IEEE TRANSACTIONS ON EDUCATION

CALL FOR PAPERS

SPECIAL ISSUE ON

Conceptual Learning of Mathematics Intensive Concepts in Engineering

Abstract Submission Deadline: 09/30/2022

Guest Editors

- Shannon Chance, Technological University Dublin, Ireland & University College London, UK (shannon.chance@tudublin.ie)
- Farrah Fayyaz, Concordia University, Montreal, Canada (farrah.fayyaz@concordia.ca)
- Nicole P. Pitterson, Virginia Tech, Blacksburg, USA (npitters@vt.edu)
- Anita L. Campbell, University of Cape Town, South Africa (anita.campbell@uct.ac.za)
- Sadia Nawaz, University of Melbourne, Australia (nawaz.s@unimelb.edu.au)

Overview

The *IEEE Transactions on Education* solicits original manuscripts for a special issue addressing conceptual learning of mathematics intensive concepts in engineering.

Understanding mathematics is essential for the learning of many concepts in engineering. Conceptual learning of engineering requires students to successfully connect abstract and concrete concepts into a cohesive understanding of the content that goes beyond memorization of facts and use of formula. Conceptual learning has happened when a student is able to successfully explain the concept, use the concept, and create new knowledge from the learned concept (Streveler, Brown, Herman, & Montfort, 2015). 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. Solving engineering problems requires special habits of thinking that involve a simultaneous use of mathematical, social, and scientific knowledge (McKenna, 2015). What often adds to the complexity of learning mathematical concepts in engineering is the fact that the solution to an engineering problem, in most cases, is not unique, unlike a pure mathematical problem.

There is ample evidence in literature that engineering students struggle in learning mathematics-intensive concepts. Struggling students typically memorize processes and identify tricks to use in solving the mathematics intensive questions (Wage, Buck, Nelson, & Hjalmarson, 2021). They show low motivation levels in mathematics classes, and they typically experience anxiety related to mathematics courses and concepts in engineering.

To date, there remains a gap in:

- Understanding how engineering students, when attempting to learn, make sense of engineering concepts that are explained and modeled widely through abstract mathematical concepts (e.g., Fourier and Laplace analysis).
- Understanding the mental processes that happen when engineering students switch between mathematical equations (and abstractions) and the engineering concepts explained through these mathematical equations (and abstractions) – for example, ac circuit analysis using phasors.
- Understanding what makes it difficult to conceptually learn engineering concepts taught and modeled through abstract mathematical concepts.
- Investigating 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 (Fayyaz, 2014).

The guest editors believe that focusing attention on this kind of research has the potential to not only highlight the problems in learning and the successful habits of learning of mathematics intensive concepts in engineering but can also contribute towards the improvement of conceptual learning of engineering concepts in general and thereby increase student retention, motivation, innovation, and inclusion in engineering.

Topics

Topics of interest for this special issue include, but are not limited to qualitative and quantitative studies to understand:

- how learning of mathematics intensive engineering concepts happens
- the problems in learning of mathematics intensive engineering concepts
- the ripple effects of difficulties in conceptual learning in engineering courses that arise due to the lack of mathematical proficiency
- general problems in engineering education related to the problems in learning mathematics intensive engineering concepts (for example, student retention, motivation, and success, etc.)
- engineering students' perceptions of mathematics in engineering that might influence their learning

While we encourage empirical studies that present data reflecting outcomes of novel approaches, we will also welcome more conceptual presentations that include rigorous critical analysis regarding a range of topics. These could include:

- novel teaching pedagogies of mathematics intensive engineering concepts
- efforts to improve engineering student's mathematical skills within engineering courses
- efforts in high school education to improve mathematical skills that are helpful for engineering thinking

Full manuscripts can refer to general engineering-related topics but must include at least one paragraph to demonstrate applicability to Electrical and Computer Engineering (ECE) and closely related fields. Additionally, all manuscripts must include at least one paragraph discussing implications related to equity, diversity, and inclusion (EDI) in engineering education.

In the same spirit, we invite submission from diverse authors including students.

All manuscripts must use bias-free language reflecting current best practice. Since the language and hence the approaches on how to best achieve that are still evolving, we encourage, at minimum, to adhere to the APA guidelines on bias-free language (American Psychological Association, 2022).

Abstract submission criteria

Initial submissions should be in the form of abstracts (300-500 words) submitted by email to farrah.fayyaz@concordia.ca by 30 September 2022. In keeping with the journal's structure for abstracts which will apply at later stages, please mention in your initial abstract: the contribution you're intending to make (to the literature in engineering education research), the background rationale (for the application or research study you propose), either the intended plan for application of a concept or for the research you propose to conduct (i.e., your research questions and methodology), the intended outcomes, and the main findings you foresee.

Full paper submission criteria

In subsequent stages of development, in the full papers, authors should clearly address the following criteria:

- Submissions are expected to identify their contributions to one of three areas of scholarship: application, discovery, or integration. Authors are referred to the Author Resource website (https://ieee-edusociety.org/general/toe-author-resources) for more information on selecting the appropriate area of scholarship.
- Papers should support contributions and assertions with compelling evidence and provide explicit, transparent descriptions of the processes through which the evidence is collected, analyzed, and interpreted.
- Case studies will be considered for acceptance, but must present compelling evidence to support key assertions, in addition to describing the initiative.
- Scholarly position papers will also be considered if they contain arguments with sound theoretical justification.
- Please contact Lisa Jess, l.jess@ieee.org if you need assistance with ScholarOne submissions.

Information on the journal and information for authors can be found starting at http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=13.

Important Deadlines

Manuscripts will then be peer reviewed using the published review criteria. Invitation to submit a paper based on an abstract does not guarantee acceptance for publication. We will ask

authors to participate as peer reviewers, so please be prepared to review one other manuscript for the special focus issue.

- Submission of abstracts (300-500 words) by 30 September 2022 (please note that abstract shall be submitted by email to farrah.fayyaz@concordia.ca)
- Abstracts review outcome sent by 28 October 2022
- Accepted authors will be invited to attend an online expert panel discussion on state of the art in conceptual learning in November 2022
- Submission of full manuscript by 27 March 2023 (please note that manuscripts should be submitted following IEEE Transaction on Education author guidelines as detailed in https://ieeeauthorcenter.ieee.org).
- First peer review outcome sent to authors by 8 May 2023
- Revised manuscript submitted by 17 July 2023
- Second peer review outcome sent by 4 September 2023
- Re-revised manuscript (for papers under major revision) submitted by 30 October 2023
- Last possible date for submission of all revisions for copy editing and proofing is 2 January 2024
- Publication target date February 2024

References

Fayyaz, F. (2014). *A qualitative study of problematic reasonings of undergraduate electrical engineering students in Continuous Time Signals and Systems courses* (Doctoral dissertation, Purdue University). https://docs.lib.purdue.edu/open_access_dissertations/266

McKenna, A. F. (2015). Adaptive expertise and knowledge fluency in design and innovation. In A. Johri and B. M. Olds (Eds.), *Cambridge handbook of engineering education research* (pp. 227-242). Cambridge University Press. https://doi.org/10.1017/CBO9781139013451.016

Streveler, R. A., Brown, S., Herman, G. L., & Montfort, D. (2015). Conceptual change and misconceptions in engineering education: Curriculum, measurement, and theory-focused approaches. In A. Johri and B. M. Olds (Eds.), *Cambridge handbook of engineering education research* (pp. 83-102). Cambridge University Press. https://doi.org/10.1017/CBO9781139013451.016

Wage, K. E., Buck, J. R., Nelson, J. K., & Hjalmarson, M. A. (2021). What were they thinking?: Refining conceptual assessments using think-aloud problem solving. *IEEE Signal Processing Magazine, 38*(3), 85-93. DOI: 10.1109/MSP.2021.3060382