beginning, also emphasized programmatic aims and student learning outcomes. Regarding the initial development of EUR-ACE, Augusti (2010) noted that a study of engineering accreditation systems across Europe "revealed striking similarities behind different façades" which in turn made "compilation of a set of shared accreditation standards and procedures comparatively easy" (p. 2). The resulting outcomes for EUR-ACE were organized around six core dimensions, with the sixth ("Transferable Skills") stressing the importance of graduates committing to "professional ethics, responsibilities and norms of engineering practice" (Augusti, Birch, & Payzin, 2011). The framework also underscored the importance of societal, environmental, ethical, and other "non-technical" considerations in three other outcome areas. Similar language and outcomes have been retained in more recent versions of the EUR-ACE standard (e.g., ENAEE, 2021).

From its 2006 inception to the present, the EUR-ACE designation has been granted to more than 4,000 degree programs at more than 700 higher education institutions in 46 countries, in Europe and beyond (ENAEE, n.d.). As EUR-ACE continues to spread, commentators have pointed out that the complexity and diversity of European higher education institutions and policy bodies introduce both benefits and challenges for cross-border quality assurance and accreditation efforts. For example, Sánchez-Chaparro et al. noted "difficulties in interpretation and consistency" of the European standards, while at the same time opening up "learning opportunities" as accreditation agencies work to adopt common standards while respecting cross-national contextual differences (2022, p. 322). How ethics is specifically treated in such processes is beyond the scope of this chapter, but worthy of further exploration.

Japan

Engineering as a modern field of practice originated in Japan in the late nineteenth and early twentieth centuries. Over time, engineers were primarily identified as members of corporate 'households' aligned with broader national goals for economic and technological development (Downey et al., 2007). Thus, the Western concept of autonomous professionalism is relatively new for Japanese engineers, and engineering societies in Japan have historically not operated like their Western counterparts, instead mainly focusing on creating standards for education and industrial practices. Indeed, most have had little historical engagement with codes of ethics or accreditation-related activities. Downey et al. reported that the Japanese Society of Civil Engineers has had a statement of "Beliefs and Principles of Practice for Civil Engineers" since at least 1938 but argued that it was "of relatively little consequence" (2007, p. 480). Another notable exception is the Japan Consulting Engineer Association's (JCEA) first ethics codes (published in 1951 and 1961), which reflected influences from counterpart American societies (Kenichi, 2021). Kenichi additionally reports that Kimura Hisao, Chair of the IEEE Computer Society's Japan Chapter, advocated for developing ethics codes among Japanese engineering societies in the 1960s and 1970s. Yet others expressed reluctance, arguing that (1) codes of ethics might encourage engineers to demand their own rights to the detriment of their social responsibilities and (2) it was unnecessary to develop codes of ethics for individual fields when there should be a code of ethics for *all* professional societies (Kenichi, 2021). Some IEEE Japan board members were also worried that establishing a code of ethics for a particular association (e.g., IEEE Japan) might be a selfish act, disturbing the harmony of the scientific community in Japan (Kenichi, 2021).

In the 1990s, the Japanese government undertook initiatives to internationalize engineering education programs and qualifications with the goal of making their engineers more globally competitive, in turn setting in motion a burgeoning professionalization movement. Engineering societies also started to establish their own ethics codes (Kenichi, 2021), and in 2000 the Japanese *diet* (legislature) passed an updated Professional Engineers Law, which explicitly referred to the ethical duties of engineers (Downey et al., 2007). Another key development involved the 1999 founding of the Japan Accreditation Board of Engineering Education (JABEE), which created an accreditation system similar to the US model. And in 2002, an ethics outcome was added to Japan's accreditation criteria, stipulating that graduates of accredited programs should demonstrate "understanding of … engineers' social responsibilities (engineering ethics)" (Downey et al., 2007). Yet early efforts to develop and roll out accreditation criteria came with growing recognition that there was a lack of ethics education in Japanese engineering education and uncertainty about how it should be taught (Iseda, 2008; Kanemitsu, 2021). Nonetheless, Sato and Harada (2005) found that 76.1% of surveyed institutions were soon thereafter offering courses in engineering ethics.

During this same period, the Japanese Society for Engineering Education (JSEE) established a committee to study the syllabi of engineering ethics courses in Japan and found that they incorporated some core ideas and key concepts from Western engineering ethics, such as the analogy between ethical problem-solving and design thinking and specific tools for ethical decision-making (Kobayashi & Fudano, 2004). The JSEE's Engineering Ethics Research Committee also assumed an instrumental role in providing nationwide guidance and resources related to engineering ethics education. Since 2012, this committee has developed three versions of the "Learning and Educational Objectives of Engineering Ethics Education." The most recent version features four learning objectives: (1) understanding the relationship between science, technology, society, and the environment (cognitive domain); (2) understanding the role, responsibilities, and duties of engineers (cognitive domain); (3) ethical judgment abilities and problem-solving abilities (cognitive domain); and (4) attitudes and shared values as professional engineers (affective domain) (Kobayashi & Fudano, 2016). These are in general alignment with current JABEE requirements, with one of the nine learning criteria focused specifically on "understanding of effects and impact of professional activities on society and nature, and of professionals' social responsibility." This criterion is in turn elaborated with a series of more specific statements:

- "Understanding of impact of technology of related engineering fields on public welfare"
- "Understanding of implication of technology of related engineering fields on environmental safety and sustainable development of society"
- "Understanding of engineering ethics"
- "An ability to take action based on the understanding mentioned above" (JABEE, 2016, p. 4).

Additionally, a dedicated design criterion specifies that graduates should be able to "specify constraints from public welfare, environmental safety, and economy" (JABEE, 2016). Such statements reflect a fairly typical range of concerns found in many accreditation frameworks. (For more on Japan, see Chapter 33.)

China (mainland)

Contemporary concerns about quality assurance in Chinese higher education must be situated against a much longer historical legacy and backdrop, including the civil-service examination system in Imperial China, which serves as one of the very first examples of a standardized test system (O'Sullivan & Cheng, 2022). This system ensured that students met the criteria (or 'learning outcomes,' in a modern sense) for professional politicians and bureaucrats serving the Imperial government – some of whom later became what we would now call engineers (Dodgen, 2001). The state employed various efforts and tactics to indoctrinate examinees, including through government-issued textbooks and the contents of the exam itself (Lin, 2021).

In more contemporary terms, developing countries such as China have often taken a pragmatic approach to developing professional standards and accreditation systems. This can take the form of borrowing from the West, as reflected in a series of ethics codes published from 1933 onward by the Chinese Institute of Engineers (CIE) (Zhang & Davis, 2018). As Zhang and Davis (2018) argue, the adaptation and evolution of these early codes seemed to reflect practical realities and national development objectives rather than Confucian cultural values. They and others (e.g., Cao,

2015) have additionally noted a lack of formal ethical codes for engineers in mainland China from the Communist Revolution (which ended in 1949) to the present. Yet this is not surprising given China's ideological context, that is, where Western ideas of autonomous, independent professionalism stand in tension with Communist party authority and values.

Nonetheless, ethics and related concepts have recently surfaced in engineering education, particularly against the backdrop of a pragmatic approach to accreditation policy-making. Given the lack of a pre-existing accreditation model, the Washington Accord was used as an actionable 'startup template' in China, but without fully acknowledging or challenging its fundamental ideas, concepts, and assumptions (Zhu, Jesiek, & Yuan, 2014). Chinese policy-makers made adjustments to the ABET accreditation process to ensure that the resulting policies were better aligned with China's unique cultural and political context (e.g., by seeing ethics and ideological education as related or interchangeable). Accreditation expert and former university administrator Li (2017) observed that the adoption of the Washington Accord accreditation criteria in the early development of China's engineering accreditation system served the pragmatic goal of ensuring that the professional qualifications of Chinese students who graduate from accredited programs would be recognized by other Washington Accord signatories – thus enabling global mobility of Chinese talent.

In 2013, China became a provisional member of the Washington Accord, and in 2016 a full signatory member. Scholars have argued that a major motivation for establishing an accreditation system for engineering education was in part linked to concerns over academic quality and administration (Wang, Zhao & Lei, 2014). Wang et al. also pointed out that, in contrast to other countries, China's accreditation system exhibited more 'top-down' characteristics. Rather than primarily relying on representatives from industry to shape the standards for accreditation, the central government spearheaded coordination and policy-making, including organizing expert panels for formulating learning outcomes for engineering programs.

Current Chinese accreditation standards include ethics-related statements in four different outcome categories, namely (c) Design/Development Solutions, (f) Engineering and Society, (g) Environment and Sustainable Development, and (h) Professional Ethics. Notably, the only direct mention of social responsibility in engineering is in outcome (h), which states that students who graduate from accredited programs should "possess literacy in humanities and social sciences and social responsibility," be able to "understand and comply with professional morality and norms in engineering practice," and "exercise [their] responsibilities" (CEEAA, 2022a, section 4.3). Like many other accreditation policies, the other learning outcomes noted here (i.e., (c), (f), and (g)) variously indicate that engineering practice – including design, analysis, and problem-solving activities – should include attention to social, environmental, health, legal, and cultural, and other impacts.

Nevertheless, Li (2017) reminded engineering educators in China that accreditation criteria should not be considered equivalent to engineering program quality standards. In other words, the accreditation standards are a minimum benchmark, and the ethics-related learning outcomes may not wholly satisfy the government's expectations regarding graduate engineers' ethical and political qualities. For instance, some moral and ideological educational goals set by the central government – such as cultivating the builders and successors of Socialism with comprehensive development in morality, intelligence, physical fitness, and aesthetic appreciation – are not explicit in the accreditation policies but are nonetheless central to the training of Chinese engineers.

Given the top-down governance structure of China's policy-making, China has also employed multiple tactics to ensure that engineering programs and accreditation experts accurately interpret the accreditation criteria set by the central government and incorporate them into educational reforms and program evaluations. To begin, the government implemented several 'innovative' organizational structures to purportedly guarantee the 'autonomy' of accreditation activities while also maintaining the central government's influence in accreditation practices. It designated the Chinese Association for Science and Technology (CAST) as the official agency responsible for representing China's membership within the Washington Accord. The major accreditation body, the Chinese Engineering Education Accreditation Association (CEEAA), then became a corporate member of CAST, despite the fact that CEEAA was initiated by and located in the Chinese Ministry of Education. As "the largest national non-governmental organization of scientific and technological workers in China," CAST oversees other engineering societies such as the China Civil Engineering Society. Additionally, these societies were granted the authority to offer expert guidance and direction concerning engineering accreditation within their respective fields of expertise. Therefore, one notable aspect of engineering ethics education in China is that engineering societies organize nationwide professional development activities that train faculty in their specific engineering fields to teach discipline-based engineering ethics (e.g., civil engineering ethics, safety engineering ethics, etc.).

From as early as 2016, the central government has also regularly published guidelines on how to interpret and implement the accreditation criteria appropriately. The Chinese Engineering Accreditation Association (CEEAA) published the two most recent guidelines in 2020 and 2022. These guidelines provide details on how each learning outcome should be evaluated and how to understand certain key terms such as 'ethics' and 'social responsibility' in students' learning outcomes. In the most recent revision, one of the six major guiding principles is related to the cultivation of responsible engineers:

> To further clarify the requirements for implementing the fundamental task of "cultivating moral character and nurturing talented individuals," it is demanded that the educational objectives of professional training reflect the education policy of fostering socialist constructors and successors who possess comprehensive development in morality, intelligence, physical fitness, aesthetics, and labor. The graduation requirements should also incorporate relevant content regarding socialist core values.
>
> *(CEEAA, 2022b, pp. 5–6)*

As this statement suggests, the pragmatic adaptation of Western professional standards and processes in the Chinese context reflects a core concern with positioning ideological allegiance to the Chinese Communist Party (CCP) above other types of ethical commitments and values.

Discussion and conclusion

As documented in this chapter, modern forms of accreditation in higher education have strong historical roots in the US system of higher education. The first formal mechanisms to accredit engineering degree programs also originated in the United States, evolving considerably over a century-long period and ultimately having a marked global influence. However, explicit attention to ethics and related concerns in accreditation requirements is a more recent trend. For the countries examined in this chapter, such statements first appeared in 1970s-era policies in the United States and Canada. These same guidelines additionally reflected the early presence and influence of outcomes-based educational philosophies, albeit in tandem with period expectations for content and curricula as 'inputs' for engineering degree programs seeking accreditation. A more widespread transition to outcomes-based standards for engineering education occurred from the 1990s onward, accompanied by growing attention to ethics and related concerns.

Further, the preceding account suggests considerable convergence toward a common, core set of ethics-related outcomes in accreditation frameworks in many different countries and regions. Such documents most often refer to (1) professional/ethical responsibilities in general; (2) ethics as an 'upstream' constraint or consideration in problem solving, design, and so on; and (3) the 'downstream' impacts of engineered solutions on society. Further, most accreditation policies now mention environmental and/or sustainability concerns, in some cases as dedicated learning outcomes. Interestingly, the scope of ethics-related outcomes in the two global policies introduced above (Washington Accord and EUR-ACE) essentially cover this outcome space.

It is worth pondering whether and how a kind of global 'standard' for accreditation has been developed and advanced in recent decades, in part linked to broader processes of globalization. Yet our analysis suggests notable points of difference and divergence. For example, we observe the somewhat recent appearance of diversity and equity considerations in some accreditation criteria, such as Canadian policies that jointly refer to 'ethics and equity.'

It remains to be seen whether similar statements start to appear in other accreditation frameworks. We also find that explicit mention of ethical codes of conduct or practice only appears in general accreditation guidelines from the United Kingdom, even though such codes are well established in many other countries discussed above. Further, our analysis suggests important contextual nuances in two East Asian settings. The overarching storyline in Japan seems most significantly inflected by local cultural values (e.g., collectivistic ways of being, promoting social harmony) and particular understandings of how Japanese engineers contribute to national progress. The Chinese case is likely also shaped by similar cultural values, but with political and ideological forces at the forefront, especially in terms of ensuring that the ethical and social responsibilities of engineers align with party values and priorities.

There were, of course, practical limits to the breadth and depth of analysis we were able to present here, and we acknowledge a growing body of scholarship exploring engineering accreditation histories and trends in other contexts, developed and developing countries alike. We hope our efforts inspire more cross-national comparative research, and indeed highlight emerging opportunities for bringing more ethics-related outcomes into accreditation guidelines worldwide.

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Appendix. Ethics-related outcomes/attributes from select accreditation frameworks

ABET - EC2000 (Lattuca et al., 2006)	**ABET - Current** (ABET, 2018)	**UK - SARTOR3** (UKEC, 1998, p. 3)	**AHEP1** (UKEC, 2004, pp. 11–12) (same for IEng and CEng programmes)
Outcome 3.f; "an understanding of professional and ethical responsibility" Outcome 3.h; "the broad education necessary to understand the impact of engineering solutions in a global and societal context" Outcome 3.j; "a knowledge of contemporary issues"	Outcome 3.2; "an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors." Outcome 3.4; "an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts."	"E. Make a personal commitment to live by the appropriate code of professional conduct, recognising obligations to society, the they must: E.1 comply with the Codes and Rules of Conduct; E.2 manage and apply safe systems of work; E.3 undertake their engineering work in compliance with the Codes of Practice on Risk and the Environment; E.4 carry out the continuing professional development necessary to ensure competence in their areas of future intended practice."	*Design;* "[I]dentify constraints including environmental and sustainability limitations, health and safety and risk assessment issues" *Economic, social and environmental context*; "Understanding of the requirement for engineering activities to promote sustainable development"; "Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues"; "Understanding of the need for a high level of professional and ethical conduct in engineering" *Engineering Practice*; "Understanding of appropriate codes of practice and industry standards"

AHEP4 - Current *(UKEC, 2020)*	**Canadian Accreditation Board (CAB) - 1976** *(CAB, 1976, p. 10)*	**Canadian Engineering Accreditation Board (CEAB) - 2008** *(CAB, 2008, p. 13)*	**Washington Accord - Version 1.1** *(ABET, Inc., 2006, p. 13)*
Design and Innovation: B5. "Design solutions for [IEng: broadly-defined; CEng: complex] problems that meet a combination of societal, user, business and customer needs as appropriate. This will involve consideration of applicable health and safety, diversity, inclusion, cultural, societal, environmental and commercial matters, codes of practice and industry standards." *The engineer and society:* B7. "Evaluate the environmental and societal impact of solutions to [IEng: broadly-defined; CEng: complex] problems."; B8. "Identify and analyse ethical concerns and make reasoned ethical choices informed by professional codes of conduct."; B9. "Use a risk management process to identify, evaluate and mitigate risks (the effects of uncertainty) associated with a particular project or activity." (IEng); "B11. Recognise the responsibilities, benefits and importance of supporting equality, diversity and inclusion." (CEng); "C11. Adopt an inclusive approach to engineering practice and recognise the responsibilities, benefits and importance of supporting equality, diversity and inclusion."	B-1.7. "An understanding must be acquired of: a) the quality of the natural and human environment and the impact of technology; b) the function and activities of our society, business and government in shaping our society and its values; c) the legal responsibilities and ethical guidelines and constraints applied to the profession."	3.1.4. "Design: An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, economic, environmental, cultural and societal considerations." 3.1.8. "Professionalism: An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest." 3.1.9. "Impact of engineering on society and the environment: An ability to analyse social and environmental aspects of engineering activities. Such abilities include an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society; the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship." 3.1.10. "Ethics and equity: An ability to apply professional ethics, accountability, and equity."	Attribute 9. *The Engineer and Society*, "Demonstrate understanding of the societal, health, safety, legal, and cultural issues and the consequential responsibilities relevant to engineering practice." Attribute 10. *Ethics*, "Understand and commit to professional ethics, responsibilities, and norms of engineering practice." Attribute 11. *Environment and Sustainability*, "Understand the impact of engineering solutions within a societal context, and demonstrate knowledge of and need for sustainable development."

EUR-ACE - 2008 *(Augusti, Birch, & Payzin, 2011, pp. 7–9)*	**Japan Accreditation Board of Engineering Education - Current** *(JABEE, 2016)*	**China Engineering Education Accreditation Criteria (CEEAA) - Current** *(CEEAA, 2022a)*
Outcome 2. Engineering Analysis, "Graduates should be able to … recognise the importance of societal, health and safety, environmental and commercial constraints." Outcome 3. Engineering Design, "[A] n awareness of societal, health and safety, environmental and commercial considerations." Outcome 5. Engineering Practice, "They should also recognise the wider, non-technical implications of engineering practice, ethical, environmental, commercial and industrial." Outcome 6. Transferable Skills, "[D]emonstrate awareness of the health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of engineering practice."	Criterion 1(2)(b), "An ability of understanding of effects and impact of professional activities on society and nature, and of professionals' social responsibility" • "Understanding of impact of technology of related engineering fields on public welfare" • "Understanding of implication of technology of related engineering fields on environmental safety and sustainable development of society" • "Understanding of engineering ethics" • "An ability to take action based on the understanding mentioned above" Criterion 1(2)(e), "Design ability to respond to requirements of the society by utilizing various sciences, technologies and information" (including) "An ability to specify constraints from public welfare, environmental safety, and economy to be taking account of"	c) Design/Development Solutions: "Able to design solutions for complex engineering problems, design systems, units (components), or process flows that meet specific requirements, and demonstrate innovative thinking during the design phase while considering social, health, safety, legal, cultural, and environmental factors." f) Engineering and Society: "Able to conduct rational analysis based on engineering-related background knowledge, evaluate the impact of professional engineering practices and solutions to complex engineering problems on society, health, safety, law, and culture, and understand the responsibilities to be assumed." g) Environment and Sustainable Development: "Able to understand and evaluate the impact of engineering practices for complex engineering problems on the environment and social sustainable development." h) Professional Ethics: "Possessing humanistic and social science literacy, a sense of social responsibility, and the ability to understand and abide by engineering professional ethics and standards, fulfilling responsibilities in engineering practice."

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CONTEXTUAL MAPPING OF ETHICS EDUCATION AND ACCREDITATION NATIONALLY AND INTERNATIONALLY

Sarah Junaid, José Fernando Jiménez Mejía, Kenichi Natsume, Madeline Polmear, and Yann Serreau

Introduction

The previous chapter in this handbook outlined the development of accreditation practices and documents over time. This chapter picks up where Chapter 32 ends, describing the 'here and now' and assessing the state of the multicultural context at a point when people are connected trans-nationally more than ever before. This chapter probes the words used in current accreditation policy documents as these words influence curriculum design. We consider how terms used in various countries' documents compare and look for values-related patterns using an established cultural framework. In summary, this chapter aims to initiate discussion and probe the following questions:

1) *How is engineering ethics described in accreditation documents?*
2) *What commonalities and differences are evident trans-nationally?*
3) *What patterns can be observed in the way learning outcomes or competencies are written that can provide insight into how ethics might be taught to engineering students?*

The chapter is presented in two parts: (part 1) a global analysis that addresses the first two research questions and (part 2) four case studies to address the third research question. We begin by describing our positionalities to illustrate why we care about this topic.

Acknowledgments

It is important to acknowledge all contributors who played a significant role in building the premise for the work presented here. All the authors on the papers Junaid et al. (2021) and Junaid et al. (2022) were key contributors to the work reported in this chapter. In alphabetical order by surname, they are Alison Gwynn-Evans (AGE, South Africa), Sarah Junaid (SJ, United Kingdom), Helena Kovacs (HK, Switzerland), Johanna Lönngren (JL, Sweden), Diana Adela Martin (DM, Ireland), José Fernando Jiménez Mejía (JFJM, Colombia), Kenichi Natsume (KN, Japan), Madeline Polmear (MP, the United States and Canada), Yann Serreau (YS, France), Corrinne Shaw (CS,

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South Africa), Mircea Toboșaru (MT, Romania), and Fumihiko Tochinai (FT, Japan). This chapter would not have been possible without the tremendous efforts – in translating texts, extracting data, reviewing and critically evaluating national accreditation documents – presented in our previous studies by our colleagues.

The idea of critically analyzing ethics education through the lens of accreditation was sparked by an organic discussion at the European Society of Engineering Education (SEFI) special interest group on ethics (SIG-Ethics) at the SEFI 2020 conference, held virtually. It was from this discussion that the policy subgroup of SIG-Ethics was born with the aim of critically analyzing the portrayal of ethics in engineering accreditation documents across countries in order to observe regional and global trends and differences. The group started with four members (SJ, HK, DM, YS), where the quantitative framework and qualitative analysis was first developed and published with four countries analyzed in a European-focused study (Junaid et al., 2021). The group expanded with colleagues from Africa, Asia, Europe, North America, and South America joining the policy group (AGE, JL, JFJM, KN, MP, CS, MT, FT) to carry out a global analysis, with a global team and diverse voices. This resulted in a publication in 2022, further developing our quantitative approach and introducing a new qualitative cultural framework (Junaid et al., 2022). This chapter builds on the work and brings more focus on values (through case study narratives) and a new statistical approach to pattern observation through principal component analysis (PCA). This is an ongoing project by the SEFI Ethics SIG, and any researcher or practitioner working on accreditation is welcome to join by contacting Sarah Junaid (the project lead) or Diana Adela Martin (the SIG-Ethics co-chair).

Authors' positionalities

Wishing to compare the place of ethics in engineering education in different cultures, this chapter presents the findings and personal narratives derived from the words used in accreditation policy documents. The discussion of values is core to this chapter, and as such, it is important to describe the background of the authoring team that shapes our perspectives and informs our contribution to this handbook. The five authors are engineers and experimental physicists by training, with expertise in various fields (biomedical, civil, electrical, environmental, and general engineering). We are all active in higher education at the levels of practical teaching, curriculum development, and influencing national frameworks for engineering ethics education. We vary culturally and we identify across four different cultural clusters (more about cultural clusters is presented below). We seek increasingly global representation in our group of collaborators. However, this chapter has a heavy representation of policy documents available in English or documents that our team could translate into English. We recognize we have yet to capture the complete landscape, and the chapter is biased toward Western values. However, we have tried to bring diverse voices into this discussion through our affiliations, global networks, and cultural identities.

The premise of the chapter is based on the policy work carried out by the European Society of Engineering Education (SEFI) special interest group Ethics (SIG-Ethics).

Together, we believe that, in educational practice today, ethics and moral decision-making are usually taught peripherally to technical subjects; they feature in curricula in limited ways. We assert that ethics must be integrated more into higher education engineering programs. Although some practitioners advocate for change – and communities of practice in engineering ethics are starting to gain critical mass – such grassroots efforts need top-down enablers to facilitate wider adoption. Accreditation is an essential mechanism for precipitating change. Thus, we evaluate *how* *much* and *in what ways* ethics is articulated in the documents of various nations and accrediting bodies, representing as much of the globe as we have been able to access to date.

Part one: analysis of how engineering ethics is portrayed in accreditation documents within various clusters

Background

This study constitutes a step towards a global comparative analysis of policy documents that inform the design of engineering curricula. It aims to identify differences in ethics learning outcomes and competencies required for engineering courses trans-nationally. Research indicates that social and cultural dimensions are critical in normative ethics and moral reasoning (Alas, 2006). As such, we believe that countries' policy documents will reflect cultural norms and societal values that will consequently influence graduates' ethical awareness and engineers' ethical practices. Honest reflection and decision-making are integral parts of our social construct where a social collective creates and accepts ideas and concepts. Yet the demarcation and presumed separation of moral reflection and logical thinking have been noted at engineering, governmental, and policy levels (Bacchi, 2007). Bacchi posits that a broader engagement of ethical reflection in policy-making is needed; she recommends reducing the dependence on ethicists shaping policy – more engineers and experts from diverse fields must get involved. Indeed, higher-education policy is influenced by the political and economic framework it sits and operates within (Ball, 2015a), and these voices should chime in on policy formation. Policy, by its nature, is not neutral; it reflects the collective value system. A well-rounded constituency can help shape policies that more effectively support the collective.

Bardi and Goodwin (2011) assert that values – the ideals people perceive as necessary – drive how they think, perceive, act, and behave. Although values can be considered universal, cultures vary in the hierarchy they allot and the importance they place on various aspects, and these vary on individual and collective bases. Collective values can be regarded as part of the cultural identity of a group; however, Bardi and Goodwin note that they are subject to change due to time, critical events, personal choices, and environmental factors.

Understanding 'policy as text' means assessing how policy is written, whereas understanding 'policy as discourse' requires considering policy implementation (Ball, 2015b). Both can provide insight into underlying values expressed in policy. The power of policy language can express neoliberal structures and economic values embedded in our social structure (Beasley & Bacchi, 2007). This has implications for our higher education institutions (HEIs) and the engineers trained to work within these structures.

Policies play a significant role in the interpretation and design of engineering curricula. They can, therefore, be used to shift values by recommending or requiring specific ways of thinking, perceiving, acting, and behaving. The implications at this level are systemic, and an analysis of how ethics is conveyed (policy as text) can provide insight into how it (policy as discourse) could be used. Viewing national engineering accreditation documents through the lens of cultural structures can help us understand such implications regarding the degree to which ethics education is embedded in engineering locally, nationally, and globally. The caveat to this work is an awareness that there is no universally agreed definition of 'ethics' and, as such, ethics has been explored by identifying associated terms – ones that appear implicitly in the context of the engineering profession.

A conceptual framework for the study

We endeavor to produce a trans-national review of accreditation documents, which presents some challenges, and the work reported in this chapter is part of our ongoing efforts to do so. In revealing the political dynamics in engineering accreditation systems in five anglosphere countries, Klassen (2018) highlighted the importance of analyzing relevant literature and policy documents of the engineering curricula in political, organizational, and historical contexts, using pluralist political theory. Our study builds on Klassen's groundwork, acknowledging the importance of the dimensions he noted. So, realizing that not every country can be included in exploratory analyses of the type we are conducting, we sought to establish a framework and research methodology to help us address the challenges of representativeness, sampling bias, and language interpretation. We considered how we would categorize countries and what meaningful classification tools we could use to analyze ethics at the policy level.

We adopted a model based on cultural identities in the workplace pioneered by Geert Hofstede et al. (2010, 2011). The seminal 'Hofstede model' is not specific to engineering education; it was drawn from comparative research of corporate environments and organizational cultures across more than fifty countries. According to Hofstede, "Culture is the collective programming of the mind that distinguishes the members of one group or category of people from others" (Hofstede, 2011, p.3). Therefore, culture is a collective phenomenon that groups of people construct.

Hofstede's model was built using IBM's database of 100,000 surveys collected via the company's network involving 50 countries. It was later expanded to other corporations but was made without input from non-corporate organizations, such as rural or not-for-profit entities.

Despite its limitations, the Hofstede model provides an empirically grounded way to classify various cultural contexts regarding six factors. Any cultural group can be located somewhere along a continuum for each of the six factors that Hofstede presented as dichotomous or 'bi-polar' dimensions, with extremes labeled at either end. The six dimensions of culture involve power distance, uncertainty avoidance, masculinity versus femininity, individualism versus collectivism, long-term versus short-term orientation, and indulgence versus restraint. Power distance entails acceptance of those without power and the level of equity in power distribution within the group, society, or culture. Uncertainty avoidance depicts the degree of desire for predictable outcomes and avoiding an uncertain future. Masculinity versus femininity is the societal preference towards achievements and ambition versus altruistic motivations, traditionally associated with the distribution of roles between men and women. Individualism versus collectivism regards how people relate to each other and make decisions based on individual needs versus group needs. Long-term versus short-term orientation entails the preference of efforts towards the future, such as pragmatic problem solving, forward-looking, and adaptability of traditions (balancing the present and past, related to steadfastness and preservation of traditions). Indulgence versus restraint relates to relative control in allowing gratification of human needs and desires versus social norms and codes that may regulate them.

Some criticisms were voiced against Hofstede's work (Kirkman et al., 2006), precipitating refinement; the Hofstede model was built upon by the Global Leadership and Organizational Behavior Effectiveness (GLOBE) initiative to cover 150 countries. It expanded from six dimensions to nine: performance orientation, future orientation, gender egalitarianism, assertiveness, institutional collectivism, in-group collectivism, power distance, humane orientation, and uncertainty avoidance. Like the Hofstede model, the GLOBE model is also based on business interests.

In this chapter, we reference 11 cultural clusters. In this study, we used the GLOBE cultural clusters and the dimensional factors formulated by Hofstede to cluster and analyze policy documents related to engineering ethics education. Despite the emergence of the more elaborate GLOBE model, we also drew from the Hofstede model due to its usefulness and simplicity for mapping features to distinguish different cultures. We used GLOBE as a primary guide for clustering and the Hofstede dimensions to compare various aspects of the clusters' accreditation documents.[1] Based on these models, we identified 11 global cultural clusters: Anglo, Arab, Confucian Asia, East Europe, Germanic Europe, Latin America, Latin Europe, Middle East, Nordic Europe, South Asia, and Sub-Saharan Africa (GLOBE Foundation, n.d.; Hadwick, 2011; House et al., 2002; Ronen & Senkar, 2013). Although these models were developed in the business sector, they hold applicability for engineering, which has corporate, business, and management dimensions. From a philosophical perspective, however, there is a distinction between engineering practice and engineering business. The roles of engineering in civic life, social entrepreneurship, and policy-making are not restricted to engineering within corporate practices. These should be explored further to challenge assumptions regarding the role of engineering and engineers in society. The results could help engineering downplay its corporate identity and provide increased focus on the needs of future societies. Despite their corporate emphasis, these two models offer a starting point for assessing historic and present structures; they can help us contextualize the different roles of engineering. The Hofstede and GLOBE models provide a valuable lens for clustering cultures in meaningful ways based on explicit dimensional factors. We recognize that, by applying this conceptual framework, we neglected other temporal and regional factors that influence curriculum development. For example, competencies identified by recent document of France's Commission des Titres d'Ingénieur (CTI) 2022 include sustainability-related changes. The changes address current and imminent socio-environmental needs that have led to legislative changes within national and European Union laws.

Collection of accreditation documents

The authors of this chapter are part of an international team of colleagues who have previously analyzed accreditation documents across 12 countries within five continents to identify trends and differences (Junaid et al., 2021; Junaid et al., 2022). These studies used a mixed-methods approach, which involved quantitative analyses of key ethical terms used both explicitly and implicitly and qualitative analyses of learning outcomes stated in accreditation documents based on the cognitive level (degree of thinking versus doing) they require of students. We used the same accreditation documents collected earlier and, for this chapter, conducted additional analysis using the culture-based conceptual framework presented above. By including 12 countries, our analyses have represented parts of seven different cultural clusters, identified using the abovementioned GLOBE clustering and Hofstede dimensions.

Thus, accreditation documents for both studies came from the following 12 countries. The cultural cluster each represents is indicated first, and the name of the country or countries involved is shown (in parentheses): Africa (South Africa); Anglo (Canada, Ireland, South Africa, the United Kingdom, and the United States); Confucian Asia (Japan); East Europe (Romania); Latin America (Colombia); Latin Europe (Belgium, France, French-speaking Switzerland); and Nordic Europe (Sweden). Note that South Africa was considered in two clusters, Anglo and African, due to the disparate cultures within the country. A total of ten accreditation documents were analyzed in the previous study. In most cases, we used the country's accreditation documents. However, the CTI French accreditation has been sought by Swiss and Belgian institutions on a voluntary basis. Therefore, we consider this CTI French accreditation document as representative of Latin Europe cluster. For this chapter, the author team analyzed previously collected accreditation documents to answer new research questions and conducted additional exploratory analyses using statistical procedures to yield a deeper understanding.

Cultural analysis

We carried out the cultural analysis for this chapter in two phases: (1) quantitative analyses to investigate learning outcomes explicit and implicit to ethics using the list of terms derived from the studies (Junaid et al., 2021; Junaid et al., 2022) and (2) qualitative analyses to investigate verb usage associated with the relevant learning outcomes. Quantitatively, in the previous studies, we counted the frequency of explicit terms (where the word 'ethics' or 'ethical' appeared) and terms that implied ethics (using a list of keywords). To develop the list, we extracted a range of keywords from the contents page of five engineering ethics textbooks (Junaid et al., 2021; Junaid et al., 2022). Then, we collated the words and achieved consensus across the authors regarding the refined list for use in coding. The 14 key terms we identified that implicitly reference ethics are 'global view,' 'values,' 'profession,' 'responsibility,' 'charters and codes,' 'critical reasoning,' 'organization,' 'safety and risks,' 'sustainability,' 'international context,' 'integrity,' 'technologies,' 'justice,' and 'society.' Variations of these terms, for example, 'professional' and 'societal,' were also included in the word search.

In the previous study, our subsequent qualitative analyses of verb usage investigated the context of the explicit terms concerning learning outcomes and competencies. We incorporated advice from 'A pragmatic master list of action verbs for Bloom's Taxonomy' published by Newton et al. (2020). Verbs appearing in accreditation documents regarding clear requirements for 'ethics' or 'ethical' indicated what students should be able to do. We cross-examined the verbs we found using Bloom's learning taxonomies. Our reason for excluding learning outcomes that did not explicitly mention ethics was due to the broad interpretation that people using the documents can adopt; for example, sustainability in curriculum design may focus wholly on technical solutions to the problem rather than also addressing the ethical implications of the solutions and of how the solutions (such as products) are created or manufactured. Equality, diversity, and inclusion were also not considered in our analyses for three reasons:

1) These topics have cultural and political contexts, which are highly sensitive to regional and national variability.
2) These subjects are often managed at the organizational level and may not necessarily be captured at the policy level. This may wrongly skew any interpretation of these subjects, possibly introducing new prejudices that will be counter-productive to the aim of this work.
3) These topics require more data and need to be addressed in further depth than the study presented here. This chapter reports a solid start and offers a way forward.

We did not explore the nuances in linguistics or local differences in word interpretations. To avoid introducing differences in linguistic translations, the previous study was carried out in English. This included using official English translations of accreditation documents where possible. Exceptions to this were Colombia, Romania, and France because authors on our team are native speakers and were able to interpret applicable documents (Junaid et al., 2022).

Analysis of explicit and implicit ethical terms

The results of earlier work, presented in full in Junaid et al. (2022), indicate that the word 'ethics' and 'ethical' appear from two to ten times across the ten documents (average 4.7 +/- 2.6 across cultural clusters) across the learning outcomes and competencies. This contrasted with the 14 implicit reference terms, which were found more frequently than the explicit terms. The implicit terms occurred between 6 and 187 times (average 88.7 +/- 62.4 across clusters). The documents under review varied in length from approximately 500 words (Sweden) to over 100 pages (Canada), and this is one reason for the wide variation in frequency found.

Moreover, some implicit terms were more heavily emphasized than others. Most notably, 'profession,' 'society,' 'charters and codes,' 'international context,' and 'responsibility' represented around 70% of occurrences of implicit terms across all ten documents. The remaining words such as 'values' and 'integrity' accounted for less than 10% of term usage across groups. The word 'justice' did not appear in documents of any culture (except the root word 'just,' which we will discuss in the case study of Colombia), and this supports the claim that engineers have generally assumed an apolitical and asocial stance. This omission could be seen as suppressive due to the principal role justice plays in respectful current theories about the origin and aims of morality, particularly in the development of moral philosophy to support moral decision-making. From a philosophical viewpoint, empathy and justice are keywords used to describe morality. Therefore, we found it surprising that neither term was present despite the increasing trends toward considering ethics in policy documents and curricula. More central to this, justice is recognized as one of the fundamental pillars of personal ethics and morality, which are values developed during a person's infancy. Studies have also shown human species developing moral capabilities for over two million years (Tomasello, 2016).

Comparing cultural clusters, our analyses revealed clear differences in emphasis of implicit ethical words. These may be explained by considering the different historical, cultural, and legal frameworks for accreditation in each country, but, due to the complexity of the problem and the scarcity of information on the matter, a complete comparison is beyond the scope of this chapter. To provide some examples, however, within documents from the Anglo, Latin European, and African clusters, the words 'profession' and 'security and risks' occur most frequently. We believe that certain similarities apparent among these three cultural clusters could relate to (a) the geographical and cultural proximity between Latin Europe and some Anglo countries (Ireland and the United Kingdom) and (b) the presence of the British Empire in South Africa during the nineteenth and twentieth centuries. These clusters' focus on safety and risk is perhaps a by-product of industrial revolutions from the eighteenth century onwards, where manufacturing, mass production, and rapid economic growth in places like the United Kingdom also brought in an increasing regard for human safety, the need for standardization, and the introduction of professional institutions. The differences may also highlight the social and historical contexts at play. For example, the Latin European cluster emphasizes 'sustainability' more than the African cluster, which more often refers to 'security and risk,' perhaps reflecting areas of concern nationally. Our analyses suggest additional variations and commonalities among clusters that warrant future investigation using historical, economic, political, and/or social lenses.

For this chapter, we conducted PCA (principal component analysis) to explore the occurrence of the implicit terms across the cultural clusters (including a total of ten countries) to help us understand the results of the prior work reported by Junaid et al. (2022). The PCA projected vectors in a two-dimensional space using (a) the seven cultural clusters as dependent variables and (b) the 14 implicit terms as dependent variables (Figure 33.1). By setting these as 'dependent variables,' we can identify patterns in variance between clusters and between implicit terms used in the accreditation documents. It is important to note that although South Africa is identified as belonging to both Anglo and African clusters, the country was included in the African group and not included in the Anglo group to avoid data duplication.

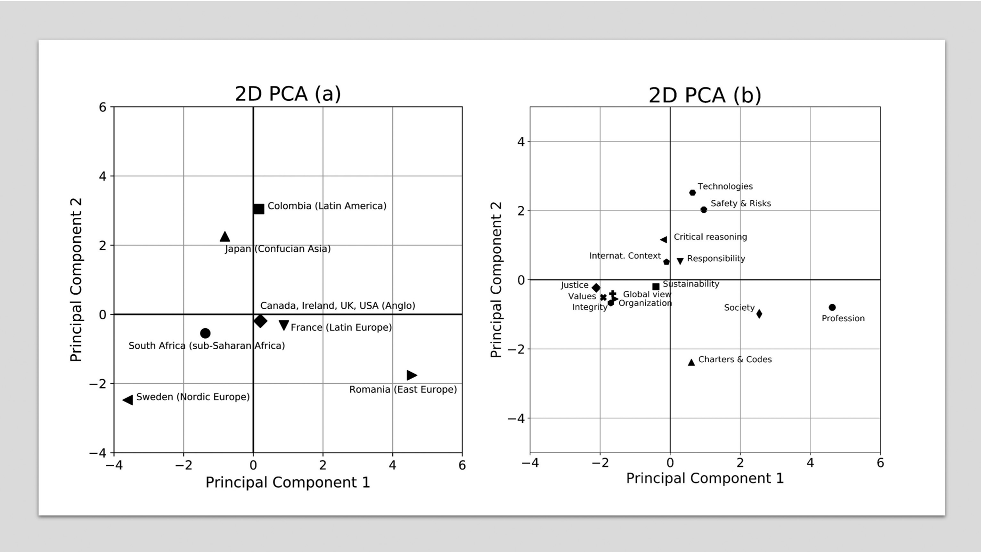

Figure 33.1 PCA diagrams in two dimensions using (a) the seven cultural clusters as dependent variables and (b) the 14 implicit terms as dependent variables. NOTE: the United Kingdom and United States are shown as UK and USA respectively.

Looking first at Figure 33.1a, the first two principal components add up to 67% of the cumulative explained variance, and the first three, together, explain up to 84% (note: the cumulative explained variance is not shown in the figure). It's important to note that the matrix contains a relatively small amount of non-homogeneous data – among the documents consulted, some refer exclusively to accreditation processes in engineering and others to a broader set of professions – and the documents are very dissimilar in their structure. As a result, this analysis represents an exploratory first step to help us better understand the situation. Due to the small sample group, we graph and report our findings with reference to the individual countries and their respective clusters, and we use the terms 'country' and 'cluster' interchangeably in our reports.

Some points we observed in the Figure 33.1a statistical matrix were:

1) The Anglo cluster (Canada, Ireland, the United Kingdom, and the United States) published the most inclusive range of terms, and thus sits closest to the center of null variance. In addition, at least in the two-dimensional analysis, the cluster with the second lowest variance is France (representing Latin Europe), closely followed by South Africa (of the African cluster).
2) The data for Colombia (Latin America), Romania (Eastern Europe), Sweden (Nordic), and Japan (Confucian) are peripheral compared to the central core of the rest of the countries in the figure. The proximity between Japan and Colombia does not imply significant cultural similarities between both countries. This pattern suggests that statistically speaking, South Africa, France, and the Anglo cluster have similarities across their accreditation documents regarding ethics. In contrast, the distances between the other countries indicate that their ethics accreditation words differ substantially in these two principal components that are, as of yet, unknown.

3) In the direction of the first principal component (PC1), Sweden is markedly opposite to Romania. This indicates differences in the data corresponding to the categories 'charters and codes' and 'profession,' which are the most important for Romania but do not even appear in the Swedish documents. The Hofstede index relating to PC1 is possibly most influenced by power distance (PDI) due to the differences across countries for this index. Power distance entails acceptance of those without power and the level of equity in power distribution within the group, society, or culture. Among these countries, Romania has the highest PDI at 90, while Sweden has the lowest at 31. Listed from highest to lowest PDI: Romania (90), France (68), Colombia (67), Japan (54), South Africa (49), Anglo (36), and Sweden (31) (Hofstede et al., 2010, pp. 57–59). Although PC1 is not correlated with PDI in all countries, it is reasonable to interpret that 'profession,' which is oriented towards higher social status, and 'charters and codes,' which are the requirements for the status, are correlated with PDI.
4) In the direction of the second principal component (PC2), The category most influencing it is 'society,' and the Hofstede index relating to it is individualism (IDV). Collectivist countries with low IDV tend to have higher PC2: from highest, Colombia (13), Romania (30), Japan (46), South Africa (65), France (71), Sweden (71), and Anglo (83) (Hofstede et al., 2010, pp. 95–97). Here, IDV and PC2 do not precisely correlate, as Romania, with an IDV of 30, which is lower than Japan and can be interpreted as collectivist, has a lower value in PC2. However, it is reasonable to interpret that society orientation and collectivism are correlated. At least, the tendency towards individualism or collectivism should have a significant influence on their engineering ethics.

Shifting now to Figure 33.1b, where the implicit ethical terms were defined as dependent variables, the first two principal components added up to 46% of the cumulative explained variance, and the first three added up to 68%. For this case, the following patterns were observed:

1) In the direction of the first principal component, the terms with the most variance were 'profession' and 'society,' which, together with 'charters and codes,' were those with the highest percentage in frequency of occurrence in the global analysis. These three terms were used heavily in the referenced documents, in contrast to the other terms.
2) In the direction of the second component, the greatest distance, and thus most considerable variance, corresponded to 'technologies' and 'charters and codes,' but at opposite ends of the scale. At the same time, the term 'safety and risks' appeared close to 'technologies.'
3) Several terms grouped tightly together: 'global views,' 'integrity,' 'organization,' 'values,' and 'justice.' Moreover, 'sustainability,' 'responsibility', 'international context,' and even 'critical reasoning' were not far removed from this tight cluster. However, several of these terms ('justice,' 'values,' 'integrity,' and 'global views') were consistently underrepresented across the accreditation documents, which explains the lack of variance seen. On the other side, the terms 'society,' 'profession,' and 'charters and codes' stand almost in opposition to the tight cluster and the rest of the terms. These peripheral terms indicate the most variance between accreditation documents.

Interpretation of the cultural analysis

Our analyses of implicit ethical terms found that words such as 'justice,' 'integrity,' and 'values' are sorely missing. These may be hidden or assumed to be covered under other umbrella terms like 'ethics'; however, ethics is an ambiguous term, and accreditation documents typically define terms with a greater level of clarity to reduce confusion and help ensure reliable results across assessment teams, for instance. Values, like ethics, can be complex and can change due to time, environment, events, and personal reflection. Impermanent meanings and shifting interpretations may be reasons why these words have sometimes been avoided in writing accreditation documents (Beasley & Bacchi, 2007). We found considerable differences among cultural clusters. For example, the term 'charters and codes' was highly emphasized in Latin America and East Europe, whereas the term was not mentioned in the Confucian Asia and Nordic Europe clusters. This may be due to the historical, political, social, or religious contexts or a combination of the four. It might also be due to mandating that engineers register with professional bodies to work in the profession. For example, graduates in Colombia (Latin America) from an unaccredited degree will not have their qualification recognized as a higher education engineering degree. It is necessary for graduates from Colombian universities to register with a professional body to work as engineers. Therefore, it is unusual that the term 'profession' showed a stark drop in emphasis in Latin America compared to the other clusters. There may be social context that can explain this and would need to be explored further.

One way of examining the place given to ethics in engineering training curricula is to analyze the verb types related to the way ethics-related learning objectives are described. To this end, the taxonomies initiated by Bloom provide categories of verbs used to define learning objectives. Most variations of Bloom's original taxonomy include six levels, from the most elementary to the most complex. The six levels can be summarized as follows: remembering, understanding, applying, analyzing, evaluating, and creating (Anderson et al., 2001; Krathwohl, 2002; Mallalieu, 2023). For the verbs in the repositories we studied, the 'apply' level was the most represented when relating directly to ethics learning (39%). The 'evaluate' level was the least represented.

Nevertheless, if we consider that ethics will be an essential component of the role of engineers in the coming years, we might wish to move the level of objectives toward the highest level, 'create.' This would mean that the passive 'apply' level would no longer be in the first rank – it would have to cede this top rank to a higher level that requires higher-order thinking.

The universal emphasis on 'apply' is understandable, with engineering requiring technical skill-based competencies. However, the low use of 'evaluate' verbs within subjects that link to ethical practice serves as an interesting area for further study. The more limited mention of 'ethics' and 'ethical' learning outcomes that we found skewed towards more cognitive-based learning, that is, ethics education rather than ethical practice. A general analysis can hide national nuances that could help in understanding how ethical practice is influenced by accreditation-level learning outcomes. For example, France's accreditation process is competency-based and, therefore, requires demonstrable practice of the competencies. This is reflected in the emphasis, in French accreditation documents, on 'applying,' 'analyzing,' and 'synthesizing' (Bloom's original term) or 'creating' (a modification made in later adaptations of Bloom's taxonomy).

The analyses of verbs we present in this chapter have several limitations. Firstly, we acknowledge the limitations of inferences derived from one (or only a few) representative countries within a cultural cluster; we do not intend to extrapolate the values from one country and act as if they represent the complete set. Rather, we use the Hofstede and GLOBE models to help us work toward wider inclusion of diverse cultures in our overall effort to understand ethics-related accreditation characteristics and trends. For example, Japan, the only country in the Confucian Asia cluster, has unique cultural and historical structures that can be quite different to other countries within the same cluster (for more on this, see Chapter 32). A second limitation is that an ethical model for drawing the quantitative analysis of terms was not used; rather, the research team collated a list of terms (Junaid et al., 2022). A potential benefit to this approach was reducing biases embedded in an existing model. Nevertheless, this study has a clear Anglo bias since the terms were collated in English, and few non-English terms were considered. Thirdly, the Hofstede model is limited to six bi-polar dimensions and focuses on organizational cultures; it may not consider the cultural identities that define other value systems beyond the corporate realm. Fourth, we have presented only a general overview of the data and data patterns due to the small data set. Observations from this exploratory study must be viewed cautiously; it is impossible to infer causation. Finally, the master list of action verbs to define learning that we derived using Newton et al. (2020) is limited to Anglo papers and therefore presents an Anglo and British bias of cognitive learning. Despite these limitations, this study provides early pilot data and has helped highlight nuances in engineering ethics education trans-nationally and trans-culturally to explore more extensively for further research.

Part two: case studies of four countries' accreditation documents and their cultural context

Part two of this chapter discusses four different regional contexts, identifying similar and dissimilar qualities of how ethics is framed in four case-study countries drawn from the overall set of ten countries analyzed above and reported previously by Junaid et al. (2022). The countries investigated in depth below, with regard to engineering ethics accreditation documents, are Colombia (Latin America), France (Latin Europe), Japan (Confucian Asia), and the United Kingdom (Anglo). These four case studies were selected from distinctly different cultural clusters to give readers a broad global overview. The four also represent the authors' home countries, allowing our team to highlight nuances.

The following four cases contextualize commonalities and differences, suggesting a pathway for understanding diversity and inclusion globally. The case studies help compare and contrast various scenarios related to engineering education to increase our understanding of what various countries value. They can help us and our readers build cultural awareness and develop stronger global interpersonal skills.

Latin America case study: Colombia

In Latin America, most accreditation processes are voluntary and regulated by state entities. This condition does not prevent the application of a varied set of quality accreditation models and proposals for higher education institutions and university programs (UNESCO et al., 2018).

For this chapter, the Colombian case study focuses on Agreement 02 of 2020 (CESU, 2020), interpreted from Spanish, as there were no official English translations. The analyses yielded the results summarized below using the methodological approach from Junaid et al. (2022).

A list of key terms explicitly defined in the Colombian legal framework are 'accreditation' (CESU, 2014, art.12, p. 30), 'competence' (CESU, 2020, art.2, p. 8), 'graduate attributes' (Colombia, 2019, numeral 2.5.3.2.3.2.3, p. 12), 'learning outcomes' (Colombia, 2019; CESU, 2020, p. 8), and 'responsibilities of engineering practice' (Colombia, 2003, art. 33, p. 16). The precise definition of each term has value in cross-culture analyses (Junaid et al., 2022). The set of definitions provided in the Colombian legal framework can facilitate nuanced understanding – regarding how terms are used, the meaning behind their use, and how they may be interpreted differently in other places. For instance, most defined terms in the Colombia document correspond to legal acts approved in the last decade. In the case of 'accreditation,' the Colombian document defines the term as "the act by which the State adopts and makes public the recognition that academic peers make of the quality of a program or institution based on a previous evaluation process in which the institution, the academic communities, and the Council participate" (CESU, 2014, art. 12, p. 30). Thus, although accreditation is voluntary, the Colombian state is the agent that evaluates and recognizes the quality of engineering programs, making the accreditation process essentially public. In comparison, other countries like the United Kingdom administer their accreditation process through professional institutions, devolving that responsibility to the collective community of professionals in engineering.

The count of the implicit ethical terms – the order of recurrence in parentheses – is as follows: 'society' (59), 'charters and codes' (32), 'international context' (26), 'profession' (21), 'critical reasoning' (19), 'global view' (11), 'responsibility' (7), 'technologies' (6), 'integrity' (3), 'values' (2) and 'sustainability' (1). It is worth noting that the previous analyses by Junaid et al. (2022) did not consider 'inclusion' and 'diversity,' but these are mentioned within the Colombian document in the following sentence: "A declared commitment to the comprehensive training of people to face, with ethical, social, and environmental responsibility, the endogenous development challenges and to participate in the construction of a more just and inclusive society that recognizes and promotes diversity" (CESU, 2020, p. 20). This sentence references a more 'just' society and, by using the root of the word 'justice,' it indicates an affinity with the term. In this case, an explicit intention is to preserve the national ecosystems, peoples, and ethnicities – this constitutes a critical focus for the professions and a reflection of historical and political contexts. Changes found in France's CTI 2022 document (when comparing it with the earlier CTI 2018 that it supersedes) indicate emerging emphasis on sustainability goals; likewise, this Colombian case demonstrates how social debates are expressed through legal and political forms on accreditation processes.

In the Colombian document, among the set of verbs describing learning outcomes relevant to ethics, we found that about 24 were action verbs (e.g., 'apply,' 'demonstrate,' 'participate,' 'transform'), whereas 30 prioritized cognition (e.g., 'analyze,' 'define,' 'know,' 'understand'). Additionally, 32 blended the realms of action and cognition (e.g., 'create,' 'inquire,' 'research,' 'think'). This finding contrasts with the broader analyses by Junaid et al. (2022), in which cognitive verbs predominated widely over action verbs across the sample of ten countries. Nevertheless, there is a need for both verb types in education curricula. On one hand, cognition is the process of thinking that includes self-awareness, reflection, and consciousness about the world as it is; metacognitive development is essential to develop in the engineering profession (Cervin-Ellqvist et al., 2021). On the other hand, there is the need for action, which necessitates developing skills and translating practical abilities through ethical decision-making that experienced engineers have developed into educational frameworks in engineering.

Based on the master list of action verbs suggested by Newton et al. (2020), according to the original Bloom's categories, it is possible to compare the number of verbs related to learning ethics reported in the accreditation documents analyzed by Junaid et al. (2022) with the equivalent verbs of Colombia's Agreement 02/2020. The Colombian document uses the verbs 'apply,' 'analyze,' 'evaluate,' and 'create' (levels 3–6, the higher levels of Bloom's taxonomy), but the first two categories of remembering and understanding are missing. This bias may initially appear to be a positive shift toward applying knowledge. However, if we follow the premise behind Bloom's taxonomy, the lower learning levels should provide scaffolding to loftier levels of cognitive learning; in this sense, it is assumed that middle and primary education provides these learning fundamentals in the national education system. Whether this aim is achieved or not is essential for fulfilling professional training.

Latin Europe case study: France

In France, 200 schools, 51 of which are private, are accredited to deliver at least one engineering degree course. Engineering degrees are issued at the school level, which is not the case in other professions in France such as medicine, where the qualifications are issued at the national level (Grelon, 2021, p. 68). These engineering schools are accredited by the Commission des titres d'ingénieur (CTI), created in 1934 as an autonomous joint body (CTI, 2022). The French engineering degree corresponds to a master's degree, level 7 of the European Qualifications Framework (CTI, 2022). Since French engineers are not constituted as a professional order, the practice of engineering is not governed by such a professional order nor is the training of engineers linked to it. Instead, the training of engineers in France is situated within the European framework for higher education and the Bologna process (CTI, 2022; Djurovic & Lubarda, 2014; European Education Area, n.d.). Thus, the CTI promotes the quality assurance of engineering education, and it delivers the European quality label for engineering education EUR-ACE® of European Network for Accreditation of Engineering Education (ENAEE) (Augusti, 2009; Augusti, 2013).

Engineering schools are required to apply ethics initiatives and define a strategy for social and environmental responsibility, with objectives that are monitored. The school must also ensure "compliance with the requirements of scientific integrity, deontology and ethics. It conducts awareness-raising activities among students on these subjects" (CTI, 2022, p. 8). This starkly contrasts the Anglo cluster, which does not mention integrity. CTI describes the engineer as someone who identifies "professional, societal and environmental, ethical and deontological problems created by technological innovations" (CTI, 2022, p. 19). It makes CTI (France) a document that emphasizes ethics, among the documents analyzed, explicitly as a piece of a framework for engineering decision-making.

A set of competencies proposed by schools is associated with each engineering curriculum. Among the set of competencies required by the CTI, training in social and environmental responsibility constitutes a major criterion for accreditation (CTI, 2022). This includes societal issues, basic teaching of environmental and societal responsibilities, life-cycle analysis and design, *et cetera*, highlighting the ecological and climatic imperatives currently at play in Europe and globally.

Among the more generic competencies required by the CTI, themes that can be closely linked to ethics include ethical and professional responsibilities, issues of life at work (relations at work, health and safety, and diversity), transition, ecological and climatic imperatives, and needs of society.

More directly, the in-depth discussion of "concepts of ethics, deontology and occupational health and safety" (CTI, 2022, p. 27) is explicit. The document stipulates that a part of the teaching must be allocated to ethics, health and safety at work, social relations, sustainable development, and the ecological transition. With such imperative and structured guidance, one would expect a clear link to what is taught and/or delivered to students regarding ethics.

Our textual analyses showed that the engineer's postures associated with the ethical themes were defined by specific verbs in the French documents: 'consider,' 'report,' 'integrate,' and 'accompany' (CTI, 2022, p. 21). The implicit wordlists used in our earlier analyses that are highly represented in this framework are 'profession,' 'international context,' 'responsibility,' and 'sustainability.' Considering the all-encompassing term 'ethics,' there is no universally agreed definition, and as such, the implicit terms are invaluable in manifesting what 'ethics' means in the context of the engineering profession.

Compared to other clusters, what delimitates this cluster, according to our method, is the major part taken by sustainable development, international context and global view. To add to this, the lack of references to rules and codes as emphasized in clusters such as Latin America or East Europe is interesting. This could reflect civic rights over authoritative power, drawing on the legacy of French enlightenment and the constitutional right of liberty, equality, and fraternity.

Through this lens, this constitutional right has filtered into how professions as structures of authority are required to behave and operate for the good of society.

Confucian Asia case study: Japan

Some East, Southeast, and South Asian countries have accreditation bodies for engineering education as part of national engineering councils, while others have them as independent organizations. In either case, they have prepared their programs since the late 1990s due to the growing need for global alliances regarding education and licensing, including the Washington Accord and APEC Engineer, the Asia-Pacific Economic Cooperation as part of the International Engineering Alliance (IEA). It is an interesting challenge to reveal the earlier relationship between their education policies and ethics in the context of each country prior to that time. However, such research requires in-depth historical analysis of each country. Furthermore, small countries such as Vietnam do not have their own accreditation bodies but are accredited by Western programs such as ABET of the United States. This is not ideal as it does not account for embedding the value system of a country. Therefore there is a real danger of transplanting Western value systems that may not reflect the nuanced differences in the region. Supporting smaller countries to develop their own accreditation systems can allow an authentic reflection of what society needs from engineers and suggest how that training could be developed regionally.

Adopting others' standards is a reasonable decision given the burden of launching their own programs when accreditation is emphasized in the context of globalization, but local nuances are particularly critical within the actual practices of engineering ethics education. Cultural context can often play a significant role. However, such research requires a great deal of effort for this cultural cluster. Therefore, this section will focus on the current criteria of Asian countries that have their own accreditation bodies and original criteria, which are available in English, with particular attention to the case of Japan (for more on Japan and China, see Chapter 32).

In Japan, in the broader sense, the Ministry of Education (MOE) has accredited educational programs. A non-governmental, United States–style accreditation system was introduced in 1947 when the Allied Forces led the establishment of the Japan University Accreditation Association (JUAA). However, the MOE neglected the system after the restoration of sovereignty in 1952. Later, in the 1990s, the need for global quality assurance in education led to the establishment of Japan Accreditation Board for Engineering Education (JABEE), and the JUAA also regained its presence over the same period. JABEE offers a rigorous accreditation process running every 6 years with a 3-year review that individual programs undergo, which can be cumbersome for higher education institutions (HEIs). In contrast, JUAA accredits institutions rather than programs and therefore covers all degrees across the HEI. The MOE has also encouraged the autonomous development of each university by relaxing the standards and introducing an individual voluntary assessment system, resulting in three different accreditation bodies. However, the vision of an accreditation system relevant to Japanese society has not been achieved yet.

The engineering education reform in the 1990s thus aimed to conform to global standards, modeled on the United States system. From this perspective, JABEE attracted a great deal of attention at first. However, it could not resolve the incongruity with the predominant cultural style. The number of JABEE accredited programs has been declining since the late 2000s because of the system's unclear effectiveness for graduates and the cumbersome preparations for the accreditation.

The characteristics of the JABEE accreditation criteria are derived from the following historical background. They begin with Criterion 1 as follows:

1.1) Profile of Autonomous Profession (establishment, disclosure, and dissemination of the image of an autonomous engineer).
1.2) An ability of multi-dimensional thinking with knowledge from a global perspective.

In criterion 1.1, the English translation of the document uses the word *autonomous*, whereas the Japanese document uses another word that has the meaning of *independence*. Both words are pronounced 'jiritsu' in Japan. Partly because of the same pronunciation, the two words are sometimes used interchangeably in relation to individualism. The difference of the two meanings is not so clear for many Japanese people; however, when written in Kanji (Chinese characters used in Japan), the difference is evident: 'jiritsu' as autonomous is written as '自律' and independence as '自立.' In both words, the first character '自,' which is pronounced 'ji,' means 'self.' The second characters of both of the words have the same pronunciation, 'ritsu.' The fact that they have different meanings is very obvious for Japanese people: '律' means 'rule,' 'law,' 'code'; '立' means 'standing up.' Therefore, even if we do not know the definition of these words, we can guess that '自律' implies something about autonomy (rule for oneself to act) and '自立' about independence (standing up by oneself).

The importance of autonomy in ethics can be said to be the definition, but this is not obvious in Japan, where harmony with the organization and not disturbing it have been emphasized. In the 1990s, the emphasis on individualism and autonomy as opposed to collectivism became a major social issue in Japan. It was an important philosophy in the establishment of JABEE that clashes with Japanese norms.

In criterion 1.2, globalization was another issue in the 1990s. 'Multi-dimensional thinking' from a global perspective is related to relativism in post-war Japanese education, as well as consideration for the global economy. In Japan, consideration for other countries is inevitably linked to memories of the Pacific War. The year 1995 marked the fiftieth anniversary of the end of the War, and thus review of post-war values became a major social concern.

This multi-dimensional global perspective is like that of Latin America. Unlike Latin American countries, however, Japan's accreditation documents do not emphasize the need to overcome anthropocentrism with respect to the planet's biological diversity. Latin America's attitude toward environmental issues may be related to the region's evident deterioration of strategic ecosystems and the neoliberal economic development model that has plunged much of the population into severe inequity and violence. The historical and environmental interests of each country may influence this difference.

Furthermore, equity for people is not stated in Japan. While it may be implied in the accreditation requirements, Japan's focus is on something else: the development of independent and autonomous leaders who can respond to the globalized society that became more evident in the 1990s. The accreditation guideline states the following:

> This item indicates education and intellect required for the independent globally active individuals who take leading roles to structure sustainable and changing society emphasized [*sic*] on spiritual value shifting from the materialized society.
>
> *(JABEE, n.d.)*

As demonstrated above, Japan focuses on cultural diversity in a global society. This context is emphasized because Japan has adopted accreditation for engineering education as a Western system that is indispensable for economic globalization.

Design and communication were also important ideas of the 1990s in Japan. Japanese engineering faculties were training engineering scientists rather than engineering professionals. The engineering scientist conducts research and development at a university or corporate laboratory, while the engineering professional engages in engineering practice in a company or independently. American engineering design education was an innovative idea for Japan. These basic ideas are also important when understanding Japanese engineering ethics and the influence of the United States in teaching engineering ethics.

In comparison to the Latin European case, 'dialogue structure' is a French approach that emphasizes philosophical dialogue in education. In Japan, the similar competency is described as "(f) Communication skills including logical writing, presentation and debating," but it can be read as a prerequisite for communication that values harmony within a group as much as, or more than, critical discussion. Furthermore, the older generation promoting the accreditation system in Japan often complains about the lack of communication skills of the younger generation.

In Japan's first constitution established at the beginning of the seventh century, the first article emphasized respect for harmony, '以和為貴,' based on the Confucian *Analects*. The *Analects* (13.23) also states: "子曰, 君子和而不同, 小人同而不和" [the Master said, "the superior man is affable, but not adulatory; the mean man is adulatory, but not affable"] (Legge, 1861, p.137). The word '和' translated here as 'affable' is the word translated as 'harmonious' or 'peaceful' in general. Harmony is not inherently favorable, but the two are often confused in collectivism. It has been a major cause of corporate misconduct in Japan.

Anglo case study: United Kingdom

Degree accreditation for engineering programs in higher education institutions (HEIs) in the United Kingdom is not legally required. However, accreditation is an essential component to validating engineering programs and ensuring they are fit for purpose. The Engineering Council is an umbrella organization that sets and unifies the professional competencies for all engineering disciplines and their corresponding institutions. Thirty-nine licensed specialized engineering institutions use these competencies as authorized bodies to accredit degrees within their respective disciplines in HEIs such as the Institute of Mechanical Engineers (IMechE) and the Institute of Civil Engineers (ICE). The following case study focuses on the IMechE. Like the Japanese accreditation requirements, the UK process is rigorous and requires several review stages and visits. The advantage of accreditation is its alignment with other internationally recognized teaching quality benchmarks for engineering education, including the EUR-ACE Accord, the Washington Accord, and the Sydney Accord. This gives UK graduates the advantage of having a degree that is internationally and nationally recognized and that satisfies the educational requirements on the pathway to professional chartered engineering status in their disciplines.

Upon finding satisfactory evidence of the program meeting the requirements, the accrediting body awards the HEI with accreditation for the program for 4 years, which remains valid on the conditions that (a) annual reports and assessment samples are sent for review and (b) any changes to the program, including learning outcomes required within modules, are ratified by the accrediting body. Renewal for accreditation at the end of the 4 years requires a complete review of the program with a site visit. In addition to industry-specific accreditation, all HEIs must satisfy their responsibilities to students according to the Higher Education and Research Act 2017 (HERA), which led to the government establishing the Office for Students (OfS) as a public body under the Department of Education to oversee and regulate Higher Education in England and hold HEIs accountable. (For more on the UK system, see Chapter 32.)

Earlier multi-country analyses conducted by the authors (Junaid et al, 2022) revealed three key findings from the UK perspective. Firstly, the definition of terms from the competencies guidelines of the United Kingdom's AHEP-4 (Association of Higher Education Professionals) includes the third most comprehensive list of terms defined (of all ten documents analyzed). This UK document included eight target terms: 'accreditation,' 'competence,' 'delivery,' 'graduate outcomes,' 'higher education,' 'learning outcomes,' 'module,' and 'program.' From the previous AHEP-3 permutation, three definition terms had been removed for AHEP-4: 'awareness,' 'knowledge,' and 'know-how' – and interestingly, all three of these verbs are ones that Newton's taxonomy analysis recommends avoiding when defining learning outcomes (Newton et al., 2020). Secondly, the number of implicit ethical terms (shown in parentheses here) heavily emphasized 'profession' (24), 'safety and risks' (21), and 'society' (20). These constituted 62% of the terms found. Combined with the terms 'charters and codes' (13), 'technologies' (11), and 'responsibility' (9), 93% of all terms identified for the study were covered. There appears to be a greater emphasis on safety and risk in the UK documents compared to the multi-country average, and this reflects the United Kingdom's reputation for high safety standards in the workplace and the influence of the legally binding Health and Safety Executive (HSE). The HSE was established after the Health and Safety at Work Act was passed in 1974. It set a precedent in criminal and civil law by assigning responsibility for protecting their employees to the highest senior levels in organizations. Furthermore, the UK engineering industries' contribution to the industrial revolutions also necessitated the focus on health and safety, charters, and codes. However, our analysis found no terms for 'global view,' 'organization,' 'international context,' 'integrity,' or 'justice.' These are unusual omissions, considering the first industrial revolution put UK engineering on the global map and onto the international stage. These exclusions will inevitably be reflected in curricular designs lacking both international outlook and impetus to address inequalities more widely, even though these competencies are required through being signatories of international accords. Membership in these accords may allow graduates to work as engineers in cross-national teams; however, our study indicates that more emphasis is needed on these qualities ('global view,' 'organization,' 'international context,' 'integrity,' and 'justice') in the learning outcomes to prepare students to navigate these roles on a global stage.

Observations and discussion

Accreditation documents can help bring ethics to the fore of engineering programs. However, this chapter does not explore the translation of policy into curriculum design. The results of integrating these terms into accreditation documents may not go far enough in challenging (future) engineers to take active roles in protecting and nurturing society and the natural environment (see Chapters 6, 9, and 35 for more on these topics). Engineering solves human-conceived problems, which in turn creates new problems to solve.

Our research into differences and commonalities identified through comparative, trans-national study is driven by the belief that nuances embedded in policy documents drive engineering curriculum development and, hence, influence how and what our engineers may be taught. Dialogue that considers the historical, socio-political, socio-economic, and environmental influences can bring new insights regarding what engineering curricula are doing (and how they are doing it) to develop competent engineers from nation to nation, region to region, and from one cultural cluster to another. It is essential to explore how these aspects drive curriculum delivery and expose students to value-driven contextual nuances in ethical awareness, ethical decision-making, and ethical practice to prepare them for working in global teams. The scope of this work presented here represents an initial step toward realizing these ambitions.

Realizing our goal of comprehensive, global cross-cultural analysis will require a larger study, to include more countries – so that we can more fully understand culturally nuanced differences in engineering ethics education. This will help us understand how ethics is conveyed in accreditation documents globally, to support more purposeful curriculum design and bring new insight regarding the ethical competencies that engineers need to work in locations around the globe. How ethics is seen and contextualized in parts of the world we haven't yet covered may help us understand ethics more fully. Therefore, to extend what we have achieved in this chapter, we will need to collect and analyze more data. We therefore put forth a call and an invitation to readers – those with interest in supporting or collaborating in the work – to join us in the work that still needs to be done.

The limitations of the analyses conducted to date serve as areas for further research. For example, more can be done via linguistic and discursive analysis: analyzing power through language, the uneven influence and dominance between languages and cultures, and how these play into accreditation processes globally (for more on this, see Chapters 35 and 36). The interplay of different fields influencing ethics education needs experts in disparate fields (see Chapters 14–18) to work together to synthesize new insights from these analyses. We need linguists, engineers, policy-makers, sociologists, political scientists, and philosophers (see Chapters 1–13). Finally, exploring the role of engineering in the context of corporate and non-corporate social structures (see Chapters 9 and 11) also challenges our institutions and graduates to consider the different roles engineers can play as, for instance, the civic engineer, the entrepreneurial engineer, the policy-making engineer, and so on.

Conclusion

Analyzing the rhetoric and discursive linguistics in accreditation documents (beyond the granular analysis presented above) is necessary. Such analysis can help develop insight into how these policy documents shape program design and impact the pedagogical structures we observe in our own institutions and, consequently, in the engineers who graduate and work in society. All clusters in our study used action-oriented learning levels: 'apply,' 'analyze,' 'evaluate,' and 'create.' We can, therefore, assume that most reference systems in the context of ethics are designed to inspire action. Nevertheless, if we consider that ethics will be an important component of the role of engineers in the coming years, we might wish to move the level of objectives towards the highest learning level, 'create,' which is more representative of responsibility. This would mean that simply 'remembering' (the passive level) would no longer be in the first rank. It would have to cede this current rank to a higher level to 'apply.'

This chapter has touched on the social, political, and environmental realms that engineers can influence. The authors posit that the future engineer should be actively involved in these spheres, even more than before, because of the power and risk that emerging technologies have on our societies.

Note

1 The GLOBE system was used for clustering the countries included in the accreditation analysis. The GLOBE clustering was more comprehensive and included more countries. The Hofstede dimensions were used to analyze and compare patterns between accreditation documents.

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ACCREDITATION AND LICENSURE
Processes and implications

Angela R. Bielefeldt, Diana Adela Martin, and Madeline Polmear

Introduction

Striving toward the ethical and competent practice of engineers in the workforce motivates linkages between the individual professional licensure of engineers and accreditation to control the quality of the educational preparation of engineers. Significant differences exist globally, regionally, and even among engineering subdisciplines in the requirement and/or importance of engineering licensure for employability. The requisites for engineering licensure and the processes for setting these rules also vary widely. Further, there are complex and differing relationships between the accreditation of engineering degree programs and the licensure or certification of engineers globally. It is beyond our scope to present an extensive range of global examples of these conditions. Instead, the ethics of these requirements and processes from a few examples will be examined in this chapter, including issues of power dynamics, inclusion, and transparency. After exploring these topics at a high level, the authors leverage their personal experience and empirical work to reveal nuances not typically evident via two in-depth case studies set in the context of two original signatories of the Washington Accord. The first case examines civil engineering in the United States, probing the ethics of licensure requirements and the processes for setting educational accreditation requirements. It reveals the complex interactions of multiple organizations, including state governments, multiple non-profit groups, and a professional society. A second case study in Ireland examines the consequences of licensure and accreditation policies on engineering ethics education. Here, there is more direct government control at multiple levels, but it manifests differently through engineering education at different higher education institutions. These examples provide a grounding that others can use when considering their locally relevant specifics.

Licensure

Licensure is intended to help ensure professional competence and responsibility, such that an individual engineer can fulfill their primary ethical requirement to protect human health, safety, and welfare. Licensure can occur at the level of 'engineering,' at the discipline level (e.g., civil engineering, mechanical engineering), or at the subdiscipline level (e.g., structural engineering). Given the heterogeneity of licensure requirements and processes globally, this chapter provides

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examples from different countries. The examples are primarily drawn from the United States, the United Kingdom, Canada, and Ireland. The rationale for this focus is multifaceted, including the context and expertise of the authors (further explained under Author Positionality), the availability of English resources and documents related to licensure, and the cultural and structural focus on licensure in these countries. For example, in the United States, an individual can lose their license to practice engineering due to ethical violations.

The extent to which engineering should be viewed as a profession and demand licensure for individuals to call themselves engineers and conduct engineering work as their job and career is contested and varies by geographical context. Each government individually determines licensure requirements, and these vary substantially. Engineering licensing occurs within individual states in the United States and provinces in Canada – a practice that has been critiqued as overly restrictive compared to licensure at the country level, which is more common (e.g., Cleary, 2018). Licensure typically requires a combination of educational preparation (judged of sufficient quality) and relevant on-the-job work experience under the mentoring of a qualified engineer, with some jurisdictions, such as the United States, additionally requiring examinations to prove competence. Sometimes, this work experience must be within a particular geographic jurisdiction (e.g., in Canada or the United States). Geddie (2002) found that the local work experience requirement was the "most significant obstacle noted by foreign-trained engineers" (p. 129) in becoming licensed to practice in the province of British Columbia, Canada.

In addition to country-level licensure, efforts are being made across countries to standardize and recognize certification. For example, the International Professional Engineers Agreement (IPEA) has 16 countries as full members and 3 countries as provisional members, and the Asia Pacific Economic Cooperation (APEC) Agreement offers substantial equivalence of professional competence requirements across 14 countries and 2 provisional members; the IPEA and APEC countries have significant overlap. Within Europe, the EUR ING certificate under Engineers Europe (formerly FEANI) applies across 33 countries.

The laws and policies concerning non-licensed individuals working as engineers differ among countries. The Netherlands doesn't require licensure or registration (Davis, 2015), and in France, engineering is "both a job *and* a title" (Didier, 1999, p. 474). Within the United States, many mechanical, electrical, and chemical engineers working 'in-house' for a manufacturing or other business firm function without a license under the industrial exemption, which has been characterized as a threat to the profession (Spinden, 2015; Swenty & Swenty, 2017). Most US states have significant exemptions to engineering licensure laws, with an average of 14 different exemptions per state (Swenty & Swenty, 2023). Similar industrial exemption to engineering licensure occurs in the United Kingdom. In contrast, this industrial exemption does not exist within Canada, except for the province of Ontario. These examples speak to the heterogeneity of licensure practices across countries and cultures, with differences even between industries and regions.

Walesh (2022) proposes that many engineering disasters could have been avoided by requiring that professionally licensed engineers direct projects:

> All the engineering organizations behind these failures were exempt from placing licensed engineers in charge. Engineering did not need to be conducted under the direction of competent and accountable engineers whose paramount ethical and legal responsibility was public protection. Instead, the "engineering" was primarily driven by bottom-line-oriented managers and executives.
>
> *(p. 1)*

However, the significance of licensure and its role in determining ethical behavior and quality in engineering remain contentious topics, as exemplified by the comments in opposition to licensure posted in response to Walesh's article.

Engineering licensure requirements rest on the argument that engineering is a profession and, thus, should be licensed similarly to disciplines like medicine. However, "Marxists (Braverman, 1998), Foucauldians (Nettleton, 1992) and others [have] used power lenses to question and challenge the control and authority vested in professionals due to their esoteric knowledge base and supposedly superior ethics" (Klassen, 2018, p. 13). Professions more broadly have been critiqued as "sites of substantial inequity and marginalization" (Klassen, 2018, p. 13).

Accreditation role in licensure

Engineering licensure is commonly linked to receiving education from accredited engineering programs. Program accreditation is assumed to ensure that the quality of educational preparation is sufficient to ensure engineering competence and ethical behavior. In many countries, governmental entities control both engineering licensure and educational accreditation. For example, in the United Kingdom, the Engineering Council controls both engineering licensure and accreditation; in Ireland, Engineers Ireland (EI) also has a dual function. Klassen (2018) states (italics added here for emphasis):

> There is a widespread assumption in Anglo-American contexts that accreditation exists to align the focuses of professional education in universities with the needs of professional bodies and ultimately employers, where professionals go to work. [This] perspective provides an underpinning assumption for legislation whereby the state delegates regulatory power to the professional body *in return for a commitment to serving the public good and upholding high standards of ethics*. This assumes a very clear definition of the scope of practice being regulated, and proactive steps taken by the professional body to intervene and discipline their members if they malpractice or operate without a license. Interestingly, neither of these assumptions appear to hold well in the case of the engineering profession.
> *(p. 14)*

Countries typically tie their licensure requirements to accredited degrees within their own country. This creates barriers for individuals who have earned degrees that are not accredited. It also creates mobility problems for individuals possessing engineering degrees from outside the country. Various international groups are trying to address global mobility issues by determining substantial equivalency of engineering accreditation standards. The first significant effort to establish accreditation equivalency across countries was the Washington Accord (see more information in Chapter 32). Countries participate in the Washington Accord through representation by governmental or private entities; for example, the Accreditation Board for Engineering and Technology (ABET) represents the United States. However, there continue to be barriers for individuals receiving engineering degrees from countries not signatories to the Washington Accord. For example, Geddie (2002) found significant financial and time barriers associated with the examinations and interviews used to evaluate the competence of foreign-educated individuals to be licensed in the province of British Columbia, Canada.

Klassen (2018) argued that the accreditation process generally fails to acknowledge that a high percentage of students who graduate with degrees in engineering pursue careers outside of engineering. In the United States, 65% of degreed engineers were working in occupations not considered engineering, and 18% of those working in engineering occupations did not have a degree in engineering (NAE, 2018). Fortunately, there is a significant overlap between the knowledge and skills embedded in engineering accreditation requirements and the skills needed for careers at large (OECD, 2021).

In addition to the accreditation requirements that apply uniformly to all engineering disciplines, there may be additional requirements for specific engineering disciplines. Within ABET, these 'program criteria' are largely set by the professional societies that relate to each discipline. Each professional society uses different processes to modify these criteria. Other examples vary by country and discipline. For example, in the United Kingdom, the Joint Board of Moderators, comprised of five different professional groups, accredits civil engineering and related programs; the Institution of Mechanical Engineers accredits mechanical engineering degrees; the Institution of Engineering and Technology accredits electrical and electronic engineering degrees.

Processes to determine accreditation standards

How accreditation processes are structured and who determines and controls these structures have ethical implications. The professional groups and regulatory bodies involved in accreditation have self-interest and therefore may "act to maintain their own privileged and powerful position as a controlling body," which might confound their commitment to the public interest for high quality and ethical engineering (Harvey, 2004, p. 212). Further, "goals and decisions emerge from bargaining and negotiation among competing stakeholders jockeying for their own interests" (Bolman & Deal, 2013, p. 194-195). Goals differ among countries with respect to global competitiveness (e.g., intellectual property), between for-profit companies and public agencies (profit vs. wise stewardship of resources), among disciplines (differences in salary and prestige), and privileged versus less privileged groups (e.g., particular nations over others; and in the United States, white men vs. minoritized groups). The extent to which accreditation processes prioritize true public good versus other interests merits consideration.

While the processes for engineering programs at higher education institutions to become accredited have been well documented, uncovering the processes used to set these rules is more challenging. From the outside, there might seem to be a broad consensus on accreditation requirements and procedures. But this is far from the case. There is typically a fairly small number of people who develop accreditation policies and procedures. The extent to which these individuals develop criteria that match their personal opinions versus the broader views of diverse stakeholders is generally not apparent. The process by which individuals are selected to serve on these committees and their qualifications, expertise, representation of diverse stakeholders, and true level of engagement in the process is also unclear. Who has a seat at the table and is included or excluded has embedded ethical considerations. For example, Case (2017) contrasted the 'shop culture' of working engineers versus the 'school culture' of engineering academics, which differ in the value placed on particular knowledge and skills. In Ireland, accreditation bodies strive to include two academics and an industry practitioner on each accreditation panel, which helps assess whether the program under evaluation is substantially equivalent to the programs that the academics deliver in their own institutions and aligns with the requirements of industry (Murphy et al., 2019).

The International Engineering Alliance [IEA] (2021) has established *Graduate Attributes and Professional Competencies*, which are closely related to the Washington Accord and the International Professional Engineers Agreement. The Washington Accord has 23 signatories and seven provisional signatories as of 2023. Signatories have committed to mutual recognition of substantial equivalency of accreditation standards and processes (Hanrahan, 2013). If mutual recognition is truly the case, analyzing the process of any one signatory would accurately represent all. Underlying cultural differences may shape the "individual accreditation processes and variations in accreditation criteria as well as different documentation requirements and reporting processes" (Patil & Gray, 2009, p. 20). Thus, no one set of processes should be deemed optimal or the most ethical. The basic process for accreditation of engineering programs consists of a repeatable cycle of review (3–6 years being most common); documentation of self-assessment that the program meets the accreditation requirements (typically a combination of student learning outcomes and/or curriculum structure and content, qualifications and number of faculty members, processes for student admissions, and verification of fulfillment of graduation requirements); program review by individuals typically including an on-site visit (number, qualifications, and training of the reviewers are specified); and specific outcomes/decisions of the accreditation process. Some governments have a single set of requirements for all engineering degrees; others have varying requirements for different engineering disciplines (as is the case under ABET and in the United Kingdom).

In the United States, some highly respected universities have opted not to accredit some of their engineering degrees, viewing ABET accreditation as unnecessary, burdensome, and/or restrictive. These highly ranked programs at research-intensive universities do not believe they need traditional accreditation to vouch for their quality (Klassen, 2023). Examples of universities and programs opting out of ABET accreditation include Stanford University (Electrical Engineering 2013, Environmental Systems Engineering 2015, Chemical Engineering 2020), the California Institute of Technology (Caltech, Chemical and Electrical Engineering in 2018), the University of California Berkeley (Electrical Engineering 2017), and Tufts University (Biomedical Engineering 2022). In its announcement that it would not re-accredit its environmental engineering degree, Stanford University stated: "The accreditation process … isn't quite at the cutting edge of the field" (Stanford, 2015). Another university discontinuing ABET accreditation stated (Caltech, 2017):

> The undergraduate program in Chemical Engineering at Caltech is widely regarded as one of the most rigorous in the world. In our efforts to maintain that rigor in light of the rapid pace of change in this discipline, Caltech's Chemical Engineering faculty have concluded that the process of engineering accreditation by ABET limits our ability to offer the best possible education.

The letter cited limitations to flexibility, specifically that "the restrictions and requirements imposed by ABET criteria and examiners have led to an excessively structured curriculum," and concerns with the vagaries of individual program evaluators (PEVs). Despite the lack of requirements to meet ABET accreditation outcomes, engineering ethics content remains embedded within required courses in the Caltech chemical engineering curriculum, including a senior chemical engineering lab course that embeds ethics within team projects and the analysis of case studies (Caltech, 2022). Alternatively, some programs have opted to accredit under the general criteria rather than the appropriate program criteria, which impose additional restrictions (e.g., Massachusetts Institute of Technology (MIT) Civil Engineering).

The following sections provide case studies of accreditation and licensure in the United States and Ireland to complement the broader overview of the preceding sections. The US case study focuses on civil engineering, exploring ethical issues within accreditation and licensing processes. These overall processes are drivers for the ethics requirements in engineering education and licensure. The second case study, in Ireland, reveals the consequences of the licensure and accreditation requirements on the ethics education in engineering.

Author positionality

The cases were selected based on the authors' expertise. The first author has led accreditation efforts in the civil engineering program at her institution for 15 years, served on the American Society of Civil Engineers (ASCE) Body of Knowledge 3 Task Committee and Program Criteria Task Committee, and is a licensed professional engineer in Colorado, United States. Her experiences offer insight into the development and implementation of civil engineering accreditation in the United States. The second author provides a case study in Ireland based on her doctoral dissertation. During her dissertation research, the second author interviewed instructors and evaluators to understand the accreditation process in Ireland and the role of ethics within it, and observed several accreditation events. The second and third authors are involved in an international study on the role of ethics in engineering accreditation (Junaid et al., 2022) and use this work as well as their engineering education research experience in different countries (Ireland, the Netherlands, Belgium, and the United Kingdom) to inform their perspectives.

Case study: United States, ABET, civil engineering

In the United States, state governments control engineering licensure. The licensing process typically involves the shortest path when the individual has graduated with a Bachelor's degree from an ABET-accredited engineering program, passed two national examinations, and has 4 years of qualifying practice vouched for by professionally licensed engineers. An individual graduating without an ABET-accredited degree may be eligible for licensure after an additional 1–4 years of qualifying experience. Some states issue a general Professional Engineer (PE) license with the expectation to practice in one's area of competence; other states license PEs in specific disciplines (e.g., Professional Civil Engineer). In addition, structural engineering (SE) is separately licensed in many states. Most states allow individuals licensed in one state to easily become licensed in another through the process of comity.

The two licensing examinations are common nationally and controlled by the National Council of Examiners for Engineering and Surveying (NCEES), a nonprofit organization. The Fundamentals of Engineering (FE) exam is largely multiple-choice, is proctored, online, and has versions for different engineering disciplines. The exam is commonly taken by senior-level (i.e., final-year) undergraduate engineering students, and some engineering degree programs require their students to take the FE exam before graduation. The FE exam can be taken at any time and repeated if not passed. The FE exam includes a few questions on engineering ethics and professional practice or societal impacts (3–8 out of 110 total). The quality of these questions and the ability to actually evaluate ethical reasoning abilities have been critiqued (French, 2006). The NCEES is not transparent about who writes the exam questions, including those related to ethics, stating only that "NCEES exams are developed by licensed engineers and surveyors who volunteer to write and evaluate exam questions in conjunction with NCEES procedures and accepted psychometric standards" (NCEES, 2021, p. 4). The second exam, Principles and Practice of Engineering (PE), was historically 8 hours and tested higher-order engineering design skills; professional, licensed engineers scored it. However, the PE exam has also moved to a multiple-choice format. The PE exam includes no content on ethics.

Some states have additional licensure provisions that target ethics, such as a further examination that covers ethics and/or local legal issues (e.g., Texas, California, Nevada, and South Dakota). Most of these exams appear to be in 'take home' format with simple multiple choice or true/false questions. Some states require that an individual seeking professional licensure obtain letters that attest to personal and/or professional character and/or integrity (e.g., Texas, Oregon, Mississippi, Rhode Island, Montana). For example:

> The Texas Engineering Practice Act states that a person seeking to obtain a license to practice professional engineering shall provide evidence of good professional character and reputation which, in the judgment of the Board, is sufficient to ensure that the individual can consistently act in the best interest of clients and the public in any practice setting. Such evidence shall establish that the person is able to distinguish right from wrong, is able to think and act rationally, is able to keep promises and honor obligations, and is accountable for his/her own behavior.
>
> *(Texas, 2022, p. 2)*

Most states require continuing professional development via education to retain one's license, ranging from 8 to 15 hours per year (which may be documented on an annual, biennial, or triennial basis), called professional development hours (PDH) or continuing education units (CEU) (E1 Education, 2020). Nine states have no requirements for continuing education documentation. Fifteen states have some minimum requirements for continuing education hours related to ethics education (ranging from 0.33 to 1.5 hours per year). Professional development hours are often earned by attending professional conferences or online education sessions. The quality of this education is uncertain and, therefore, has been critiqued in some cases as simply a money-making business for groups and professional societies that exercise their power to create requirements for PDH and then also offer those hours (Nevada, 2020).

Overall, the importance and extent of licensing in the United States varies significantly among disciplines, appearing the highest in civil engineering, where nearly all civil engineering graduates take the FE exam and three-fourths go on to attempt professional licensure, compared to less than half even starting the professional licensure path by taking the FE exam among mechanical, electrical, and chemical graduates (based on author calculations from ASEE (2020) and NCEES (2019) data).

ABET is a non-profit organization that sets accreditation standards in the United States. ABET relies heavily upon volunteers to lead the development of the accreditation requirements and to implement the requirements by reviewing programs. ABET recently reported the age, gender, race/ethnicity, and job-sector demographics of its volunteers, but these were not disaggregated among roles (ABET, 2022). Akera et al. (2019) note that "many ABET volunteers are older, retired, and tend to have more conventional views about their discipline" (p. 13). The ABET Engineering Accreditation Commission (EAC) has been critiqued for lacking transparency and open feedback processes. Within the EAC, professional societies are primarily responsible for establishing the program-level criteria associated with specific disciplines and selecting and training the program evaluators. Civil engineering has been one of the most transparent, publishing widely on its processes. In 2023, there were 365 ABET-accredited civil engineering programs across 268 US institutions and 90 institutions outside the United States (representing 20 countries).

The American Society of Civil Engineers (ASCE) is the lead society associated with civil engineering within ABET. The ASCE Code of Ethics has explicitly included sustainability since 1997 and added diversity and equity provisions in 2017. The civil engineering program criteria (CEPC) include the requirement that "faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience" (ABET, 2023, p. 23). There are curriculum requirements in the CEPC related to professional licensure dating back to 2002, and sustainability and professional ethics since 2016. The

ASCE publishes a commentary document to explain the rationale and expectations associated with the criteria to guide civil engineering PEVs and faculty. The commentary (ASCE, 2019a) states:

> Graduates should be able to explain the unique nature of civil engineers' responsibility to the general public and the consequent emphasis on professional licensure in civil engineering professional practice.
>
> *(p. 24)*

> The program Criteria … reflects an expectation for a higher level of achievement in professional ethics than required by General Criterion … requiring a curriculum to include an opportunity for students to go beyond a simple understanding of ethical responsibility and have students analyze issues.
>
> *(p. 22)*

> The Civil Engineering Code of Ethics includes as one of the Fundamental Cannons that "Engineers shall strive to comply with the principles of sustainable development …" … The criterion simply requires coverage of sustainability in the curriculum be sufficient so graduates can include key concepts of sustainability in an engineering design.
>
> *(p. 18)*

By comparison, ethics is lacking from other ABET EAC program criteria with the exception of construction (where ASCE is also the lead society) and cybersecurity.

The ABET CEPC are derived from the Civil Engineering Body of Knowledge (CEBOK). The CEBOK "defines the knowledge, skills, and attitudes necessary for entry into the practice of civil engineering at the professional level" (ASCE, 2019b, p. vii). The 2019 edition (CEBOK3) specifies the expected cognitive level of achievement of 21 outcomes using Bloom's taxonomy verbs and recommends pathways to meet these requirements, which include undergraduate education (the lower levels of all 21 outcomes), postgraduate education (2 outcomes), and mentored experience on-the-job (14 outcomes). The CEBOK3 also includes seven affective outcomes. The ethical responsibilities outcome in the CEBOK3 was cross-linked with the outcomes of design, professional responsibilities, professional attitudes, sustainability, and lifelong learning.

The ASCE has established a repeatable cycle every 8 years whereby it reviews the CEBOK, then determines the extent to which the ABET criteria are aligned with the CEBOK and if changes to the CEPC are warranted (Ressler & Lynch, 2011). The ethics outcome in the 2019 CEBOK compared to the 2008 CEBOK had a lowered level of achievement from undergraduate education (to Bloom's level 2 'explain' from 4 'analyze') and entry to professional practice (to Blooms level 5 'develop' from 6 'justify'). In addition, the 2019 CEBOK3 added the affective domain expectation to "advocate for ethical behavior in the practice of civil engineering" (level 5), achieving level 2 as part of undergraduate education ("comply with applicable ethical codes") (ASCE, 2019b, p. 61).

The development of both the CEBOK and CEPC included numerous cycles of soliciting and responding to stakeholder feedback. This occurred via specific committees in ASCE, discussion boards, and open surveys that were broadly distributed. Nevertheless, limited outside participation in these forums occurred. The development and results of feedback were carefully documented and distributed via peer-reviewed, open-access papers (e.g., Bielefeldt et al., 2019; Nolen et al., 2022). The CEBOK and CEPC represent a compromise as consensus on these topics was not reached.

The ASCE tries to comprise committees that are broadly representative, including individuals from academia (faculty members) and practicing engineers, individuals representing multiple subdiscipline areas in civil engineering (e.g., structures, geotechnical, construction, transportation, water resources, environmental), and a variety of personal demographics (age, gender, etc.). Despite these efforts, the committees have recently been predominated by academics with a low representation of traditionally underrepresented groups (e.g., women of color). The recent CEBOK3 committee included four individuals with ethics expertise, and the current CEPC committee includes individuals with expertise in ethics, sustainability, licensure, and diversity, equity, and inclusion (DEI). The CEBOK and CEPC groups opened their meetings to corresponding members not serving on the committee but wishing to provide input. Thus, while the committees have recently included 10–18 members, there were also 20–70 corresponding members who provided additional perspectives.

The CEBOK2 review resulted in the addition of ethics to the ABET CEPC in 2015. When reviewing the CEPC with respect to the CEBOK3 in 2020–2022, the ethics outcome was revised to state that "the curriculum must include application of: an engineering code of ethics to ethical dilemmas; principles of sustainability, risk, resilience, diversity, equity, and inclusion to civil engineering problems" and "explanation of professional attitudes and responsibilities of a civil engineer, including licensure and safety" (ABET, 2023, p. 22). There was extensive discussion around the ethics outcome, with an early proposal of "apply the ASCE Code of Ethics to an ethical dilemma." This reflected the fact that the ASCE Code of Ethics (2020) uses a hierarchical stakeholder model that embeds sustainability and DEI elements. However, stakeholder feedback on the practicality of this suggestion noted that many programs co-educate civil engineering students alongside other engineering majors with respect to professional ethics and, therefore, requiring the specific civil ethics code would be problematic.

ASCE also sets the requirements for, approves, and trains ABET program evaluators (PEVs) for civil engineering programs. The qualifications to be a civil engineering PEV include registration as a PE, at least 10 years of experience in the practice of engineering, and membership in the ASCE at the Member or Fellow grade. From ABET, all PEV candidates complete about 20 hours of online training and a 1.5-day experiential workshop simulating an ABET accreditation visit; this PEV training may qualify as PDH for licensure. PEVs also agree to a code of conduct policy that includes confidentiality and conflict-of-interest issues. Akera et al. (2021) noted that some of the individuals they interviewed "spoke about consistency, PEV training and variation" (p. 5) as part of their frustrations with the ABET review process.

A recent paper by Ressler and Lenox (2020) explored the potential for ASCE to withdraw from ABET, identifying the benefits and costs of ABET membership from the perspective of ASCE. These authors have deep engagement, leadership, and service with both ABET and ASCE. They recognize "ASCE's ability to establish, promulgate, and enforce educational standards through ABET accreditation represents a powerful tool for advancing the Society's strategic interests" (p. 7). "However, these benefits are not being fully realized, because ASCE's perspectives and interests so often diverge from those of ABET and many of its Member Societies" (p. 10).

This case illustrates the complexity and interconnected nature of groups that influence engineering ethics education in civil engineering in the United States through specification and affect licensure and accreditation processes. Compared to other disciplines, civil engineering appears to be at the forefront in the United States regarding concern for ethics in the education and practice of engineers. Yet the practical implications of these regulations on ethics education are unclear, given the strong role of the engineering culture (which preferences technical expertise and business or profit motives in the workforce) and the significant level of control of individual teachers in their classrooms. The next case study illustrates the consequences of licensing and accreditation on ethics education in engineering programs in Ireland.

Case study: licensure and accreditation in Ireland

Moving from process to practice, this case study presents empirical data rooted in the Irish context of engineering education to illustrate the impact of accreditation on curriculum development and the link between accreditation and educational change. Engineers Ireland (EI) has formally accredited engineering programs in the Republic of Ireland since 1982. Graduates of accredited programs may achieve one of the professional titles of Chartered Engineer, Associate Engineer, or Engineering Technician. From 2013, in order to apply to become a Chartered Engineer, candidates need to hold a Master's Degree from an engineering program accredited by EI. Under the terms of the Washington Accord, EI also recognizes qualifications obtained outside Ireland that meet a similar educational level. Ethics is part of the licensure process for becoming a Chartered Engineer via a dedicated requirement, which requires professionals to provide examples of ethical practice in their written application. This is understood to comprise evidence that the candidate has "complied with appropriate codes and rules of conduct" (competence 5.1), "managed and applied safe systems of work" (competence 5.2), "ensured that their engineering work complies with the code of practice on risk and the environment" (competence 5.3), and "ensured their continuing professional development to maintain the currency of their professional engineering knowledge and skills" (competence 5.4). Evidence pertaining to ethics can also be provided for different competencies, which require the candidate to show that they understood and applied advanced knowledge of the widely applied engineering principles underpinning good practice (competence 1.2). The written application is followed by an interview, comprising a presentation and a discussion with the panel where candidates are further asked about how they meet the five competencies.

EI was one of the six original signatories of the Washington Accord in 1989, which targeted the mutual equivalence of Bachelors of Engineering degrees (International Engineering Alliance, 2015). The Washington Accord included a focus on ethical responsibilities and the societal role of the engineering profession, including sustainability (see Chapter 32) (International Engineering Alliance, 2014). The emphasis of global accords on ethical and societal considerations in the practice of engineering is considered to have led to the establishment of engineering ethics education as a mandatory accreditation requirement in signatory countries (Coates, 2000).

In Ireland, ethics first appeared in 2007 in the accreditation criteria; they were revised and extended in 2014 and 2021 (Engineers Ireland, 2014, 2021). In addition to a program outcome dedicated to professional and ethical responsibilities, the most recent formulation of the accreditation criteria includes an outcome on sustainability (Engineers Ireland, 2021).

The accreditation process in Ireland

EI, like ABET, accredits an individual program rather than an entire college or institution. Each program offered by an engineering college or faculty undergoes a separate accreditation process, for which it prepares its own set of documents based on guidance and objectives set by EI. This is a quality review process occurring approximately every 5 years. It encompasses three steps that are quite similar to the ABET process: (1) internal self-study documentation, (2) a site visit over 2 days, and (3) an external evaluation report submitted by the representative of EI and the accreditation panel.

The EI Registrar is responsible for managing the evaluation process, selecting the accreditation panel members, and preparing the agenda for the accreditation visit. Each program has an internal team preparing the documents and overseeing the organizational aspects of the visit, including the guided tour of facilities and separate sessions with students, alumni, and employers. The accreditation panel responsible for evaluating the program is comprised of two external academics and one industry representative.

Ethics in the context of accreditation

Martin's (2020) doctoral study examined the evaluation of ethics for accreditation in Ireland. The study used internal documentation prepared by the programs, accreditation reports, interviews with evaluators and instructors, and observation of accreditation events. It identified how ethics was being considered and evaluated at the three stages of the accreditation process mentioned above in 23 engineering programs offered by six institutions across Ireland.

Internal self-study documentation

Within the qualitative descriptions in the self-study documents prepared by participant programs, ethics was often described as 'complementary' or 'ancillary' to four 'technical' core program outcomes, that is, (A) technical and scientific knowledge, (B) problem-solving, (C) design, and (D) conducting experiments. One self-study noted: "Programme outcomes E [ethics], F [communication], and G [teamwork] are associated with developing a *complementary skill set* in graduates and are generic to most branches of engineering" (Martin, 2020, p. 250). Ethics was described in similar terms by a program that had the objective of "equipping students with 'advanced technical, design, research and complementary skills to be of direct benefit to the profession in particular and society in general'" (p. 250–251). Another program at the same institution mentioned a similar distinction between two types of outcomes. According to the documents submitted by one of the participant university's programs:

> while the first four outcomes relate to the acquisition of a sound technical and analytic base and a mastery of the necessary discipline-specific knowledge, the last three outcomes relate to the practice of engineering in a work and professional context.
>
> *(p. 251)*

The internal self-study documentation highlighted that the programs had a stronger focus on attaining scientific and technical outcomes distributed throughout the 4 years of study, while ethics was integrated into just a few courses and course units. Notably, the outcomes purporting to technical and scientific knowledge and problem-solving were described as core technical outcomes. Ethics had an ancillary role in several programs, which was reinforced by descriptions that the program aspired to produce "graduates with the necessary theoretical foundations, domain-specific technical knowledge and practical and ancillary skills" (p. 251–252).

The description of the 'complementary' status of ethics within the engineering curricula was reflected in the numerical self-assessment of how programs deemed each of their courses to have met the ethics outcome. For this numerical self-assessment, Engineers Ireland (2015) recommends using a five-point scale for the programs to indicate how the learning outcomes set for each of their modules meet the seven program outcomes set by the accrediting body. These scores range from 0 (module does not contribute to the outcome) to 4 (strongly contributes). Engineers Ireland (2015, p. 4) states this is "the most important section of the accreditation document."

The analysis showed that ethics was the program outcome with the lowest weight in the curriculum of the engineering programs that participated in Martin's (2020) study.[1] The average for the ethics program outcome considering all courses offered by 17 of the 23 programs participating in Martin's (2020) study was 1.56/4.00, less than half the average for the outcome purporting to technical and scientific knowledge (3.18/4.00) and problem-solving (3.12/4.00).[2] Considering disciplinary differences, the lowest averages registered in the numerical self-assessment of ethics were encountered in the programs of Electric and Electronic Engineering (average 0.81/4.00) and Electronic and Computer Science (average 0.88/4.00) (Martin et al., 2019).

The curricular weight given to each of the seven program outcomes together with the explanation provided about the implementation of these outcomes seem to place nontechnical skills on a different par than technical skills. Engineering programs tend to emphasize the attainment of technical, scientific, experimental, and design outcomes throughout the four years of study, viewing them as 'fundamental,' 'core,' and 'discipline specific' skills. Ethics, alongside the learning outcomes of communication and teamwork, have their place in a smaller number of courses and are described as providing a 'complementary' or 'ancillary' skill set. Engineering programs are thus seen to explicitly cultivate the dichotomy between what traditionally have been called 'hard' skills and 'soft' skills. This distinction and language are problematic for privileging technical skills, sending the message to students that professional skills are optional, and marginalizing educators and engineers who practice and promote professional skills (Berdanier, 2022).

Accreditation visit

The accreditation events observed during the doctoral research study (Martin, 2020) revealed different strategies for approaching evidence that distinguished between technical and professional outcomes. As such, during accreditation, discussions related to the analysis of evidence led to an agreement among evaluators to distribute their responsibilities such that the panel was "split into a hard and soft outcome" for each evaluator (Martin, 2020, p. 254). Reflecting on the approach to evidence, ethics "tends to be not singled out," such that the program outcomes purporting to technical and scientific knowledge, problem-solving, and design were discussed as a group, while the program outcomes purporting to ethics, communications, and teamwork were discussed as another group (Martin, 2020, p. 254). During the peer assessment process, less time was dedicated to discussing how programs met the non-technical outcomes compared to the time allocated for discussing the technical outcomes.

Some evaluators expressed their belief that ethics did not need to have the same emphasis as technical outcomes (Martin, 2020, p. 244–246). This view seems to have been shared by the instructors of the programs evaluated. The final plenary sessions of the accreditation events observed also reflected a lower threshold for what was deemed an acceptable provision of ethics education. Discussions between evaluators and the internal program team focused mostly on how technical outcomes had been met. As long as the evaluators' comments about technical outcomes were positive, the seemingly weaker curricular presence of ethics outcomes (based on the quantitative rubric scores or evidence) was deemed acceptable, and the programs were recommended for accreditation.

Overall, the participant programs' low focus on ethics outcomes (rendered via both low self-assessment scores and internal evidence) was perceived as a common state of affairs. Evaluators noted that there was "mostly low scoring" in ethics or that ethics outcomes "are hit lightly" (Martin, 2020, p. 245). During one accreditation event, two evaluators were in agreement that "this is mostly the case everywhere." Evaluators noted it was common for programs to give a low priority to the implementation of ethics. During interviews following the accreditation events observed by Martin (2020, p. 258), an evaluator stated that "sometimes it might appear like it is tagged on a bit at the end … not quite an afterthought, but it is probably not given as much importance." Another evaluator shared a similar opinion, considering that "ethics is way down the priority list" and is "mainly there just to cover the requirements of Engineers Ireland, … but the amount of module[3] content dedicated to it would be minimal" (p. 258).

Martin's (2020) study found that evaluators regard ethics as not having a fundamental role in the engineering curriculum. Reflecting on his experience as an evaluator, one participant stated that "programs do not see it as important. They probably prioritize having the core skills as an engineer or as a technician as being the primary skills requirement coming from the course" (p. 256). While technical outcomes are implemented in a systematic manner in the curriculum of engineering programs, ethics does not receive the same treatment according to another evaluator, who claimed that:

> if you take technical subjects, like structures or signal processing, the academics will make sure that the design of the program incorporates these, and in a logical and coherent way. But they do not take the same approach about the ethical material.
>
> *(p. 258)*

The lack of comprehensive implementation of ethics, often incorporated via an individual champion's efforts, is also reflected in an evaluator's remark that "programs were all relying on this person to show that ethics has been integrated into the program" (p. 258). The outcome is a normalization of the lower presence of ethics in the engineering curriculum. As such, teaching ethics in one or two courses will "hit the target sufficiently to avoid being a problematic issue" and for the program to avoid ending up in "a condition territory" when it comes to receiving the accreditation (p. 246).

Members of accreditation panels expressed difficulties in evaluating the ethics program outcome. According to an evaluator, the ethics outcome is the most challenging to evaluate because "we are not specialists in ethics. … there is this part of us that believes that we are not really qualified to evaluate that … because we are not trained to do that. So first of all, this is something new. Second of all, a lot of us, and especially people teaching highly technical tools, never thought about it and they never asked that question" (Martin, 2020, p. 263). One evaluator even stated that "I just do not like the ethics" outcome, and considers the technical outcomes are "the easiest" to assess (Martin, 2020, p. 263).

External evaluation reports

The evaluation reports contained little information to guide programs in strengthening or increasing the presence of ethics. In the recommendations related to ethics, there was a notable absence of suggestions for specific content or increasing the curricular presence of ethics. In contrast, there often was the recommendation to "strengthen ties with industry" or "introducing employers in the advisory board" (Martin et al., 2021, p. 369).

Summary

More attention was given to the procedural aspects of how programs prepared and displayed their evidence of the ethics outcome than to ensuring sufficient weight was given to ethics in the curriculum or exploring the broadness or societal relevance of its treatment. Although evaluators noticed the lower weight given to ethics in the curricula of engineering programs, it tended to be considered a common state of affairs, with the evaluators reasoning that ethics does not need the same emphasis in the engineering curriculum compared to technically oriented outcomes. Martin's (2020) study found that the existence of an accreditation criterion dedicated to ethics does not necessarily lead to a curriculum that addresses the social and political dimensions of engineering practice broadly (Conlon, 2013; Murphy et al., 2019). The study thus points to a lower threshold for the ethics outcome, compared to technical outcomes, of what was judged to be a satisfactory education. It also suggests that while accreditation can offer an impetus for including specific content in the engineering curriculum, it is not a guarantee that programs offer the best education to meet the requirements set by accrediting bodies. The impact of accreditation on curriculum development and educational change can be limited by the programs' resistance and sometimes self-limiting beliefs as to what engineering education is about. This adds to the current debates (mentioned in the previous section) of whether accreditation is indeed necessary for offering high-quality education (Caltech, 2017).

Closure

There is a complex interplay between accreditation and licensure that connects engineering education and practice while regulating the competencies and expectations of engineers. Important in grounding these linkages is the notion that engineering is a profession. Licensing and accreditation are key considerations in the conversation around engineering ethics education. These processes and the standards they set guide curriculum development, including the role of ethics; highlight what is valued and required in engineering practice, such as ethical responsibilities; and inform professional conduct, such as behaving ethically and the implications of not doing so. Establishing ethical processes for setting and enforcing engineering licensure and educational requirements, such as attending to inclusion and transparency, is critical. Accreditation and licensure continue to grow in importance with the globalization of the engineering workforce and the need for cross-cultural understanding of ethics (Chung, 2015). International efforts such as the Washington Accord and the European Network for Accreditation of Engineering Education (ENAEE, 2021) provide a level of global alignment among the processes and criteria for undergraduate engineering programs to be accredited. Although many accreditation documents include a marginal consideration of ethics compared to other outcomes, there is still variety in how ethics is implicitly and explicitly treated and defined (Junaid et al., 2022). This heterogeneity is greater for licensure, where processes and standards, including whether they are mandated, vary across disciplines, industries, and regions within the same countries. Disciplinary variation in licensure and education is notable and appropriate. However, given the increasingly interdisciplinary roles and implications of engineering work and continually evolving challenges, lifelong learning concerning ethics is critical for all working engineers. Globalization and mobility in the engineering workforce call into question the applicability of standardizing ethics (Clancy & Zhu, 2021; Zhu & Jesiek, 2020). The role of accreditation and licensure thus have implications for engineering ethics education not only via curricular and professional expectations but also via the cultural and power dynamics through which they are developed and implemented.

Notes

1 Note that the analysis follows Engineers Ireland's (2014) formulation of program outcomes. These were subject to redesign following the study, with a revised set of criteria being published in 2021.
2 The other six programs could not be included in the analysis of the self-assessment scores due to using a different self-assessment scale that could not be converted to the scale recommended by Engineers Ireland (2015).
3 In the Irish higher education system, a 'module' is the typical designation for a 'course' in the US.

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A FEMINIST CRITICAL STANDPOINT ANALYSIS OF ENGINEERING ETHICS EDUCATION AND THE POWERS AT PLAY IN ACCREDITATION, RESEARCH, AND PRACTICE

Jillian Seniuk Cicek, Robyn Mae Paul, Diana Adela Martin, and Donna Riley

Introduction

Ethics is essential to the engineering profession, embroiled within engineering regulations, codes, canons, and decision-making. As such, it's also part of engineering education, mandated and monitored in engineering programs accredited by national and international regulatory bodies (for more on this, see Chapters 19 and 22). However, ethics is complex, and even if engineering educators were to develop methods to teach to this complexity (and we argue that to date, they largely don't), it would still be difficult to assess under accreditation. Ethics requires practice; it cannot (just) be leveled and measured.

This practice must be muddy and messy, and prioritized over the achievement of reductionist individual learning outcomes (Woolston, 2008). Although we shouldn't teach engineering ethics for the sake of accreditation, it's impossible to separate our pedagogical decisions and approaches from accreditation regimes. The reduction of ethics to serve accreditation decouples it from its complexity and connections to broader concepts that are inextricably linked, including equity, diversity, inclusion, and social and environmental justice.

Here, we hesitate to define ethics. Wilson (2008) draws on Tafoya's (1995) Theory of Uncertainty to explain how you can't know both context and definition simultaneously; we're more concerned with understanding engineering ethics education in the context of accreditation and research. Therefore, to begin this journey, we offer Walker's *Moral Understandings: Alternative 'Epistemology' for a Feminist Ethics*. She writes about the necessity of ethics and moral legitimacy as a fight for moral justice to "end male domination, or perhaps to end domination generally" (Walker, 1989, p. 15). In our experience, this is not an approach commonly taken in engineering. In fact, in this chapter, we argue that current engineering ethics education and accreditation, if anything, promote and maintain demographic and social injustices.

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Engineering ethics content and pedagogy are often rooted in objectivity and reductionism, (unconsciously) promoting Western, educated, industrialized, rich, democratic (WEIRD) ideals (Martin et al., 2023) that call to mind colonial practices encountered in engineering practice (Davies, 2021; see Chapter 9 for more on this topic). There is less attention paid to critical perspectives on what engineering ethics is and who decides; on how engineering ethics interacts with professional codes, societies, and licensure organizations; and on the power influences that exist within engineering ethics structures and approaches.

Thus, how engineering ethics education and accreditation are emphasized – or not – in the literature and the power dynamics influencing them need to be questioned. We examine how three parallel goals of engineering ethics education come together and into conflict with each other: teaching future engineers, obtaining and maintaining accreditation, and conducting pedagogical research. *How are we, as engineering educators, motivated to engage in engineering ethics teaching and learning? How are these efforts self-limiting within the epistemological and ontological frames that comprise engineering ethics education, accreditation, and practice? What roles do accreditation artifacts play in thought leadership, in enacting accountability, in perpetuating limiting epistemologies, and in driving or resisting change?*

This chapter puts forth a critical feminist standpoint analysis of engineering ethics education in the context of accreditation, research, and practice using a narrative methodology. We challenge engineering ethics education and accreditation as Western/Global North concepts exclusionary to other perspectives. We explore the epistemic power relations within engineering accreditation and its reductionism and assess-ability. We examine how boundaries are drawn. We conceptualize engineering ethics education accreditation as a rhetorical justification, performative discourse artifact, and feckless change strategy. We address the silences in the literature and then close by arguing that, inadvertently, we are puppeteers of accreditation, perpetuating inauthentic change and limiting transformative engineering ethics education. Throughout the chapter, we leverage scholars who have engaged in these critical discussions and consider how to turn these philosophical discussions into action.

Positionalities

Each author has engaged with engineering ethics education and accreditation processes in diverse contexts and systems. These experiences come from our roles as accreditors, researchers, faculty members, administrators, and board members through a range of engineering education positions affording us different freedoms and power and forms of constraint. We are (at the time of writing this chapter) an assistant professor, doctoral candidate, senior researcher, and engineering dean. We engage in critical and sociotechnical engineering education research, and combined, have lengthy careers as theorists in social justice, decolonialization, and critical theory, where we aim to challenge the status quo in engineering cultures and identities. We are all women of various European ethnicities, working in, studying, and promoting justice-oriented perspectives in engineering education through research, practice, and community service. We come from different backgrounds, including diverse socio-economic statuses, sexual orientations, nationalities, religious or spiritual beliefs, political structures, ages, educational journeys, (dis)abilities, and family structures. We have each struggled to undo habits of behaviors and thoughts, including implicitly engrained WEIRD traditions for three of us raised as settlers in North America, and for one of us born during communism in Romania, the afterlife of Marxist philosophy. These are not easy tasks. Due to language, awareness, and our choice to lean into our authority of experience in this chapter, our literature review comes from WEIRD-centric journals, conferences, and experiences that cannot and should not be generalized for all possible experiences. We acknowledge the limitations of our perspectives and experiences, rooted in our demographic standpoint. We offer this critical feminist standpoint analysis as a culmination of our collective experiences, understandings, acts of resistance, criticisms, and hopes for advancing more critical scholarship and research of WEIRD engineering ethics education in the context of accreditation, as it hardly exists.

Approach

For this work, we ask: *How is engineering ethics education represented in the literature and in our experiences? What stories are told, and what is silenced? What are the power dynamics at play, the implicit gaps in research, and the silences in the texts on accreditation and engineering ethics education?*

To explore these questions, we combine a review of the literature with critical feminist standpoint analysis, leaning on authority of experience and reading the silences in texts (Olsen, 1978; Scott, 1999). It is important to note that "standpoint theory has been criticized for its tendency to universalize white, western, middle class women" (Beddoes et al. 2011, p. 286). We thus use this analysis cautiously, deploying it with the intention of uncovering the silences and bringing it into conversation with critiques of Western normativity.

As a methodology, the authority of experience is closely aligned with feminist standpoint theory, which asserts that women's experiences are essential for knowledge-building, particularly within our WEIRD and patriarchal society, and are "legitimate sites of knowledge" (Beddoes & Borrego, 2011, p. 286). Feminist standpoint theory is connected to the sciences (Haraway, 1988), "maintain[ing] that scientific knowledge in a 'gender-stratified society' has marginalized women's experiences and has therefore produced knowledge biased by male interests and perspectives" (Beddoes & Borrego, 2011, p. 286). It acknowledges that the personal insights gained from women's experiences are "distinctive resources" (p. 286) unable to be perceived by dominant groups and thus essential to be considered alongside scientific understandings to produce knowledge with "theoretically richer explanations" (Harding, 2001, p. 145, as quoted in Beddoes & Borrego, 2011, p. 284). Feminist standpoint theory involves "studying … interpretation and intention" (p. 292), with its value found in how "the findings then are used to challenge existing power relations and guide future research" (p. 292).

We intentionally embody standpoint theory in this work, and explicitly name and claim it as feminist work (Riley, 2013). We identify as women, a group outside the dominant demographic of engineering; we hold that engineering and its cultures and driving forces, such as accreditation, exist in this patriarchal world, rooted in and dominated by patriarchal "ideologies, values, and institutions" (Beddoes & Borrego, 2011, p. 285); and we consciously choose to "listen to women's voices" (p. 292) – our voices – and be guided by our own experiences of accreditation. In this way, we are conscious "participants" in this work, aiming to produce "new and less coerced information" by harnessing our viewpoints (McLoughlin, 2005, p. 374). We employ a narrative style to augment our findings with our personal experiences and anecdotes rather than tracing causality by inferring from empirical data. We shared stories as part of our research approach, exchanging anecdotes about our experiences with and knowledge of accreditation in our contexts to kindle this work and forge our pathways into the literature.

Story-telling as a research methodology has been advocated for by Indigenous (Wilson, 2008) and critical race scholars as a valid research method and also a necessary method (Datta, 2018). Through story-telling, researchers are given agency and power, leading to more "connected, collaborative, and comprehensive" research (p. 42). Story-telling as a methodology deconstructs our positions as researchers and provides us with a space to apply critical self-consciousness and self-realization through our interactions and relationships with the research.

In this way, story-telling, as part of our approach, supports our feminist standpoint position. "For a position to count as a standpoint," Harding (2001, p. 147, quoted in Beddoes & Borrego, 2011, p. 292) has written, "we must insist on an objective location – women's lives – as the place from which feminist research should begin." Through this, we're able to model and exemplify the importance of adjusting research methodologies to unlearn, disrupt, and resist normative tendencies. Therefore, unlike systematic literature reviews, our review was intentionally not comprehensive. In this chapter, our discussion is influenced by the literature within the spheres of our experiences, and the gaps rather than the continuities woven into our stories.

As such, we critically reviewed and reflected on journal articles, textbooks, conference proceedings, and reports from these sources:

- Journals (*Australasian Journal of Engineering Education*; *Engineering Studies*; *European Journal of Engineering Education*; *IEEE Transactions on Education*; *International Journal of Engineering Pedagogy*; *Journal of Women and Minorities in Science and Engineering*; *Journal of Engineering Education Transformations; Science and Engineering Ethics; and International Journal of Engineering, Social Justice and Peace*)
- Textbooks (*Springer POET, Philosophy of Engineering and Technology* book series)
- Conference proceedings (*American Society for Engineering Education*; *Canadian Engineering Education Association*; *European Society for Engineering Education*; *Frontiers in Education*; *Global Engineering Education Conference*; *World Engineering Education Forum*)
- Reports we've encountered (often confidential, so we include only our observations and reflections)

Western normativity

Engineering ethics education and accreditation are dominated by a Western/Global North system that perpetuates a neoliberal and colonial worldview. The introduction of ethics as an outcomes-based accreditation criterion is often credited for the increase in engineering ethics classes (Martin et al., 2021) and "potentially elevat[ing] the prominence of instruction in engineering ethics and the societal context of engineering" (Herkert, 2000, p. 303). However, these assumptions place too much power in accreditation while ignoring a rich history of engineering ethics education that was multifaceted and interdisciplinary.

Engineering ethics education was required well before accreditation and outcomes-based assessment (Wacker, 1990). For example, focusing on the United States: As early as 1968, Sterling Olmsted developed *Liberal Learning for the Engineer*, which prompted experimentation with teaching interventions addressing technology's societal implications (Wisnioski, 2012, p. 165). In 1970, the Punderson Conference brought together 35 engineering, humanities, and social-sciences instructors to discuss greater coherence between the technical and liberal components of the engineering curricula and increase their societal relevance (Gravander, 2004). In 1977, a report commissioned by the Hastings Center mapped the status and prospects of engineering ethics and addressed for the first time the aims and content of engineering ethics education, instructor qualifications, and available teaching materials (Baum, 1980; Mitcham & Englehardt, 2019). The late 1970s and 1980s saw the publication of the first textbooks on engineering ethics (Mitcham, 2009; Weil, 1984).

Nevertheless, the literature and public discourse (mostly from the Global North) often credit outcomes-based accreditation processes as a prompt for introducing and developing ethics in engineering programs. These changes did increase research on designing curricula to measure engineering competencies, an increase seen between 2000 and 2010 across the United States, Canada (Brennan 2018), and Europe in parallel with the timing of outcomes-based processes.

The expansive adoption of the Washington Accord, which has strong status and power in the international community, led to the alignment of accreditation systems in countries worldwide (Patil & Codner, 2007). The Washington Accord, signed in 1989, has six original members, representing engineering education systems from WEIRD and Anglo-Saxon countries. Since its inception over 30 years ago, it's grown in scope and power (Klassen, 2018). Currently, it includes 23 countries with full rights and eight provisional signatories, an expansion explained as the outcome of globalization (Sthapak, 2012). The current provisional signatories (i.e., those on track to receive approval in the future) are all from countries in the Global South. This process of assimilating into Western norms is fraught with power issues, where we are implicitly using the mainstream definition of ethics and seeing ourselves as 'ethically' colonizing the Global South.

The influence of the Washington Accord has spread to signatory and non-signatory countries alike, where accreditation requirements, although not completely overlapping (Patil & Gray, 2009), nevertheless have a similar focus (Hanrahan, 2008; Paul et al., 2015). Engineering accreditation competencies often aim to broaden engineers' scope, and "inform them about their ethical, social, and professional responsibilities" (Sethy, 2017, p. 987). However, by focusing on competencies, accreditation processes overly endorse outcomes-based education, which leads to reductionist approaches to engineering ethics education. By proximity, engineering ethics education becomes steeped in serving neoliberal interests, where competencies and their assessment prioritize graduating engineers who can contribute to the economy rather than engineers who could serve society's needs (Handford et al., 2019; Leyva, 2009; Riley, 2012). In this sense, *globalization* in the engineering ethics education landscape is more a domination exercise by Western domains than an attempt to create a global engineering ethics education encompassing a broad range of cultural perspectives and ethical frameworks (Anwar & Richards, 2013; Gray et al., 2009; Haug, 2003).

This homogenizing of engineering ethics education creates a singular conceptualization that can be harmful when mismatched with local populations. With singular conceptualizations of accreditation requirements 'spreading' worldwide, we see a diffusion of the considerations as to what engineering ethics is and how ethical decision-making is taught. Diverse views sit apart from this: Confucian philosophy (Zhu, 2020), anti-colonial, feminist, African values, and others are not represented in canonical engineering ethics. Typically, the major ethical theories in engineering ethics education are consequentialism or deontology frameworks, which developed in the cultural space of Europe and Ancient Greece, "a specific product of the Western philosophical tradition" (Luegenbiehl, 2009, p. 149). This domination and the perpetuation of uniform ideals can create a dissonance for 'non-WEIRD' student populations (Clancy et al., 2022), which is a significant portion of engineering students worldwide given that WEIRD demographics are "the least representative populations one could find for generalizing about humans" (Henrich et al., 2010, p. 61).

Literature acknowledging the power dynamics in the development of professional codes of ethics and accreditation metrics is nascent (Klassen, 2023; Seron & Silbey, 2009). Ethics literature often focuses on the pedagogies used to teach ethics (Hess & Fore, 2017); however, these pedagogies rarely take a critical perspective on what engineering ethics is, how engineering ethics interacts with professional codes, and how power influences engineering ethics structures and approaches (Martin et al., 2021). The critical literature that exists is cited heavily throughout this chapter; however, it is typically disconnected from having any power in the process. Thus, the educational ideal set in the UNESCO World Declaration on Higher Education for the 21st Century to "understand, interpret, preserve, enhance, promote and disseminate national and regional, international and historic cultures, in a context of cultural pluralism and diversity" (UNESCO, 1998, p. 3) is lost in the articulation of accreditation ethics requirements.

We argue, based on our personal beliefs and first-hand experiences, that ABET and its efforts at globalization is a colonial neoliberal project intentionally planned 'to take over the world'. In 2009, George Peterson, the executive director of ABET from 1993 to 2009, who led the organization through EC 2000, wrote about the importance of ABET's venture into non-domestic accreditation, emphasizing that it would produce engineering graduates qualified to work "in any country on earth" (Peterson, 2009, p. 82). ABET "oozes zealotry, bewildering vocabulary, unexamined tenets, reliance on imperatives rather than indicatives, irrefutable claims, and support from administrators and politicians, not practitioners" (Woolston, 2008, p. 4). Accreditation seems not to be about education and learning but about power, with the goal of maintaining and expanding a particular cultural role and status in engineering (Slaton, 2012). Accreditation is big (financial) business that supports "corporate instrumentalism" and "corporatism in engineering," reducing the "professional independence of engineers" and the importance of public interest while increasing capitalist market expansion (Handford et al., 2019, p. 171). Yet, non-Western locales, even if conscious of this domination, still adopt these framings, as the power of being ABET-accredited outweighs fighting Western domination (Balakrishnan et al., 2021). To change the system, a double anti-colonial push is recommended: first, the formulation of requirements must be opened to include diverse non-Western values and theoretical perspectives and authentic reckoning of the harms resulting from WEIRD ethics shaping engineering practice; and second, research must be consolidated to form more inclusive and broader engineering ethics education and accreditation processes that confront, resist, and avoid defaulting to WEIRD samples, research methodologies, and theoretical lenses.

Epistemic power relations

In addition to WEIRD dominance, the biases and devaluations of engineering ethics education are deeply embedded in the cultural epistemological power hierarchy of knowledge. This has multiple threads, including (1) *othering*: the perpetuation of the superiority of technical knowledge and skills over the 'complementary' engineering competencies; (2) *false authority*: those with objective, technical knowledge have independent authority to make decisions, including ethical decisions; (3) *unquestionable rigor*: assuming that the positivistic, structured approaches of ethics accreditation are thorough and indisputable; and (4) *engineering elitism*: undervaluing and/or discounting non-expert and non-engineering perspectives during accreditation.

Firstly, engineering ethics is often seen as *other* than the 'core' knowledge required for engineering students (Cech, 2014; Monteiro et al., 2017; Stevens et al., 2007). Although recognized within most accreditation processes, it is often lumped with *professionalism* and *social context* and described using language such as 'soft,' 'complementary,' or 'ancillary' (Parker et al., 2019). It has historically been described as a "complement to the technical content" (Wacker, 1990, p. 97), positioning ethics as a less important, non-essential topic in engineering education. Whether through direct comments or indirect actions, we've observed accreditation visitors perpetuate this othering hierarchy in their attention and efforts to evaluate the 'more essential' (and thus superior) technical knowledge and skills and gloss over the 'other' 'professional skills.'

To counteract these discourses, engineering ethics education is often packaged to be more like technical topics, such as by emphasizing quantitative methodologies like decision trees and risk factors (Harris et al., 1997). This also devalues it. As Newberry (2004) writes, "we should resist the tendency to engineer-ize ethics" by viewing it as another rational-scientific problem to be solved. Commandeering ethics as a calculative skill perpetuates the bias that "soft skills are 'easy', and perhaps don't require formal education, while hard skills are 'difficult' and must be continually reinforced in multiple classes" (Bauschpies et al., 2018, p. 2). This reflects "the profession's tendency to marginalize, ignore, silence, and/or atrophy the … central elements of ethical engineering practice" (Riley & Lambrinidou, 2015, p. 2), which include the non-technical dimensions of engineering, local knowledge, agency of all persons, and the public as the profession's primary client.

Often engineering ethics is conflated with the social, economic, environmental, and global impacts of engineering solutions (e.g., within ABET student outcomes 1–7). It's not to argue these macro topics aren't also critical concepts to ethical engineering, but rather that these blended and ancillary approaches demote essential competencies into "diluted … everything-but-the-kitchen-sink outcome[s]" (Riley, 2016) and 'othered' topics, which devalue and limit the attention on the teaching and assessing of ethics in engineering education. We don't skip calculus courses and blend calculus learning outcomes into thermodynamics courses; all these topics (ethics, social, economic, environmental, etc.) are important to teach independently, as well as in integration.

The second epistemological tension is the perpetuation of a *false sense of authority* and how this relates to engineering ethics education. There is a dichotomy: although ethics is othered and devalued in engineering education, in a parallel discourse it is frequently emphasized as essential to engineering identity. Ethics is synonymous with engineering as a profession and has been acknowledged as core to professional engineering conduct for over 50 years (Rottmann & Reeve, 2020). Students acknowledge this importance in how they define engineering (Doré et al., 2021); however, it is combined with the belief that positivist approaches are superior, and engineering ethics education tends to "favor sober deliberation and reason over passion and sentiment" (Fernandez, 2021, p. 3). A belief in objectivity and the ability to rationally solve problems, including ethical problems, gives students a false sense of power and authority over engineering decisions. Gary Downey (2012) argued how this bias for 'normative holism,' embedded in engineering's rhetoric of improving the welfare of humanity, creates a false logic in which engineers assume that when they engineer, they must be doing 'good.' This implies that an engineer doesn't need ethics education and can consider themselves ethical as long as they graduate from an accredited program, behave professionally, and abide by the law (Bauschpies et al., 2018).

Building on this is the "flaw of the awe" (Bauschpies et al., 2018, p. 1), a culture that positions engineers as purely objective, the ultimate authority, and even as the public 'savior.' Engineers are perceived as 'heroic', which perpetuates a greater sense of obligation to the public. Although 'awe' of nature (waterfalls, sunsets, etc.) is typically humbling, 'awe' of engineers is very individualistic and leads to awe of oneself, and to the assumption that engineers have all the power and greatness needed to make (ethical) decisions (Fernandez, 2021). This sense of superiority and feeling of being "technological guardians of the public good" furthers engineers' belief in their elite (though arguably unethical) ability to speak on behalf of communities without engagement, "often delegitimizing or discounting local knowledge, agency, and voice" (Bauschpies et al., 2018, p. 1).

Third, given that engineering education tends to perpetuate and attract systematic and analytical approaches to knowledge building, there is an underlying *unquestionable rigor* to said processes, and it becomes difficult to challenge approaches such as outcomes-based assessment. These analytical, systematic, and structured processes inherently hold power over engineers, engineering educators, and engineering accreditors because they *appear* to be robust (Woolston, 2008). Heywood (2016) confirms: "It seems that if an objective (outcome) is stated in terms of what a person is able to do that there can be no question about its validity" (p. 3). Not surprisingly, this appearance of robustness creates inconsistent and inauthentic approaches to teaching engineering ethics. This competency lives within a knowledge paradigm that actually cannot be systematically and objectively analyzed. For example, we observed accreditors being unconcerned by low-scoring and failing ethics accreditation evaluations, remarking, 'That's normal.' The belief in the positivistic, systematic approach is so strong that it is maintained even when there is methodological evidence it is not working. These notions are cradled within the false notions of engineering as objective (Lord et al., 2019), and in the pursuit of "rigor" (Riley, 2017) and validity.

The final thread of epistemic power we address is *engineering elitism* within engineering ethics accreditation. This is the idea that only experts can teach engineering ethics – similar to the accreditation argument that only engineers can teach design (Hladik et al., 2023). What constitutes an expert is curious and contradictory, however. On the one hand, we have the inexplicable continuing assumption that engineering instructors with accredited engineering degrees are unprepared and unqualified to teach engineering ethics. When engineers abdicate their responsibility to teach ethics and send students across campus to philosophers, this emphasizes the devalued 'other' status of ethics. On the other hand, within the elitism of engineering, having engineers teach engineering ethics is believed to lend "credibility to the course in the students' perception" (Wacker, 1990, p. 4). In fact, to improve ethics education, we've observed accreditors recommend strengthening ties with industry and engaging more professional engineers as guest speakers. Although professional experience and practice can be essential in making decisions (Klein, 1998; Walther et al., 2007), this assumption is problematic. Experience helps to recognize patterns in decision-making, but given the underlying *unquestionable rigor*, these 'patterns' in a rational engineering culture are often rooted in assumptions of superiority and correctness, and not necessarily in ethics (Perlman & Varma, 2002).

Each of these epistemic tensions (techno-superiority, false authority, unquestionable rigour, and engineering elitism) creates a null curriculum for students: They get the message that ethics isn't really part of the central body of engineering knowledge, yet they still have the authority and power to make ethical decisions. This cycle of power is further perpetuated by the reductionist approach we use to teach and assess engineering ethics.

Reductionism and assess-ability

Accreditation drives outcomes-based assessment, where the goal becomes teaching engineering competencies ('graduate attributes' or 'learning outcomes') so they can be assessed (Shuman et al., 2005). As such, 'ethics' is condensed into content (rather than behavior) that can be (easily) taught and measured.

In engineering education, teaching and assessing ethics often mimic other technical skills and courses, using reductionist, calculative, and objective approaches. This takes a Newtonian, determinist, and mechanist view of the universe, a belief that the human and more-than-human world can be broken into its mechanical parts and described by mathematical equations (Bauschpies et al., 2018). Rottmann and Reeve (2020) dub this reduction as the "rules and codes approach," which "remains a baseline feature in engineering ethics education" (p. 148). Although more accessible (and assessable) for students, this approach "may unintentionally omit ethical principles that have not been codified, implicitly treating ethical codes as uncontested statements of moral good rather than historically contextualized settlements negotiated by professional regulators, their constituents and the public" (p. 148–149).

This reductionist approach overemphasizes teaching ethics through case studies (Martin et al., 2020; Polmear et al., 2019) that focus on the micro ethics of engineering failures, often through analysis of mistakes in calculations or simple processes (Perlman & Varma, 2002). Inclusions of engineering ethics in the curriculum often cite engineering accidents or disasters, such as the Turkish Airlines cargo door failure, the chemical release at Bhopal, the Ford Pinto issue, or the Challenger shuttle explosion (Didier, 2000). We teach ethics – or 'failure' – hoping engineers will *act* more responsibly in the future. This reductionism is also maintained by calculative approaches to ethics, where ethical problems use measurement tools, "such as 'line drawing' to weigh options, creating flow charts, and using cost-benefit analyses," suggesting that the "right" decision can be found by applying "a set of heuristics" (Bauschpies et al., 2018, p. 3). Ethics is reduced to concrete concepts such as "harm," "safety," "disclosure," "honesty," or "fairness" (p. 42). These are important elements of ethics; however emphasis on these micro-ethics implies they are the primary and most important ethical considerations within engineering.

One justification for reductionism is that one cannot measure ethical *action*, only student *understanding* of ethical proscriptions or principles (Davis, 1991). As such, educators often do not hold students accountable to a high enough standard of responsible action and behavior, and rest rather on teaching and assessing rote 'understanding.' Engineering ethics is often assessed through multiple choice exams that imply ethical action is fulfilling a duty to do *one* right action, when ethical decisions often have significant complexity (Swan et al., 2019).

Heywood (2016) argued that reductionist assessment tools influence what students learn about ethics (content) and how they learn to think about ethics (strategies). Woolston (2008) argued similarly, specifically incriminating *outcomes-based assessment*, which "simply shifts the focus to assessment, specifically to the results of whatever educational process is at hand, not how the learning itself takes place" (p. 1). As such, students are trained to focus on the 'answer' being sought rather than on the processes of critical thinking and behaviors required to engage in ethical considerations for authentic real-world ethical practice (Perlman & Varma, 2002). These tactics arguably perpetuate "the disinterest shown by students for the lack of their emotional engagement with ethics issues" (Barros-Castro et al., 2022, p. 2) and result in engineering ethics education (and accreditation) that is disconnected, "unsystematic," and unimpactful (p. 1).

In our experience, many accreditation visitors don't hold programs to more than a standard of minimum student understanding, either. Ironically, most ABET assessors don't have assessment backgrounds (Akera et al., 2021). Accreditation processes are fraught with anecdotes, side comments, and direct declarations from accreditors not clearly knowing how to assess ethics as an outcome. This irony extends as the accreditors who do the assessments perpetuate the belief that professional 'soft' skills (such as ethics) can't be assessed.

While many engineering education researchers conclude that we need more interactive pedagogies that position students as agents (Whitbeck, 1998), there is a deeper consideration. Engineers' behavior has a broader set of influences and power dynamics within disasters, ones that education can affect in limited ways, at best, and that accreditation influences even more indirectly (Vaughan, 2004). The reduction of ethics to serve accreditation decouples it from its complexity and removes critical connections to broader concepts of equity, and social and environmental justice. Further, outcomes-based assessment eliminates variation in student learning. Thus, rather than supporting and increasing student diversity, a 'wicked' problem engineering has been wrestling to solve for decades, it rather 'de-diversifies' students, drawing boundaries and reducing them to a 'variable' to be controlled for (Woolston, 2008).

Drawing boundaries

Mitcham and Englehardt (2019) argue that the boundaries between the internal and external STEM communities perpetuate the boundaries between ethics as code (inside the community) and ethics as social justice (outside the community). We argue this is enacted in engineering ethics education and propagated by accreditation. This insider–outsider boundary also fosters secrecy, which Perlman and Varma (2002) contend is counter to engineering ethics, "which requires transparency" (p. 47).

In Canada, *The Ritual of the Calling of an Engineer*, a 100-year-old secretive engineering graduate ceremony, is an enactment of this power boundary. A recent analysis demonstrated this secretive ritual upholds and maintains boundaries of engineering ethics that are reductionist and positivistic (Paul et al., 2023). The ritual and ceremony, written by known imperialist Rudyard Kipling (see www.retooltheringca for more), is an engineering tradition and example of safeguarding the problematic boundaries of ethics discussed in this chapter.

As discussed, engineering codes are frequently used in teaching and assessing ethics to legitimize engineering ethics education as being within the *boundaries* of engineering. Colby and Sullivan (2008) describe how engineering codes are a "valuable framework for thinking about the goals of educating for engineering ethics" (p. 327). However, they clarify that educators must look below the surface to consider the skills, behaviors, and mindsets required to achieve the codes and avoid losing the broader implications of engineering. Codes provide an accessible approach to ethics education, but engineering educators may omit ethical principles *outside* the codes, treat the codes as indisputable statements of morality, and deny the historical framing and boundaries embedded *within* the codes (Mitcham & Englehardt, 2019; Rottmann & Reeve, 2020; Tang & Nieusma, 2017; Vesilind, 1995).

Riley, Slaton, and Herkert (2015) further this insider–outsider boundary by drawing on Slaton's (2001) earlier work on reinforced concrete standards that served to shift expertise from artisans (who aren't subject to the standards) to engineers. They argue that engineering ethics codes create a class of workers capable of "proper technical conduct" (p. 4), set apart from non-engineers who are not subject to the code. Superficially, ethics codes reflect a common set of values for the profession or lay out essential capacities for engineers to develop in their professional formation. Yet in practice, as argued, ethics is relegated to the fringes of most curricula and given little emphasis by accreditors. Codes are inherently political: created within past histories, attempting to predict future transgressions, and interpreted through the present (Mitcham & Englehardt, 2019). By maintaining a vagueness in writing codes, power interests are met while holding fast the boundaries and controlling who has access. Building on Pfatteicher's work (2005), Slaton (2012) explains: "codes of ethics that historically have urged engineers to practice only within the limits of their own competence have rarely defined those limits clearly," which makes engineering standards and codes "virtually impossible for non-experts to apply" (p. 100). These examples emphasize how codes produce professional identity and continue to maintain (*police?*) the profession's boundaries.

Engineering ethics education via accreditation also maintains a boundary between the technical and social (Friedensen et al., 2020; Martin & Polmear, 2023), the danger of which has been discussed for decades (Didier, 2000). McAuliffe (2006) argues that our education system teaches "the technician worldview, with its ideological tunnel vision and disinterest in stepping outside of professional standards," making professionals "less attuned to the situational contextual dynamics" (p. 493). The boundary between technical and social reflects Cech's (2014) work on the social disengagement culture that "seems to be inherent to engineering education" (Mitcham & Englehardt, 2019, p. 1756). The irony is that this is counter-intuitive to engineering, which "is the interaction of people and 'things,' or people and any engineered technology, that brings ethics to the fore" (Ballentine, 2008, p. 332).

The authority wielded through professional codes upholds a power boundary, giving a profession elite status. However, any attempts at changes to codes (e.g., sustainability, gender and sexual diversity, equity, inclusion, decolonization, the iron ring) cause significant stirs (Paul et al., 2023;

Riley et al., 2015) because change requires shifting a stiff boundary upheld by people with significant power. Through codes and standards, these boundaries are passed down and perpetuated within engineering ethics education, accreditation, and literature.

Rhetorical justification, performative artifact, and change strategy

Ethics, *accreditation*, and *ethics accreditation* as a rhetorical justification, performative discourse artifact, or change strategy were also prevalent across the literature.

Although our review method intentionally did not seek to describe quantitative findings, in a significant portion of articles, the terms 'engineering ethics education' and 'accreditation' were mentioned only briefly. These mentions provided context and justification and were found mainly in the introductions and/or conclusions, at times in the abstracts or background sections, and generally nowhere in the body of the literature. This was especially common in conference papers, where outcomes-based accreditation requirements were used as a rhetorical justification to validate the 'why' of pedagogical innovations.

Others positioned the addition of outcomes-based accreditation as a change strategy for engineering ethics, and ethics education as a 'response' to the call for change to engineering education (e.g., Rottmann & Reeve, 2020). Typically, this worked from an implicit or explicit assumption that accreditation could drive change in engineering education; at times, this too was merely performative, and at other times more substantive and sincere, if ignorant of accreditation's power dynamics and self-limiting nature.

Although rhetorical justification, performative discourse, and change strategy are three different narratives, we argue that the power dynamics within each are interconnected. There is an underlying harmful assumption that accreditation is beneficial to engineering ethics education and, more broadly, to engineering education. Accreditation further drives the rhetorical justification of outcomes-based assessment as a change strategy as it gives power to the data as 'evidence' that 'ethics' is included. However, the inclusion is rarely authentic and is perhaps actively encouraged to be inauthentic: "The implementation of this component was typically characterized by a 'laissez-faire' approach … strongly suggest[ing] that the engineering academic community was not motivated to achieve the spirit of the accreditation objectives" (Wacker, 1990, p. 98). There is a lack of clarity on what ethics is (rightly so, given its muddiness) and the purpose of engineering ethics education; accreditation tries to answer these by wordsmithing the perfect outcome. But there are invalid assumptions: (1) that measurement and assessment will lead to improved education; (2) that improved education will lead to improved learning; and (3) that improved learning will lead to improved ethical actions (Biesta, 2007). One could argue, as Woolston (2008) does, that accreditation and outcomes-based assessment as a pedagogical change strategy is feckless; it really only changed accreditation and outcomes-based assessment, rather than actually improving students' learning.

Silences

The power we've exposed in this chapter is also wielded in the silences. Engineering ethics, as developed by instructors and policed by accreditors, advances segregation. These are the 'holes' in disciplinary knowledge created by the exclusionary boundaries (Pawley, 2012). The WEIRD biases of engineering ethics mean we're missing feminist ethics frames (Walker, 1989) around care (Pantazidou & Nair, 1999) and justice (Jaggar, 1995), and those that call out the military-industrial-prison complex (Nieusma, 2013; Philip et al., 2018) (see Chapter 15). We are biased toward thinking about ethics rather than feeling it (Hess & Fore, 2017) or embodying it (Bombaerts et al., 2023). Winner (1990) shows how our reduction of ethics instruction to case studies and our unwillingness to challenge engineering's militarism create some WEIRD (and just plain weird) cases. The outcomes-framing of accreditation ignores and silences the active pedagogies and learning processes that can produce ethical practice when instructors and learners work as partners. As Bauschpies et al. (2018) offer:

> a determination that justice has not been served is easier to make than a determination that justice has been served. This approach would also avoid repeating the colonialist mistake. Rather than coming in as the ethics expert who knows all about justice and simply expects students to conform, the instructor engages students in listening for signals of injustice – a skill that, along with humility, should stand them in good stead when it comes to community engagement.
>
> *(p. 4)*

For over 20 years, there have been calls to consider not just professional values, but also public values in engineering ethics and social, environmental, and energy justice (Chance et al., 2021; Riley, 2023), with a need "for an extension of traditional ethical frameworks to incorporate treatment of questions of social responsibility, including the issue of sustainability" (Johnston et al., 2000, p. 315). In recent years, there have been attempts to build DEI (diversity, equity, and inclusion) considerations into engineering ethics (e.g. Chance et al., 2021; Hess & Fore, 2017; Rottmann & Reeve, 2020), founded in a 'do no harm' approach (Harris et al., 1997). The current focus is trying to shift to understanding ethics as 'global responsibility' – for example, Pawley (2019) noted the exclusion of the climate crisis and engineers' responsibility to urgently respond – and projecting a "holistic sense of ethics, sustainability, and obligation" (Chance et al., 2022, p. 164).

Nevertheless, although we are seeing engineering ethics being integrated with other important topics in the literature such as global competency, leadership, policy, stewardship, and sustainability, the "impact" or macro-framing of ethics and the social antecedents of technology remain underrepresented. It has been decades since Herkert (2000) pointed out the bias toward micro-ethics problems and away from macro-problems, focusing on individual decision-making and excluding the collective decisions of organizations, institutions, and governments. Activist work (e.g. *Science for the People*, *Engineering Social Justice and Peace*, and many other local and national community groups) that addresses engineering in society or consumer rights is excluded. Optional extra-curricular service-learning is typically ignored for accreditation, which is geared toward measuring the outcome of *every* student in *every* course *within* the boundaries of accredited engineering programs.

Engineering lacks a self-reflective mechanism to see the system in which we work (Foucault, 1990). We do not understand that accreditation regimes are ultimately about the regimes themselves, and how power and knowledge are enacted within. Accreditors remind us that engineering educators are free to go above the minimally low bar they set for ethics, never recognizing the rhetorical constraint and the shaping of the standard that occurs in those exchanges. If something is 'above' or 'beyond,' it is not *in* – it is extra (Chance et al., 2021). It is Other.

Closing: we are puppeteers

Assessment is the goal for accreditation, reducing engineering ethics to objective, measurable packages to teach and assess. This reductionism is influenced by a Western dominant culture, and rational approaches common in teaching engineering technical competencies. It results in an over-simplification of ethics, a perpetuation of linear rather than critical thinking, minimal rote understanding rather than critically reflective praxis, and a disregard of ethics' integral links to diversity, equity, inclusion, and social, environmental, and energy justice. Our collective inability to recognize the power dynamics of accreditation regimes results in us giving power over to accreditation, effectively abolishing much of what is valuable in engineering ethics education. Accreditation fosters feckless, inauthentic, and performative change, not transformation of our classrooms, our students, and ourselves. Our participation in this system makes us puppeteers of accreditation. We are caught in 6-year cycles (at best) of incremental improvements, buried in and busy with measures that themselves comprise the establishment. As such, we argue that accreditation does not support authentic, significant, and inclusive engineering ethics education and, ultimately, leads to a 'de-diversification' of engineering students.

We make four critical arguments in this chapter:

1) Accreditation is Western/Global North-centered, and when non-Western countries (and/or countries in the Global South) join initiatives like the Washington Accord, they must adopt Western/Northern standards, and local sensitivities vanish (Western normativity).
2) Technical epistemology outbalances and marginalizes other disciplinary perspectives (epistemic power relations).
3) The emphasis on micro-ethics and outcome-based assessment in ethics teaching decouples engineering ethics education from moral action and broader concepts of equity and social justice (reductionism and assess-ability and drawing boundaries).
4) The accreditation process produces "willful ignorance" (Tuana, 2006, p. 10) of its own undesirable effects (rhetorical justification, performative artifacts, and change strategy).

These four conditions work together to homogenize engineering ethics education, rooted in and puppeteered by patriarchal ideologies, values, and institutions.

Biesta (2007) offers a way out: to stop focusing on 'what works' or 'what is required' (e.g., for accreditation) and focus instead on what students ought to learn. When we bring in different ways of knowing, when we take critical perspectives, we can begin to consider why, and challenge or resist the power dynamics maintaining the status quo. We wonder: *What would engineering ethics education look like if truly accountable, if it was rooted in a diversity of experiences, realities, intersectionalities (e.g., race, class, ethnicity, sexual orientation, culture, and nationality), and ways of knowing* (Beddoes & Borrego, 2011; Riley & Lambrinidou, 2015)? Accreditation might come from the various publics we serve, rather than a self-policing that reflects existing patriarchal hierarchies of knowledge. *What would accreditation look like if it were locally situated, with accountability to the land and waters and their stewards?* Moving away from outcomes-based assessments toward those that are relational, process-driven, reflective, participatory, and liberatory may be far more appropriate for engineering ethics education.

Relying on accreditation systems to ensure ethical engineers is self-limiting at best. It distracts us from the profound work we have yet to do in reckoning with what trauma engineers have wrought on this planet and in our communities, and exploring imaginaries knit from below the surface, from the silences, and from the interstices of our knowledges.

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ACCREDITATION PROCESSES AND IMPLICATIONS FOR ETHICS EDUCATION AT THE LOCAL LEVEL

Helena Kovacs and Stephanie Hladik

Introduction

Engineering ethics is a critical component of engineering professional practice and must be included in professional engineering education (Harris Jr. et al., 1996). As engineers design new technologies that introduce new ethical dilemmas, regarding, for instance, autonomous vehicles (Martinho et al., 2021) and algorithms (Benjamin, 2019; Noble, 2018), postsecondary institutions must ensure that their engineering students are graduating with the knowledge and skills to meet emerging challenges. Accreditation documents and processes have been designed as guidelines for how engineering ethics should be taught and assessed to standardize these goals and metrics for different institutions across the nation (e.g., see the Canadian Engineering Accreditation Board (CEAB) in Canada and Commission des Titres d'Ingénieur (CTI) in Switzerland). However, questions emerge about how the broad definition of ethics put forward by accreditation bodies is understood and enacted within the local contexts of specific institutions and classrooms, each with its own heterogeneous group of instructors and students.

In this chapter, we discuss the implications accreditation has on engineering ethics education at the local level. More specifically, the chapter debates the potential gap between how ethics is articulated in accreditation documents and processes and what ethics in engineering education means locally for institutions, instructors, and students (i.e., by 'gap,' we mean its impersonality). In essence, this chapter aims to problematize the potential impersonality of ethics hidden in the documents that are bureaucratically operationalized at the level of educational programs and typically do not consider the different histories, demographics, and needs of local engineering communities. Accreditation of engineering education programs includes varied definitions and requirements, often broad, ill-defined, and implicit. This is particularly true concerning engineering ethics, where words and phrases such as 'profession,' 'society,' 'responsibility,' and 'integrity' are often used in place of 'ethics' in learning and program outcomes (Junaid et al., 2022).

Impersonality in accreditation documents and processes is in tension with how inherently personal engineering ethics is in local contexts; it must respond to the needs and experiences of institutions, instructors, students, and industry partners hiring program graduates. Lack of synchronization across different levels and stakeholders and the fact that these levels are not homogeneous can complicate the impact at the local level (Martin et al., 2021). Different political landscapes,

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local industry demands, institution-community partnerships, and faculty and student body diversity contribute to heterogeneity, making it difficult to argue that one shared understanding of engineering ethics is desirable or possible. Levels, accreditation standards, and local implementation are complex and contextual. Therefore, it is necessary to more deeply theorize and investigate the potential gap between the accreditation of engineering ethics and what engineering ethics means at the local level.

Setting this as an opening for the chapter, we genuinely want to question: *How do the broad, impersonal conceptions of engineering ethics contained in accreditation documents and processes impact how they can be translated, interpreted, or implemented in local and personal contexts?* As such, in the first part of this chapter, we emphasize the importance of understanding the history and the character of accreditation in engineering education, as well as the messages and ideas of the peculiar language the accreditation documents suggest. We will do this by drawing connections to the previous chapters in the theme. We will also briefly address the accreditation process and interrogate how it may contribute to the gap between the broad, high-level accreditation standards and local contexts. Our work regards existing accreditation documents and processes as broad and impersonal. The second part of the chapter will address educational questions related to how this gap is related to institutional positionings, curriculum design across different engineering disciplines, teacher agency and relations to ethics in engineering education, and the student as the focal point in education. In addition, we will highlight the heterogeneity in each of these levels that influences the degree of disconnect between the local contexts and the accreditation of engineering ethics. We will also graphically illustrate the very complex and contextualized picture of engineering ethics education at the local level. Finally, we will offer suggestions at both the accreditation and local levels to bridge the gap between them. The value of this chapter is very much in its potential to offer a way in which different and diverse positionalities of ethics at the local level can be considered when examining accreditation and vice versa.

Regarding the positionality of the authors of this chapter, Helena is a social scientist with a Ph.D. in Teacher Education obtained as a Marie Curie Fellow at two different institutions and countries in Europe. Her Masters was in Lifelong Learning: Policy and Management, and her Bachelor's in Community Youth Work and Non-formal Education. All educational degrees were obtained in different countries and followed different educational provisions, allowing Helena to tap into various systems and practices. Currently, she works on translational research that serves institutional changes and practice development. Her engagement with engineering ethics education comes from working on many transversal skills and exploring the difficulties in teaching and learning. Further interest in accreditation and engineering ethics education came from her previous work on policy and curricular matters and her recent research on teaching transversal skills. The fact that she works in a French-speaking context makes her close and familiar with CTI.

What would accreditation look like if it were locally situated, with accountability to the land and waters and their stewards? and this interdisciplinary educational background provides a solid grounding in the traditions of engineering education and critical approaches to education that challenge systemic inequities such as racism and sexism. An even more profound understanding of the different impacts that technologies can have on various groups arose from her postdoctoral work in an Information Science department. In her current role as an assistant professor of engineering education, she uses this critical lens to teach an undergraduate course focused on the impact of engineering on society and engineering ethics. She hopes that her students will be able not only to discuss and understand the broad ethical issues arising from the development of new technologies (which are often intertwined with systemic issues such as racism) but also apply these lessons to ask critical questions in every phase of the engineering design process – from forming a design team to considering what happens at the end of a product's life cycle. Part of Stephanie's role is to ensure that the course content and assessments align with CEAB guidelines (CEAB is used in Canada and is similar to the Accreditation Board of Engineering and Technology (ABET), which is used in many English-speaking countries) and to collect data indicating how well students are meeting those guidelines. As an authorial team, we both draw from our social-sciences backgrounds, which treated ethics as a nuanced, contextual, and complex topic. We both believe that this complex view of ethics is critical in a field such as engineering, as the new technologies and infrastructures that engineers design can considerably impact society – impacts that are not the same for different locations and groups of people.

The impersonality of accreditation

Accreditation is a process by which an external organization evaluates an institution's or program's quality and standards. Accreditation aims to ensure that specific standards are met and that quality education and services are provided to its stakeholders (Adreani et al., 2020). As stated in previous chapters of this section, accreditation also involves documents and processes that convey a very vague, broad perspective of ethics. Hence, the essence of engineering ethics is detached from the local context in many ways. While the emphasis on standards and quality is often enumerated through accreditation, the essential aspects of ethics may be so broadly stated that they are decontextualized, creating an impersonal relation between accreditation and the local contexts of the institutions, instructors, and students. In this section, we discuss three dimensions of accreditation – quality, values, and language – using a critical lens to look for how they impact perspectives on engineering ethics in ways that are enacted at a local level.

Quality

As a tool for ensuring quality, accreditation has become a crucial component in higher education. National and international accreditation systems "ascertain the existence of qualitative requirements through an evaluation process" to ensure a given service complies with the quality standards and encourage ongoing improvement (Adreani et al., 2020, p. 691). In engineering education, "accreditation programmes identify specific areas of knowledge and skills that need to be addressed in order for students to qualify as engineering graduates" (Junaid et al., 2022, p. 371). Thus, institutions use accreditation tags to argue that their programs are of a certain quality and that their graduates uphold specific knowledge, skills, and values.

In that way, accreditation creates a specific guarantee for the institutions that their students will be seen and considered worthy of the professional standards within a particular discipline and employable in a specific context. In addition, accreditation can be regional, national, or international. Regional and national accreditation is important to ensure the running and funding of the programs; international accreditation facilitates recognition across borders and is an important aspect of graduates' mobility.

In light of this, Cardoso et al. (2016) questioned whether quality assurance agencies can ensure quality, especially if quality is perceived as culture, compliance, and consistency. While those authors point to quality as negotiated and assured mainly within the institutional setting, the same is observed when the quality assurance process is externalized. Quality is often non-negotiated and fails to recognize the full range of essential factors and processes within an academic institution. Obstacles to ensuring quality, including lack of incentives and overvaluing research against other activities such as teaching, drive a restrictive agenda in quality assurance. Additionally, in discussing the role of accreditation, particularly in engineering, the relevance of quality assurance is more than often related and defined according to programs' perceived relevance to the labor market (Bendixen & Jacobsen, 2020) and often not sensitive to societal and environmental aspects that are particularly important to ethics in the engineering professions.

Furthermore, standardization of ethics in accreditation can be perceived as a double-edged sword. While standardization is important to achieve coherence in quality assurance across contexts, it disconnects accreditation from specific contexts. It perhaps undermines, misrepresents, or erases the local aspects of quality and locally important aspects of ethics. For instance, two large accreditation systems in engineering education are ABET and CTI, both used in various countries. As a result, the standards that CTI, a French accreditation body, places in France need to correspond to standards in other countries such as Canada, Belgium, Switzerland, and China.

On the other hand, each accrediting body or agency has its own set of criteria for evaluating institutions, which can create confusion and inconsistency across engineering education programs (Wysocka et al., 2022). Different demands, often very vague, can lead to disparities in the quality of engineering ethics education in different institutions. However, over-standardizing or over-generalizing an aspect such as ethics can 'wash off' the much-needed local aspects of ethics.

Values

The question of quality relates directly to the question of values. Although accreditation constitutes an important way to ensure that engineering programs provide their students with the knowledge and skills necessary to enter the profession and protect the safety and welfare of the public, often what is considered a professional standard in engineering is set up and maintained by one dominant social group. This can lead to issues where engineering designs may be viewed as successful, even if they do not work for – or worse yet, actively cause harm to – people from communities underrepresented in engineering (e.g., through misidentification of people of color by facial recognition algorithms; Buolamwini & Gebru, 2018). Attention to diversity issues in engineering education has been growing, and the need to ensure that accreditation standards are inclusive and equitable comes along the same lines. Several organizations, including ABET and the National Society of Black Engineers (NSBE) in the United States, have developed initiatives and resources to promote diversity and inclusion in engineering education and accreditation (Zoltowski et al., 2020).

Andreani et al. (2020) noted that accreditation serves neo-institutional behaviors through which quality assurance mechanisms present a delegation of power, sourcing it from institutional management to external accreditation body and that these processes support the New Public Management paradigm, focusing on "the benefits of trade in terms of efficiency and consumer freedom" (p. 694). Power relations among institutions, industry, and professional bodies have been shown to play a role in the accreditation of engineering programs, with specific impacts on engineering ethics education (Martin et al., 2021). Industry professionals often serve on accreditation boards, give feedback on accreditation documents, and participate in accreditation visits, influencing which ideas about engineering ethics are most important to new graduates working in their industries. Similarly, professional organizations may strive to ensure alignment between engineering ethics education and their own definitions and codes of ethics. While this alignment can promote greater attention to the local ethical needs of industry and professional organizations, there is the potential for bias in terms of what definitions of ethics are considered good (or good enough) and should be included or not included in accreditation.

In many cases, the values that guide accreditation documents and processes may be implicit or invisible to the institutions, instructors, and students. To that end, we wish to amplify the call for more systematic and comprehensive policy documents (e.g., Davies et al., 2010), including accreditation documents, to clarify underlying values. Knowing exactly which values are being reified in these accreditation documents can help us to identify instances in which those values may be aligned or misaligned with those upheld by institutions, teachers, and students, therefore highlighting potential gaps to be bridged.

Language

A global analysis of accreditation documents conducted by Junaid and her colleagues (2021, 2022) has shown that language in accreditation documents is very implicit and that a gap exists in strongly supporting ethics as part of an engineering degree. Furthermore, the study shows a large degree of misalignment on ethics in different accreditation documents worldwide and much space for individual interpretations. This brings us to question the perceived value of ethics in engineering education and practice, being both informed and partially constructed by accreditation bodies.

Language is crucial as it constructs a discourse, and it is through words that action (or inaction) is created. For instance, language carries implicit and explicit values. As such, policy documents, including those related to accreditation, can create an imagery of what is essential in, what should be taught in, and what is not considered part of engineering ethics. Junaid and colleagues (2022) analyzed the language of different accreditation documents. They found that words used to describe expected learning outcomes around ethics were mainly lower-level verbs from Bloom's taxonomy (e.g., 'know,' 'define,' 'be aware of'). The absence of higher-level verbs such as 'compare' or 'justify' can lead to a lack of critical thinking around engineering ethics in the curriculum. Furthermore, the lack of words such as 'global' or 'justice' gives a perception that these are not part of ethics education in engineering (Junaid et al., 2022).

Regarding the place of ethics, Junaid et al. (2022) analyzed the content of accreditation documents worldwide. They found that definitions vary to a great extent, and this leaves room for interpretation of what engineering ethics is. Very few terms were comparable across contexts, even though engineers are highly mobile professionals. For instance, in South Africa, the definitions are focused more on technical than educational terms (Gwynne-Evans et al., 2021). Observing ethics as a technical aspect of engineering assumes that ethics is a technical checkpoint, not a multi-perspective issue that must be carefully discussed. Additionally, some accreditation documents are used internationally, such as ABET (adopted in 41 countries) or CTI, using identical processes for all contexts. Having this in mind, "accreditation bodies could bring into focus the terms they use and what they mean as part of their ethical due diligence in the construction of engineering programmes across a range of countries where the context of the intended meaning of the learning outcomes as state might otherwise be missed" (Junaid et al., 2022, p. 375).

Local context(s), cultures, and positionalities

Interrogating engineering ethics education locally requires considering how 'the local' is defined. In educational research, the local can be a geographic descriptor. However, beyond this and particularly in the realm of higher education, local can be considered as an institution or department, as a discipline or a subject, as a singular program or a course, as a teaching practice, and quite certainly as a student learning experience in classes and afterward, as graduate engineers. Further, considering the complexity of 'the local' also highlights that these layers are not self-standing. Hence they are tied by power practices and are heavily relational. These layers of the local are also rarely homogeneous, meaning the interactions and impacts are different in different institutions, classrooms, and communities and, therefore, must be addressed through a comprehensive lens that includes socio-economic-political dimensions of educational practice. Beyond this, in their careers as ethical practitioners, engineering graduates are tasked with 'wicked' complex problems that concern diverse societies and the environment, some of which are critical to the people and communities around them (one sense of local), and others that have global considerations, potentially bringing another dimension into the discussion of 'the local.' Understanding the nuances of ethics at this local level is critical for their participation in society as *people*, not just as engineers.

In the following sections, we break down how high-level accreditation documents and processes are translated (or not) within three local levels: the institution and program level, the classroom and instructor level, and the student level. We use the word 'translation' (as opposed to implementation) as it encompasses the idea of a higher-level concept or framework undergoing some change in order to suit the local context to which it is being applied (Völker et al., 2023). We highlight how these local contexts matter in our interpretation of engineering ethics due to how the levels interact through power structures (e.g., instructors following a curriculum set by their institutions), as well as the heterogeneity that is inherent within a single institution or classroom as well as collectively across a nation. We wish to be clear that many of the challenges we discuss here are not caused *solely* by a mistranslation of accreditation documents or processes and may have other contributing factors, including institutional context and instructor and student values. However, by pointing out potential mismatches between accreditation definitions of engineering ethics and those at these local levels, we hope to call attention to more nuanced ways of approaching engineering ethics education that may require more specificity than currently afforded by current accreditation documents and processes.

Institutional and program level

Unlike pre-tertiary education, higher education is known to be relatively autonomous in preparing its programs and course offerings. While institutions must manage the needs and desires of various stakeholders – such as national or provincial/state professional organizations, industry members, faculty, and students – accreditation is a critical hurdle that institutions and programs desire to 'pass,' as it strengthens claims regarding the quality of degrees to their students (future and current) and to the employers who will hire those students. With the emergence of engineering ethics as an explicit criterion in many accreditation documents over the past few decades, institutions have made some progress in incorporating ethics into their programs. However, it is rare to have a systemic institutional push towards comprehensively incorporating ethics into engineering academic programs. Instead, institutions often meet accreditation standards by creating one or two standalone courses related to engineering ethics (Hamad et al., 2013). This raises some issues in how engineering ethics is integrated and perceived locally.

When all discussion of ethics is relegated to a standalone course rather than being carefully incorporated into technical courses, students may need help to connect the broad rules and lessons of engineering ethics with their day-to-day technical design work. Ethics is, therefore, decontextualized and invisible in their local work contexts; it is discussed in terms of historical case studies or professional codes of conduct, and ethics only emerges as relevant in its breakdown (i.e., an engineering disaster with ethical implications). These issues are compounded when students or even faculty do not consider these standalone courses as 'core' engineering courses (Martin & Polmear, 2023). Their positioning in the program (e.g., as an option that can be taken in any year) and the possibility that this is one of the few courses that students will encounter being taught by a 'non-engineer' can devalue these courses in students' minds. *How can ethics be core to their daily prac-*

tice when it is not core to their educational program? Suppose accreditation standards insisted on the systematic incorporation of ethics across multiple courses. In that case, it may become more accessible to locate ethics in the daily practices and discussions of engineering work and apply the broad ideas in meaningful ways in engineers' communities. Asking, in various courses, *What are the ethical issues here?* allows students to understand ethics more deeply and in ways that can be applied not just to their professional contexts, but also to situations and experiences outside of engineering. Integrating engineering ethics across the curriculum would also go a long way toward perpetuating consistency and a culture of engineering ethics in the institution rather than simply focusing on compliance as an indicator of the program's quality.

A systemic incorporation of ethics across a program would require a robust and convincing narrative of engineering ethics – something not present in current accreditation standards. The language currently used in accreditation documents is broad, unspecified, and open to interpretation, which weakens its ability to convey a cohesive narrative of engineering ethics (Junaid et al., 2022). Creating a robust and program-level narrative of engineering ethics responsive to the local context may be challenging. For example, *Who defines ethics at the institutional level, and what values do they hold?* Careful consideration is necessary regarding what ethical commitments are important for a particular institution. Local geographies, histories, and politics impact these different ethical commitments. For example, an institution may view ethical partnership and reconciliation with Indigenous communities as a key commitment to its research, teaching, and service. In this case, a local narrative of engineering ethics may prioritize ethical ways of partnering with Indigenous communities harmed by past engineering projects, such as hydroelectric dams (Martin & Hoffman, 2008). Students can then use these understandings of ethics in other professional and personal connections with Indigenous communities. However, challenges may arise if those local definitions of engineering ethics and their implicit and explicit values do not match the accreditation expectations.

In some cases, the definition of engineering ethics in accreditation documents may focus on personal accountability or ethical principles that do not recognize ethical partnerships and reconciliation with Indigenous communities as meaningful indicators of engineering ethics. On the other hand, if institutions have the power to define their own indicators, they can fine-tune their indicators to respond to the ethical histories and situations that are relevant in their local contexts. The responsibility for ensuring that engineering ethics at the program level responds to local contexts falls to the institution to define and revise its own indicators over time.

A final aspect of program-level narratives of engineering ethics that may be disconnected from local contexts and needs emerges when we consider the different ways that engineering ethics is conceptualized in different engineering disciplines. The heterogeneity in engineering programs and practices contributes to this complexity. In civil engineering, for example, ethics may be discussed in the context of the safety of roads, bridges, and buildings, showing popular case studies (e.g., the Tacoma Narrows Bridge collapse in 1940) that highlight how faulty design can lead to the loss of human life. Biomedical engineering may put a slightly different spin on ethics, drawing from codes of ethics of medical fields to highlight the importance of understanding the impacts of new biomedical devices on patients, including how to design ethical research and testing protocols. Students in software engineering may struggle to connect these types of case studies and principles to their work – after all, they are not building large physical structures and may not be writing software that will be used in the medical field. These students require yet another approach to ethics that highlights the dangers of black-boxed algorithms that perpetuate systemic inequities in often invisible ways (Benjamin, 2019; Buolamwini, 2022; Noble, 2018). While only three different engineering disciplines have been mentioned here, it is already easy to see how broad accreditation standards and indicators have very different local interpretations within the different engineering disciplines.

Once again, the broad sketch of engineering ethics in accreditation may be helpful because it allows for multiple interpretations of ethics, including all of the different ethical considerations that are more or less important in various engineering disciplines. At the same time, without explicit guidance regarding what ethics can look like in different engineering disciplines, engineering ethics education may be limited to the more visible and historical scenarios (e.g., ensuring your bridge does not fall and injure or kill anyone), while complex ethical issues that are increasingly important in today's digital world (e.g., algorithmic biases) may not be explicitly identified as essential or necessary for engineering students to learn.

To summarize this section, we see that the broad standards and descriptions of engineering equity in accreditation documents are often several levels removed from what engineering ethics means locally for institutions and engineering programs. While this may seem like a good thing in that it can allow for multiple interpretations of engineering ethics that can meet local needs, we must keep in mind that this is extra work that the institution and program must do, which may not be explicitly recognized, valued, or accepted during the accreditation process. It may be easier and cheaper for institutions to continue to design standalone ethics courses that technically meet the standards for accreditation without actually preparing students for the specific ethical challenges in their engineering disciplines and broader communities.

Course and instructor level

The local level of individual courses and instructors is also crucial to consider. Related to the ideas discussed at the institutional and program levels, the perceived value of engineering ethics comes from the messages and directives instructors receive from more senior faculty members and administrators. If internal stakeholders perceive that ethics is only being taught in order to meet accreditation standards rather than because it is a critical topic for their students to know and apply in their future work, they may simply 'teach to accreditation' (similar to 'teaching to the test') and include the bare minimum of ethics education to meet accreditation standards satisfactorily (Martin et al., 2021). If ethics coverage is met through a single standalone ethics course, other instructors may believe they do not need to cover ethics in their technical and design courses. This can create the impression that ethics is not critical to engineers' daily technical and design work. It also results in a missed opportunity for instructors to touch upon the ethical issues that arise within their local technical and design contexts, such as the ethics of user testing a new iPhone app, the ethics of sourcing raw materials, or the ethics involved in working with clients in an engineering capstone course. These examples may also be relevant to students' lives outside of their engineering work, such as purchasing new technologies or engaging in professional relationships. In essence, we can find local instances of engineering ethics in most, if not all, engineering courses, but the accreditation process can stifle the desire to think critically about these local definitions of ethics and teach them to students.

In considering how engineering ethics is personalized in courses, we must also consider each individual instructor's relationships and experiences with engineering ethics. Instructors may need help determining what definitions and examples of engineering ethics are appropriate for their students due to the broadness of the topic in both the literature and the accreditation documents. Other instructors may be grounded in the tradition/assumption of engineering as apolitical and objective (Cech, 2013). While those instructors may be comfortable teaching traditional engineering ethics case studies such as the Challenger disaster or the Tacoma Narrows Bridge, they may be less likely to include issues that appear to align more with social justice discourses, such as systemic racism in algorithms (Benjamin, 2019; Noble, 2018) or recent movements to modernize and address harm in engineering graduation rituals (Retool the Ritual, 2023). This is perhaps not surprising, given that the definitions of engineering ethics in accreditation documents, as explored by Junaid et al. (2022), did not reference terms such as "global," "value," and "justice." To attend to local definitions of justice, we must explicitly call out engineering values (including historical values of objectivism) and consider how larger systemic injustices can and should be addressed within and beyond engineering practice.

On top of the *content* of engineering ethics, the accreditation documents need to address issues of *pedagogy*. Junaid et al. (2022) note that many accreditation documents use lower-level verbs from Bloom's taxonomy (e.g., know, define, be aware of) to describe students' understandings of ethics than technical items required (e.g., analyze, synthesize, evaluate, design, or create). *Precisely how are engineering students expected to come to know engineering ethics, and what contexts (local and global) are they expected to be aware of? Is there an expectation that instructors should find ways to connect the classroom with the local community, and if so, how should they be supported in doing so?* These questions are not answered in the accreditation documents. Instructors who try to move beyond memorized definitions and historical case studies may struggle due to a lack of training and support in pedagogical approaches, including small group discussions, debates, or other activities with high student-to-student interaction (Martin et al., 2021). As students begin to engage deeply in discussions of ethics, locating engineering ethics within their personal histories and professional experiences, conflict may arise as different viewpoints clash – something that is especially likely if the course is diving into ideas of engineering ethics that may be viewed as more controversial and political. Instructors must not only deal with the content of ethics within their classroom but also with the idea of ethics as it relates to their pedagogical choices: *How can they support all students and minimize harm while still ensuring that students are prepared to address these real-world applications of engineering ethics they will face in their future lives?* Once again, the broad and impersonal definitions of ethics in accreditation documents may cause instructors to shy away from such challenging topics, classroom dynamics, or pedagogical approaches. Even if instructors find ways to create a classroom environment that allows for multiple personal definitions and understandings of engineering ethics to come together, they must still figure out how to assess students' understandings of engineering ethics, which has its challenges.

Finally, the accreditation process is chore-like and can place a heavy load on already burdened instructors. In some cases, instructors must carefully document low, average, and high-quality student work for every assignment and exam while carefully articulating which accreditation standards are being addressed by each question or section of a rubric. This work is done in addition to the regular lecturing, planning, prepping, and grading in each of their courses. In the end, these piles of documentation are sent to other faculty and staff members on a committee to be compiled and presented to those carrying out the accreditation evaluation. While these instructors may eventually hear, months later, that their program has passed accreditation, they are unlikely to receive meaningful and actionable feedback that they can implement in their courses. Therefore, accreditation risks becoming a bureaucratic procedure without local, actionable impact, leading to feelings of disempowerment and disengagement from instructors.

Student level

We can also understand the local level of engineering ethics as the experience of students – who are both learners and graduates headed out into the workforce. While accreditation standards and processes may guide the courses they are expected to take throughout their degree, students may be unaware of this, as they are often not directly part of the accreditation process other than to provide permission for instructors to use their coursework as examples of student learning outcomes. Therefore, their notion of engineering ethics is built through their classroom experiences. As we have already mentioned, a standalone ethics course (among many more technical courses) may send students the message that ethics is not at the core of their program and duties as future engineers (Martin & Polmear, 2023). This message is reinforced by the perception that an ethics course that relies predominantly upon content and pedagogies from the social sciences (such as group discussions or written work) should automatically be more accessible than their technical courses. Therefore it is viewed as less critical and often pushed to the bottom of students' lengthy to-do lists as they complete their semester's work.

Students may also need help locating themselves within traditional ethics case studies. At times, these traditional cases may be viewed as irrelevant when they deal with outdated technologies or ethical codes that are not part of the students' everyday lives and will not be part of their future professional practice. In addition, when complex techno-socio-political situations, such as that of the Challenger disaster, are reduced to a 1–2-page case description, it is easy for students to read the facts and say, 'Of course, I would never do that!' Students argue that they would do proper testing and speak up against management, even though they are missing critical context that is not easily summed up in the case. Sociologist Diane Vaughan has pointed out that the Challenger disaster was not the result of individual bad decisions but rather of years of practices and norms at NASA that created a corporate culture that normalized deviance and missed routine signals of impending disaster (Vaughan, 1996). She argues that the NASA managers conformed to requirements and did not break any rules during the launch. In this way, we can see how students' understanding of engineering ethics at the local level can be limited to individual decisions versus the cultures and norms that heavily influence those decisions in ways that are either invisible or considered unimportant until disaster strikes. Students do not realize that, in their local contexts, they can unintentionally reify those cultures and norms. Further, students' hyperfocus on individual actions may cause them to ignore or be unable to address the role that engineers play in complex systemic issues, including climate change, racism, and other biases in technology design and reconciliation efforts with Indigenous communities.

Finally, we must consider the impact of heterogeneity in the student population on the translation of engineering ethics at the local level. Students in engineering programs have different histories, backgrounds, and identities, and all of these factors can influence what engineering ethics means to them (Castagno et al., 2022). For example, a racialized woman in engineering may argue that professional codes of ethics do not adequately respond to equity, diversity, and inclusion goals in the profession. A student from a country that has been dealing with war and violence may question the idea of engineers holding paramount the safety, health, and welfare of the public (Engineers Geoscientists Manitoba, 2018, p. 1): *Which public is being protected through the use of drones and automated weaponry?* Some may argue that a professional code of ethics can be interpreted in ways that address emerging ethical dilemmas in engineering and can respond to personal codes of ethics; others may turn that argument on itself, arguing that allowing for room for interpretation means that decisions can be made that do not fully address the ethical issue or that lead to contradictions (e.g., be faithful to your employer but also hold the safety of the public paramount – *But what if your employer is doing something harmful?*).

In short, students will respond to the broad ideas of engineering ethics that are handed down to them through the curriculum. However, they will also internalize and personalize (or fail to do so) these ideas in accordance with their own histories and identities.

Summary

This section has highlighted how engineering ethics is grounded in local contexts, cultures, and positionalities. Accreditation documents and processes have implications for how engineering ethics is taught and understood by institutions, instructors, and students. Without institutional or instructor drive to connect engineering ethics as articulated in engineering accreditation documents and processes to local contexts, students can be left with fragmented, vague, and surface-level understandings of engineering ethics that will not address the ethical challenges they will face in their future professional work and as members of society. We have created a visual (see Figure 36.1) that graphically illustrates engineering ethics at these various local levels that can act as a tool for stimulating discussion and reflection.

Although we have mainly discussed the impersonality of engineering ethics accreditation documents and processes as a challenge that should be overcome, it is also possible to understand this impersonality as something that allows space for flexibility and adaptation. As mentioned in our discussion of institutions and programs, vagueness requires institutions to define their own indicators for engineering ethics, which can, in turn, respond to local contexts and priorities. Additionally, instructors may feel a greater sense of freedom in choosing the content and classroom activities that resonate most strongly with them, their students, and their communities if they are not burdened by a detailed list of ethical concepts and considerations in the accreditation documents. Our concern arises from the fact that although some institutions, programs, and instructors may thrive in this ill-defined space, others may require more guidance, which they cannot get from the accreditation documents and processes. There may also be those who continually fall back upon traditional, depersonalized notions of engineering ethics (due to a lack of experience, lack of desire or resources to change, or general resistance to the idea of engineering as politicized) who would need more of an external push to contextualize engineering ethics in their local contexts. As accreditation documents and processes are used to both shape and assess engineering programs worldwide, they are well-placed to instigate change in this way.

Conclusion

Our goal for this chapter was to problematize the idea of engineering ethics education at the local level as it relates to engineering accreditation documents and processes. We have discussed how vague language, assumptions of standardized values, and the assumption of quality in accreditation can lead to disconnects between how engineering ethics is defined and assessed in accreditation and how engineering ethics lives within institutions, classrooms, students, and their communities. We would encourage everyone involved in engineering ethics education – accreditation bodies, assessors, institution leadership, instructors, and students – to engage in deeper reflection on what engineering ethics means in diverse and heterogeneous local contexts.

We encourage institutions, programs, educators, and students to ground engineering ethics within their local contexts. This may mean connecting to institutional and community values, reaching out to industry and non-governmental partners, including ethics in more technical engineering courses, and incorporating classroom discussion that encourages students to share their definitions of engineering ethics and its importance to them. At the accreditation level, we call upon accreditation boards to explicitly acknowledge and value the heterogeneity in local engineering ethics within the accreditation documents and processes. We hope that by calling attention to what engineering ethics looks like at the local level, we can create curricula and classroom environments that prepare engineering students for the complex ethical challenges they will encounter in their workplaces and communities.

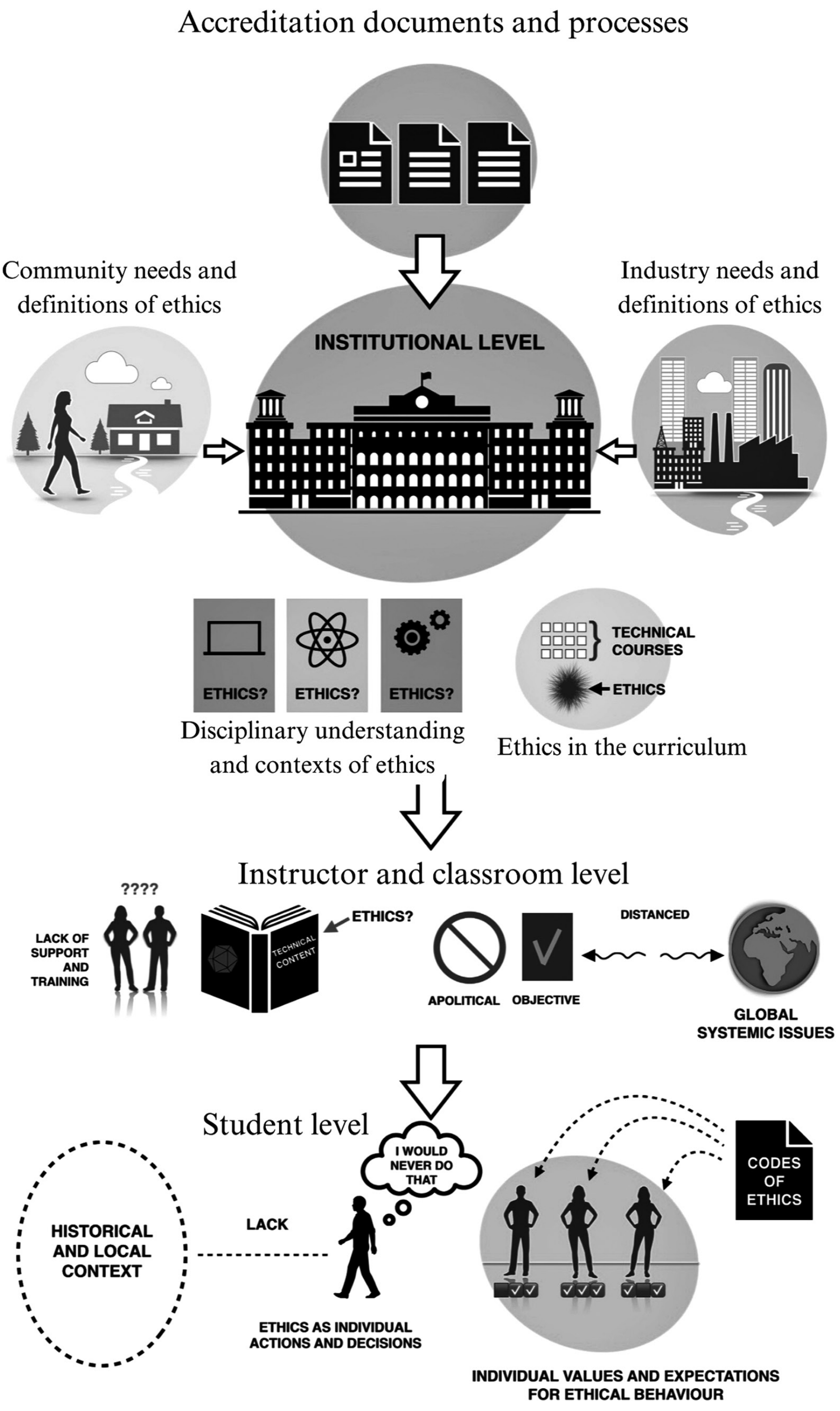

Figure 36.1 Graphical representation of potential mismatches between accreditation documents/processes for engineering ethics and implications at the institutional, instructor, and student levels.

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