Guest Editorial
Special Issue on Conceptual Learning of Mathematics-Intensive Concepts in Engineering

I. Introduction

UNDERSTANDING mathematics is essential for learning many concepts in engineering. Conceptual learning of engineering requires students to successfully connect abstract and concrete concepts to achieve a cohesive understanding of the content, and doing so goes beyond memorizing facts and applying formulas. Educators can observe that conceptual learning "has happened" once a student is able to successfully explain the concept, use the concept, and create new knowledge from the learned concept [1]. Moreover, a student's ability to understand, both qualitatively and quantitatively, the mathematical equations and computations that describe various engineering processes and phenomena is necessary for the conceptual learning of many courses in engineering.

Engineers are problem solvers—and solving engineering problems requires special habits of thinking that involve the simultaneous use of mathematical, social, and scientific knowledge [2]. The solution to an engineering problem is not unique, unlike a purely mathematical problem, and this adds an additional layer of challenge for engineering students as they navigate through the learning process. Consequently, investigating how mathematical understanding can help engineers optimize their learning of foundational concepts is imperative.

The literature provides ample evidence that engineering students struggle with learning mathematics-intensive concepts. Students who are struggling typically memorize processes and seek to identify tricks they can use in solving mathematics-intensive questions. Such students demonstrate low levels of motivation in mathematics classes [3] and typically experience anxiety related to mathematics courses and concepts in engineering. To date, there remain gaps [4] in understanding:

1) how engineering students, when attempting to learn, make sense of engineering concepts that are widely explained and modeled using abstract mathematical concepts—for example, Fourier and Laplace analyses;
2) the mental processes that occur when engineering students switch between mathematical equations (and abstractions) and the engineering concepts explained through these mathematical equations (and abstractions)—for example, alternating current circuit analysis using phasors;
3) what makes it difficult to conceptually learn engineering concepts that are taught and modeled through abstract mathematical concepts;
4) the habits of thinking and learning that would help engineering students successfully switch between the mathematical representations of engineering concepts and conceptual knowledge of the engineering concept itself.

The guest editors of this special issue—Shannon Chance, Farrah Fayyaz, Anita Campbell, Nicole Pitterson, and Sadia Nawaz—believe that focusing attention on this kind of research has the potential to address problems in learning, identify habits for successful learning of mathematics-intensive concepts in engineering, and contribute toward the improvement of conceptual learning of engineering concepts in general and thereby increasing student retention, motivation, innovation, and inclusion in engineering.

II. Community Building Through This Special Issue and the Editors' Commitment to Diversity and Inclusion

The overall selection of editors for this team, made by the lead editors for this project (Shannon Chance, the organizational lead, and Farrah Fayyaz, the conceptual lead), represented an intentional effort to cultivate skills in managing special issue publications. Shannon articulated this and many other capacity-building objectives, and Farrah identified leading experts in the field (to invite as guest editors and/or authors). With the team's help, Farrah drafted the call for papers and sent targeted invitations to authors the team hoped to engage in the project. She also collected the extended abstracts that the team solicited at the first stage of this project.

The all-woman editorial team is culturally and racially diverse. Its members share a passion for learning and teaching and a commitment to generating new knowledge and sharing it with colleagues and students.

The team is also geographically diverse, with members based in Ireland, Canada, South Africa, the United States, and Australia. Despite the benefits of geographical diversity for the subject matter, it presented time-zone challenges for scheduling periodic project meetings.

The team benefited from mentorship: John Mitchell, the outgoing Editor-in-Chief of IEEE Transactions on Education; Lisa Jess, the Supervisor of Peer-Review Support Services for IEEE Publishing Operations; and Camille

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Ventura, journals production manager, provided advice and support throughout the development and publication process. The editorial team also benefited from advice from a previous editor-in-chief, Jeff Froyd. Both Froyd and Mitchell advised Chance through guest editing prior issues of the IEEE TRANSACTIONS ON EDUCATION [5], [6] and she sought to pass along the knowledge and experience gained to a new team of aspiring editors.

The editorial team developed an innovative plan for building the capacity of the mathematics teaching community to conduct educational research and sought Mitchell's advice in this part of the process. Their call for papers identified several novel techniques intended to build research capacity and strengthen the sense of community and shared sense of purpose around research involving mathematics education for engineers.

The call solicited 300–500-word abstracts (rather than full papers at the first instance) to provide nascent ideas a chance to incubate and grow. The authors were asked to align with one of three areas of scholarship: application, discovery, or integration, as per journal policies. Concept papers and scholarly position papers with sound theoretical justification were welcomed in addition to empirical research papers. All authors were asked to provide compelling evidence and explicit, transparent descriptions of the processes through which their evidence had been collected, analyzed, and interpreted.

To encourage community building among researchers in engineering and mathematics education, including open discussion around the targeted topic, the authors of abstracts that had been submitted for consideration were invited to attend one of two online expert discussions. These were purposefully scheduled to accommodate different time zones.

In these meetings, research teams shared how their work responded to the call for papers and described the contribution they intended to make to the Engineering Education Research (EER) Community. The authors presented summaries of their papers, discussed challenges encountered during their research, and shared strategies for overcoming these obstacles. The guest editors and the other participants raised questions and provided recommendations based on their diverse experience and expertise.

To align with the guest editors' goals for promoting equity, diversity, and inclusion (EDI) across engineering education, the call for papers required all manuscripts to discuss the implications of the work related to EDI. This encouraged all the authors to consider and seek to amplify the impact of their research to support diverse groups. The editors envisioned this as a way to promote more inclusive educational environments.

Additionally, reflecting current best practices, the guest editors requested that authors use bias-free language. Given the evolving nature of inclusive language, the guest editorial team encouraged authors to, at minimum, adhere to the APA guidelines on bias-free language [7]. Unfortunately, using the third person, passive voice is required in all IEEE journals. This policy conflicts with recommendations by the American Psychological Association to use active voice and first-person in reporting one's work and one's personal reactions. (One can see for oneself how awkward this practice can be for reading!) The guest editorial team encourages IEEE to consider updating its stance on this.

The guest editors also critiqued the IEEE formatting style, which they see as having pros and cons. On the pro side, using brackets within the text to identify referenced work is systematic and succinct. On the con side, it makes the contributions of individual teams and researchers (their specific voices within the "choir" of EER) more difficult to discern than other formats (like APA, MLA, Chicago, Harvard, etc.). Thus, after recognizing that the IEEE formatting style makes it difficult for readers to identify the authors being cited in any given manuscript—and to spotlight inclusivity—the editors chose to include the first and last names of all editors and participants when drafting this guest editorial statement.

That helps the reader perceive the crucial role of women in developing this special issue: women contributed to this volume more visibly than men (approximately 20:6). This contribution is worth acknowledging and celebrating.

The editors note that an even wider team contributed to the panel discussions, and the guest editors look forward to additional publications crystalizing at later dates due to the call they issued and the community they sought to cultivate. The editors have maintained contact with some authors who are still progressing their work and expanding their datasets—so stay tuned for additional developments!

The guest editorial team closes this section with praise for two specific IEEE standards that the team sees as helpful supports for inclusivity. First, the team sees the copyediting that IEEE provides (as a standard and typically very high-quality service, without additional fee) as beneficial for supporting authors from diverse linguistic backgrounds. Second, the team thanks IEEE for allowing authors in this special issue to publish longer manuscripts than typical, which was necessary for explaining detailed concepts and including mathematical equations. Math educators often face limitations in publishing accurate representations of their work, but IEEE consistently provides effective copy editing and layout for mathematical equations.

III. INITIAL SELECTION AND PEER-REVIEW PROCESS

The call for papers for this special issue suggested topics of interest that included, but were not limited to, qualitative and quantitative studies exploring:

1) how learning mathematics-intensive engineering concepts happens;
2) problems associated with the learning of mathematics-intensive engineering concepts;
3) the ripple effects of difficulties in conceptual learning in engineering courses that arise due to the lack of mathematical proficiency;
4) general problems in engineering education (e.g., student retention, motivation, success, etc.) related to the challenge of understanding mathematics-intensive engineering concepts;
5) engineering students' perceptions of mathematics in engineering that might influence their learning.

As noted above, the editors solicited studies presenting empirical data (reporting, for instance, outcomes of novel approaches) as well as conceptual explorations undergirded with rigorous critical analysis. Concerning conceptual papers, the guest editors suggested various possible topics, including novel teaching pedagogies, efforts to improve engineering students' mathematical skills within engineering courses, and efforts in high school education to improve mathematical skills that have been helpful for engineering thinking. Additionally, although the guest editors were open to general engineering-related topics, they asked that the authors include at least one paragraph to demonstrate applicability to IEEE fields such as Electrical and Computer Engineering (ECE).

Also noted above, the call for papers asked the authors to start by submitting an abstract for consideration. Each submitted abstract was reviewed by all the guest editors individually. After the initial round of review, the editorial team met to discuss the pool and delineate which abstracts fit the specified scope and would be accepted for further development. Others were identified as out-of-scope and therefore rejected. A third category involved manuscripts that the editors described as "in-scope" but where the abstract was not clearly written, but the team perceived the idea had potential. In some cases, the research methods were not identified, or the alignment with ECE was unclear. The authors in this last category were invited to resubmit, and their new abstracts went through the same review cycle again.

A couple of months after the abstracts were selected, the editorial team organized online panel sessions of the authors, encouraging volunteers to present their research and share advice among authors and editors—and to help build a sense of community around the target issues. The editorial team invited volunteers to showcase their work and personally encouraged exemplars to set the bar high for others.

Although the editors did not conduct post-panel surveys regarding participant experience of these knowledge-exchange sessions, the team received emails from some participants describing the usefulness of the sessions in honing their research and building a sense of purpose and community. Due to drastic differences in time zones, not all authors could attend. Yet some authors actually attended both panels—choosing to join in a second time, after finding the first session useful. All guest editors attended at least one of the panel sessions, and most (defying the time-zone odds!) were able to attend both. This exercise helped the editors understand the authors' research plans and objectives and also helped them provide constructive and focused feedback to the authors throughout the publication process. The overall group was able to enjoy collaborating and getting to know scholars with shared interests.

Other than that, much of the peer-review process was standard as per any other paper submission in the IEEE TRANSACTIONS ON EDUCATION. Each manuscript was assigned one managing editor (from our guest editorial team), and this managing editor recruited three experienced peer reviewers. The call for papers had stated the expectation that authors for this special issue would agree to review other manuscripts from the issue. As the IEEE TRANSACTIONS ON EDUCATION uses a single-blind review system, the reviewers always know the identities of the authors—and according to past editors-in-chief of the IEEE TRANSACTIONS ON EDUCATION, this IEEE practice is intended to help encourage diversity of voices across IEEE publications. Here again, the editorial team applauds the organization's effort to support inclusivity.

The team also recognized the delicate balance implied in their request for authors to "cross-examine" each other. They knew that the request to review each other's work would make the entire process more transparent—and they noted to authors that others might be able to guess who had provided reviews for their papers. The editors made this explicit during the panel sessions and in their advisory emails. Their intention was to build capacity in writing and reviewing, build a sense of importance and belonging around the topic, and speed up the review process. And, yes, this request yielded some of the anticipated benefits. However, an unexpected drawback was a lack of rigor in some of the reviews. Specifically, newer authors and less confident participants seemed reluctant to provide rigorous critique, and this ultimately delayed the process as the managing editors worked to obtain thorough reviews. Securing peer reviews is an increasing challenge across the field of EER and one that the EER community needs to address by developing more strategic approaches. The editors' experience with the IEEE has been positive in this regard—the electrical and electronic education research community involved in the IEEE actively engages in peer review, and a higher percentage of people accept invitations to review than the team finds with many other journals. Hats off to IEEE TRANSACTIONS readers for chipping in on this essential process, which helps set and enforce the IEEE standard of publication quality at a level the guest editing team supports and admires.

IV. ARTICLES PUBLISHED IN THIS VOLUME

Regarding the teaching and learning of mathematics, the editors believe that content, assessment, and instruction must align toward achieving identified learning goals [8]. To best determine content, it is important for educators to understand students' difficulties in learning (as well as their patterns of misconception) and to identify missing concepts (ones that should be taught for complete conceptual learning). This special edition comprises nine articles covering three important categories: 1) assessment; 2) instruction; and 3) learning.

A. Assessment

The first article in this volume focuses mainly on assessment. The concept paper by Anita L. Campbell and Pragashni Padayachee [A1] provides useful insights for developing rubrics, based on the mathematical competencies research framework (MCRF). These authors argue that student learning quality is directly tied to the effectiveness of assessment methods. They emphasize the importance of allowing students to have a voice in the assessment process. The editorial team believes that the MCRF framework can be adapted and modified for the assessment of many engineering courses—and also for engineering design—even though the article is focused on the learning and assessment of mathematics-intensive concepts and courses in engineering.

B. Instruction

Within the theme of instruction, this special issue presents several articles, representing two categories: 1) teaching by presenting clear connections and common language and 2) teaching using technologies.

Within the first category, the article by Faezeh Rezvanifard and Farzad Radmehr [A2] highlights a key challenge in the learning of mathematics-intensive engineering courses wherein students, new to the content, are introduced to a given concept from two very different perspectives. Often, one course or one set of teachers uses the terminology of mathematicians to describe the concept, whereas other courses and teachers use the terminology of engineers (or even a specific subset of engineers). The qualitative study presented [A2] compares how one specific concept, the Laplace transform, is presented in an introductory science textbook with how the same concept is presented in an engineering textbook. The authors note a lack of connections between the two ways of describing the same concept—a disconnect that often never gets bridged for students, at least not explicitly. Typically, students are left on their own to make sense of content delivered by people with differing epistemologies and different ways of describing the world. The guest editing team believes this problem is pervasive in teaching; it occurs with many mathematics-intensive engineering concepts and in all engineering disciplines. Hence, the implications are wider than the case described here (i.e., the Laplace transform). The authors of the study [A2] provide recommendations for understanding the hurdles in teaching interdisciplinary concepts in general.

Whereas Rezvanifard and Radmehr's article [A2] highlights the need for consistency in presentation when teaching the same mathematical concepts to engineering students in different settings, the article by Carlotta Berry, Leanne Holder, Nicole Pfiester, and Tracy Weyand [A3] provides tools and techniques to highlight such inconsistencies for students and teachers within a course—to help them bridge the divides. The text helps educators: 1) more explicitly bridge terminology across the courses for students, but this bridging can also help educators better understand how components of a course fit together, and 2) be more purposeful in their linkages. The authors [A3] argue that when teaching mathematics-intensive concepts to engineering students, teachers must also present the connections between engineering concepts and mathematics clearly, and they recommend illustrating the connections using concept maps.

The article [A3] presents the authors' efforts in creating visual maps using a systematic approach to problem-solving (SAPS), or what the authors call "SAPS maps." Although their article focuses mainly on the creation of SAPS maps to link together the concepts of mathematics, physics, and engineering encountered within the first two years of an electrical engineering curriculum, the authors also reflect on the process of creating SAPS maps and emphasize the importance of providing mental images like these maps to visually link concepts and trace their applicability across subjects within a degree program or a field of practice. Tools like SAPS maps can help identify common language as well as illustrate links; they are particularly useful when teaching multidisciplinary concepts or practicing in hybrid, multidisciplinary fields.

Motivation emerges as an important topic in this special issue. The article by Berry et al. [A3] introduces motivation with regard to enhancing students' motivation for learning mathematics-intensive concepts by clearly presenting such connections—bringing greater life to math concepts by illustrating their applicability to specific engineering practices and topics. Although Berry et al. have not specifically measured student motivation, the authors of the subsequent article in this set, Hilger and Schmitz [A4], have sought to measure students' motivation. Similar to Berry et al., Hilger and Schmitz recommended presenting clear connections between mathematical concepts and engineering concepts.

Specifically, the article by Susanne Hilger and Angela Schmitz [A4] emphasizes the importance of making connections with engineering when delivering mathematics lessons, rather than the other way around. The quantitative aspects of the study [A4] found that engineering students' motivation to learn a mathematical concept increased when the students were presented with authentic examples of the application of the concept in engineering. The guest editors believe that although the discussion of teaching engineering concepts through examples of their applicability is not new, the idea of *authenticity* in such applications is. More qualitative studies—to understand the idea of authentic learning, authentic applications, and relationships between authenticity and motivation—are worth conducting and have the potential to improve engineering education further.

Moreover, the question of who should teach mathematics courses to engineering students—mathematicians or engineers—is age-old. Hilger and Schmitz [A4] presented a convincing argument that mathematics courses for engineering students must at least be designed, if not taught, in collaboration with engineering instructors. The authors argue that students who encounter nonapplied, nonengineering mathematics content are less able to identify and comprehend essential and useful connections between mathematics and engineering concepts.

Making use of technology for instruction is described by Ekaterina Rzyankina, Frikkie George, and Zach Simpson [A5]. The focus here is on teaching mathematics-intensive concepts to engineering students using digital, interactive textbooks. The authors performed a case study supporting the argument that e-textbooks can facilitate an equitable learning environment by providing opportunities to enhance background knowledge and empower students toward self-directed learning. This, the authors contend, is particularly relevant for students of different cultural or educational backgrounds. The guest editors believe this study showcases a pedagogical technique that can help support equity, diversity, inclusivity, and accessibility within engineering education in particular and education in general.

In [A6], Imad Abou-Hayt and Bettina Dahl proffer a new method to teach Laplace transforms within a computer-assisted environment using the anthropological theory of the didactic. Their qualitative study calls for bridging the gap between procedural skills and conceptual understanding through the use of computer software. The authors provide evidence that current approaches fail to make these connections effectively. The guest editors believe this approach can be used to revisit the teaching of other mathematics-intensive concepts in engineering as well, so space in the curriculum can be opened to add more examples and time for practice.

C. Learning

The three studies featured in this special issue that focus on engineering students' learning of mathematical concepts have been conducted in mathematics classroom contexts (as opposed to being embedded in engineering courses). The editors believe that these articles provide valuable discussion for building bridges between mathematics and engineering courses and, ultimately, enhancing learning.

The mixed methods study presented by Thabiso Khemane, Pragashni Padayachee, and Corrinne Shaw [A7] highlights students' typical difficulties in learning and many of the misconceptions encountered when second-year undergraduate engineering students attempt to understand Stoke's theorem, which is considered the most challenging concept in vector calculus for engineering students. The recommendations for understanding and overcoming misconceptions with this key topic can help engineering educators who depend on students' ability to apply Stoke's theorem.

The article by Svitlana Rogovchenko and Yuriy Rogovchenko [A8] highlights the problems in learning exact differentials and exact differential equations when engineering students encounter these concepts in different mathematical organizations. The authors performed a praxeological analysis of different mathematical organizations to highlight possible difficulties in learning mathematics-intensive engineering concepts. Their findings demonstrate that the lack of collaboration between mathematics and engineering courses is likely a cause of difficulties in learning.

In [A9], Fulya Kula, Nelly Litvak, and Tracy S. Craig used a mixed methods approach and action–process–object–schema framework to highlight the challenges associated with developing an "object conception" of a statistical concept, specifically regarding the sample mean. Their results indicate that even amongst proficient students, only a minority demonstrate an object conception. The authors emphasize the need for diverse learning opportunities and resources to aid cognitive development and inclusivity.

V. Future Research

Through this special issue, the editorial team has spotlighted a rather under-researched and very problematic domain within engineering education, that is, the learning and teaching of mathematics-intensive courses. The editors brought diverse perspectives into this process and are pleased to present a sizable collection of well connected yet diverse approaches and ideas.

The articles in this special issue not only add to the body of knowledge to improve engineering students' learning of mathematical concepts and mathematics-intensive engineering concepts but also open new lines of discussion regarding how multidisciplinary courses can be taught and how students learn these skills. The compilation provides insight for designing more inclusive and accessible courses. It underscores the importance of teaching math to engineering students in collaboration with engineering instructors, teaching mathematical concepts to engineering students using examples from engineering, and explicitly linking math and engineering terms.

Nevertheless, some key areas for research in this domain remain under-researched, and the guest sees an ongoing need for:

1) research on gender-based differences in the learning of mathematics-intensive courses within engineering;
2) research on what can be learned from indigenous ways of learning to enhance students' learning of mathematics-intensive concepts;
3) research on thought processes and the ways students' minds work while making sense of math-intensive concepts;
4) research on mental retention and factors that affect retention of such concepts;
5) research on how students make sense of mathematics-intensive concepts in the era of artificial intelligence (AI);
6) research on how AI can be used to teach mathematics-intensive engineering concepts;
7) research on challenges related to conceptual learning in the AI era.

VI. Final Reflections on the Editorial Process

The editorial team pioneered some innovative collaborative approaches in developing this special issue, as noted above. The team encourages others to further the model presented here: assembling editorial teams with diverse backgrounds and range of experience, cultivating the EER community's editorial skills to support the evolution of high-quality EER compilations, collaboratively constructing new knowledge across editors and authors, crafting intriguing calls for papers on newly defined and emerging topics, soliciting authorship from appropriate scholars in the field, implementing a stepped approach with extended abstracts submitted before the development of full manuscripts, hosting discussion groups during manuscript development, fostering collaboration wherever possible, and working very closely with the journal's editor-in-chief and production manager to ensure fit with the journal's interests, scope, and policies. Most innovations the editors implemented worked well, although the plan to conduct peer reviews predominantly within the author pool did not work as effectively as envisioned—perhaps in a more established realm of investigation, the cross-examination technique could work better. In this case, the team needed to tap into a wider range of scholars to gather the necessary depth and rigor of feedback.

Nevertheless, the product is something that all contributors can take pride in. It presents a highly diverse set of articles—with many innovative conceptual papers included. The editorial team completes this venture enthused and empowered for future editorial projects. The team hopes the authors feel a similar sense of empowerment and inspiration for writing and spearheading future EER publications.

Acknowledgment

The guest editors are grateful to all those who took an interest in something they are so passionate about and shared the journey together—including all the people who submitted extended abstracts, presented in and/or attended the panel sessions, and crafted manuscripts—including those not included in the final compilation. The team sincerely thanks the peer reviewers who volunteered their time and unique expertise in providing detailed, constructive feedback.

Last but not least, the editorial team extends wholehearted thanks to Prof. John Mitchell, former Editor-in-Chief of IEEE Transactions on Education, for his knowledgeable, collegial, and ongoing support for this special edition and his valuable feedback in helping Shannon Chance and Farrah Fayyaz form a demographically diverse team around important but not-well-researched topics. Mitchell's input truly enriched the editors' processes and discussions.

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Appendix: Related Articles

[A1] A. L. Campbell and P. Padayachee, "Design principles for using rubrics in engineering mathematics," *IEEE Trans. Educ.*, vol. 67, no. 4, pp. 499–507, Aug. 2024, doi: 10.1109/TE.2023.3329761.

[A2] F. Rezvanifard and F. Radmehr, "Laplace transform in mathematics and electrical engineering: A praxeological analysis of two textbooks on the differential equations and signal processing," *IEEE Trans. Educ.*, vol. 67, no. 4, pp. 508–518, Aug. 2024, doi: 10.1109/TE.2024.3349662.

[A3] C. Berry, L. Holder, N. Pfiester, and T. Weyand, "Concept maps afford connections from mathematics and physics to electrical engineering courses," *IEEE Trans. Educ.*, vol. 67, no. 4, pp. 519–525, Aug. 2024, doi: 10.1109/TE.2024.3367603.

[A4] S. Hilger and A. Schmitz, "Integration of engineering application examples in mathematics courses," *IEEE Trans. Educ.*, vol. 67, no. 4, pp. 526–533, Aug. 2024, doi: 10.1109/TE.2023.3337428.

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[3] K. E. Wage, J. R. Buck, J. K. Nelson, and M. A. Hjalmarson, "What were they thinking?: Refining conceptual assessments using think-aloud problem solving," *IEEE Signal Process. Mag.*, vol. 38, no. 3, pp. 85–93, May 2021, doi: 10.1109/MSP.2021.3060382.

[4] F. Fayyaz, "A qualitative study of problematic reasonings of undergraduate electrical engineering students in continuous time signals and systems courses," Ph.D. dissertation, Purdue Univ., West Lafayette, IN, USA, 2014.

[5] S. M. Chance, B. Williams, T. Goldfinch, R. S. Adams, and L. N. Fleming, "Guest editorial special issue on using enquiry- and design-based learning to spur epistemological and identity development of engineering students," *IEEE Trans. Educ.*, vol. 62, no. 3, pp. 157–164, Aug. 2019, doi: 10.1109/TE.2019.2923043.

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Shannon Chance received the B.Arch. and M.Arch. degrees in architecture from Virginia Tech, Blacksburg, VA, USA, in 1993 and 1996, respectively, and the Ph.D. degree in higher education administration from The College of William and Mary, Williamsburg, VA, USA, in 2010.

She joined this special issue project based on her interest in fostering students' holistic development as well as the engineering education community's capacity in research, publishing, and editing. She previously led the development of special issues of IEEE TRANSACTIONS ON EDUCATION on socio-cultural diversity in 2018 and identity and epistemological development in 2019 in engineering education. More recently, she led the development of a special issue of the *Australasian Journal of Engineering Education* on ethics in engineering education and practice in 2021 and *The Routledge International Handbook of Engineering Ethics Education* (forthcoming, December 2024). She joined the Engineering Education Research Community via the European Society for Engineering Education (SEFI) in 2012 while she was a Fulbright Scholar visiting the Dublin Institute of Technology (currently Technological University Dublin), Dublin, Ireland. Enabling her to stay in Europe and earn citizenship, she secured two Marie Skłodowska-Curie Actions individual fellowships from the European Union. This funding provided her access to employment at TU Dublin and University College London; she continues to work with both of these institutions today. She is a LEED-Accredited Professional and Registered Architect, a former Professor of Architecture with Hampton University, Hampton, VA, USA, and the Co-Designer of an Architectural Engineering curriculum for Newgiza University, Giza, Egypt.

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