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From Effective Teaching Practice to Engineering Education Research: Where are the Gaps, and How Can the Gaps Be Bridged?

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ABSTRACT

BACKGROUND & CONTEXT

Within the engineering education communities, there appears to be a wide gap between teaching practice and engineering education research (EER), particularly exhibited in the distinct research-practice divide in the knowledge production processes.

PURPOSE OR GOAL

The purpose of this paper is to use a sample of published papers on teaching practice to illustrate how the gaps between effective teaching practice and EER may be bridged.

APPROACH OR METHODOLOGY

We first draw upon three conceptual frameworks or models for Scholarship of Teaching and Learning for insights. Then we examine a sample of 54 papers on teaching practice published in 2024 by *Advances in Engineering Education*, the *European Journal of Engineering Education*, and the *International Journal of Engineering Education*. In our analysis, we marked down the data collection methods in those example papers, and annotated the research designs they employed, using methodological terminologies as per research design literature.

OUTCOMES

Our review shows that most of the studies in the example papers used one-group pre-experimental research designs, which exhibit a lower level of methodological rigour but present less ethical challenge in implementation than quasi-experimental and experimental designs. We have identified three strategies for engineering educators to turn their teaching practices into research papers: utilizing various research designs, applying various genres to academic writing, and embracing diversity and rigour in studies on teaching practice.

CONCLUSIONS

This paper will help empower academics in engineering to conduct research on teaching practice, thus enhancing the research capacities of the EER communities.

KEYWORDS

Teaching practice, scholarship of teaching and learning (SoTL), research design.

Introduction

The divide between practice or usefulness and scholarship or scholarliness is persistent within the communities of engineering education researchers across the world. This divide is manifested in the scope statements of major engineering education research (EER) journals (Liu, 2019). In particular, the American Society for Engineering Education offers two distinct publishing venues: the *Journal of Engineering Education* and *Advances in Engineering Education*, with the former focusing more on research in terms of using the findings to advance existing knowledge about engineering epistemologies and learning mechanisms and the latter focusing more on application or instructional innovations being implemented (Matusuvich & Benson, 2022; Shuman et al., 2013). The research-practice divide is also manifested in the separate tracks for preparing papers on engineering education. For example, the Canadian Engineering Education Association (CEEA) has used two tracks for paper submission —the "practice" track that includes papers focus on educational interventions or novel practices, and the "research" track that includes papers that involve systematic inquiries using empirical data. Although both tracks are legitimate within the EER communities, the intentional differentiation between practice and research in the knowledge production process suggests a gap between the two. In a similar vein, education research literature also argues education research and Scholarship of Teaching and Learning (SoTL) occupy "contested spaces" for those who study teaching and learning although they could converge in the commons (Grant, 2018).

Further, a wider gap is identified between teaching practice and EER. Beyond good teaching, a SoTL project needs to be "well defined, carefully and systematically studied, and put in the context of others' research, and the results are shared with a broader community" (Bishop-Clark & Dietz-Uhler, 2012). More specifically, based on empirical findings Borrego (2007) identified five conceptual difficulties for engineering academics who learn to conduct EER: framing questions with broad appeal to produce broad implications that go beyond one classroom; grounding research in a theoretical framework, identifying appropriate measurements for the constructs (e.g., motivation and creativity), appreciating qualitative and mixed methods, and collaborating with social science researchers.

To bridge those gaps, efforts have been made within the engineering education communities on the institutional and national levels to support academics in turning their effective practice to EER. Examples include programs for addressing SoTL project needs for faculty members and for graduate students as future faculty members, as documented by Borrego and Streveler (2014). Looking around, it is not hard to identify those learning opportunities. For example, in the Canadian context, the CEEA as a professional association hosts EER Institute at its annual conference. The teaching and learning centres of many universities offer workshops to empower academics to conduct SoTL projects.

With a similar intent, this paper attempts to use published papers in engineering education publication venues as examples to illustrate how the gaps from effective teaching practice to engineering education research may be bridged. To do so, we first draw upon three conceptual frameworks or models for insights and then present and discuss the strategies as identified from a review of 54 articles focusing on teaching practice that were published by three engineering education journals in 2024. We believe that these strategies contribute to the ongoing supports to engineering academics when they endeavour to turn their effective teaching practice to quality EER work. Thus, this paper will help empower academics who are learning to become engineering education researchers and enhance the capacities of the EER communities in general.

Existing Guidelines for SoTL Studies

We have identified three frameworks that offer approaches to studying effective teaching practice: Borrego and Streveler's (2014) Engineering Education Inquiry Framework, Miller-Young and Yeo's (2015) methodological and theoretical framework to conceptualize and

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communicating SoTL, and a typology of writing genres for SoTL projects (Healey et al., 2020). These three guidelines are presented in Table 1, Figure 1, and Table 2.

Adapted from their earlier work (Streveler et al., 2007) and Hutchings and Shulman's (1999) work on the attributes of a scholarship of teaching, the Engineering Education Inquiry Framework (Borrego & Streveler, 2014) recognizes four types of inquiry about teaching and learning, as shown in Table 1.

Table 1: Engineering Education Inquiry Framework (Borrego & Streveler, 2014)

Type of inquiry	Attributes of that Type
Teaching	Teaching as taught.
Effective teaching	Involves the use of **accepted** teaching theories and practices.
Scholarly teaching	Good content and methods *and* classroom assessment and evidence gathering, **informed** by best practice and best knowledge, inviting of collaboration and review.
Scholarship of teaching and learning (SoTL)	Is **public** and open to critique and evaluation; is in a form that others can build on; involves question-asking, inquiry, and investigation, particularly about student learning.
Engineering education research	Also is **public**, open to critique, and involves asking questions about student learning, but it includes a few unique components. (1) Begins with **a *research* question** focusing on the "why" or "how" of learning. (2) Ties the question to learning, pedagogical, or social **theory** and interprets the results of the research in light of theory. This allows for the research to build theory and can increase the significance of the findings. (3) Pays careful attention to design of the study and the **methods** used. This will enable the study to hold up to scrutiny by a broad audience, again creating a potential for greater impact of results.

Note: Authors of this paper have bolded certain words, which suggest the importance of literature review, purposeful inquiry, use of theory, and methods to various types of inquiry into teaching practice. Italics are in the original text.

In their framework, Miller-Young and Yeo (2015) created a research space for SoTL projects by using various learning theories and research methodologies, and used eight examples in published papers to illustrate the theory-methodology intersections in SoTL studies. These example studies are

A. Effect of an office hour meeting and learning reflection
B. How students describe 3D forces
C. Who can afford critical consciousness?
D. Student connections with academic texts
E. Student choice in reading strategies
F. Cultivating intentionality and integration
G. Thinking through the body
H. Race, Whiteness and Canadian identity

Miller-Young and Yeo attempt to use these studies to demonstrate a range of research approaches to studying teaching practice by drawing upon quantitative and qualitative methods, various research paradigms (e.g., interpretivism and postmodernism), and a myriad of learning theories (e.g., behaviourism, cognitivism, social constructivism, and humanism) (Figure 1).

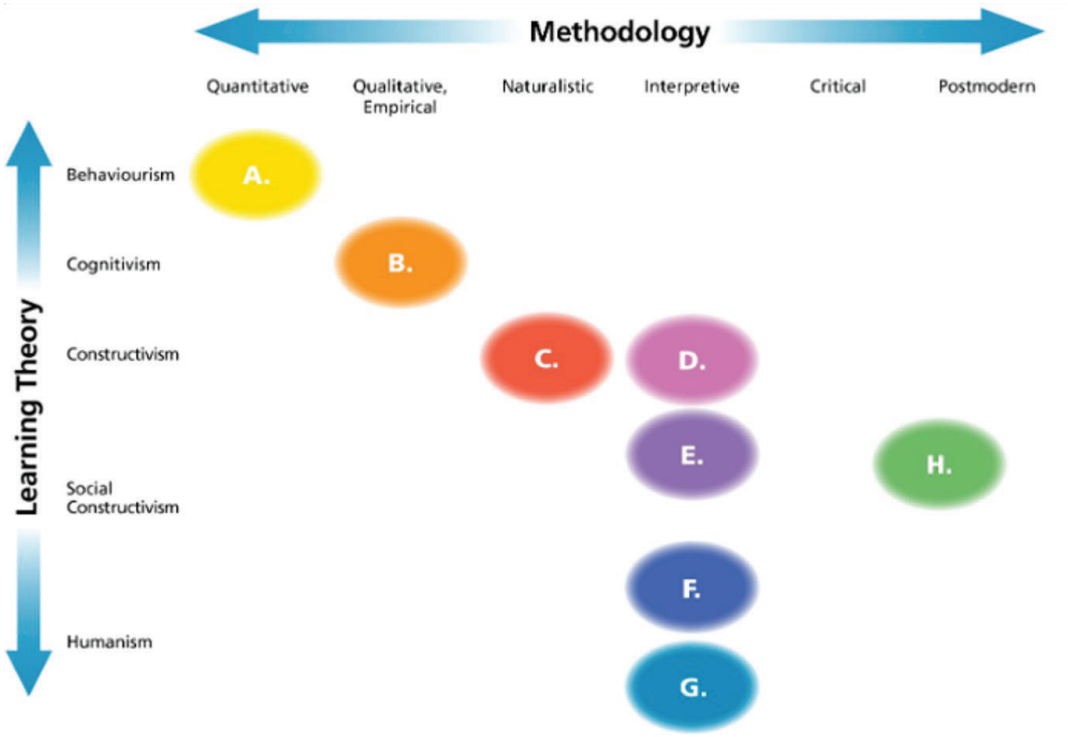


Figure 1. A methodological and theoretical framework to conceptualize and communicate SoTL (Miller-Young & Yeo, 2015)

In their book *Writing about Learning and Teaching in Higher Education*, Healey et al. (2020) called for extending the conventional writing genres about teaching and learning inquiries and presented 11 genres. Table 2 shows five genres that could be published in academic journals, conference proceedings, or books while leaving out the other genres (e.g., presentations, opinion pieces, stories, and social media) that would better fit other types of communication venues.

Table 2. Academic writing genres about teaching and learning inquiries (Healey et al., 2020)

Genres for academic writing	Characteristics
Empirical research articles	Typically include an introduction, a literature review, sections on methods, findings, discussion of implications and limitations, and a conclusion.
Case studies	Typically provide a "rich description" of a teaching and learning scenario in a particular context, and includes an introduction, discussion of the case study, and implications for other scholars.
Theoretical and conceptual articles	Typically draws selectively on relevant literature to "deepen, expand, or provoke thinking about a particular concept or practice," without involving empirical data.
Literature reviews	A stand-alone literature review that is typically organized around a guiding question and includes an introduction and sections on methods for the review, a synthesis of reviewed literature, and discussion.
Reflective Essays	Typically written in the first person to present insights rather than empirical findings. These essays could be published in an academic journal when being grounded in literature.

Note: Authors of this paper created this table by summarizing the text in the original work.

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Based on those three frameworks that were created to guide studies on teaching practice, we have summarized some strategies for SoTL projects in Table 3. These strategies serve two purposes: (a) providing insights on strategies for turning teaching practice to an academic paper; (b) offering a starting point for examining examples of published articles on teaching practice. Keeping these strategies in mind, we embarked on a review of a sample of articles on teaching practice that we identified from three journals on engineering education.

Table 3. Strategies for SoTL projects, as suggested by three existing guidelines

Guidelines	Strategies for SoTL projects
Engineering Education Inquiry Framework (Borrego & Streveler, 2014)	● Identify strategies for attaining the level of rigour that is desired by a SoTL project; ● Increase the level of rigour by using relevant literature, asking research questions about student learning, grounding the study in a theory; and subjecting methods to scrutiny and a critical examination by a broad audience where appropriate.
A methodological and theoretical framework to conceptualize and communicate SoTL (Miller-Young & Yeo, 2015)	● Get familiar with learning theories; ● Align research methodologies with learning theories used.
Academic writing genres about teaching and learning inquiries (Healey et al., 2020)	● Identify the purposes of inquiries about teaching and learning; ● Choose appropriate writing genres that fit the project.

Review Method

For the purpose of this paper, we selected a sample of recent papers on teaching practice for review and analysis. These papers were published in 2024 by three journals: *Advances in Engineering Education* (AEE), the *European Journal of Engineering Education* (EJEE), and the *International Journal of Engineering Education* (IJEE). These journals were selected because they all purposefully publish papers on teaching practice. For example, AEE's mission statement states "to disseminate significant, proven innovations in engineering education practice, including those that are enhanced through the creative use of multimedia" (n.d.). EJEE states that it "invites relevant contributions that combine *scholarliness* with *usefulness* for improving engineering education" (n.d.). IJEE publications do include papers on teaching practice although this is not explicitly stated. These three journals represent three geographic communities of researchers who engage in research on engineering education—the United States for AEE, Europe for EJEE, and a broader international community for IJEE.

In our review, by reading through the title and the abstract of each publication, we identified a total of 54 articles on teaching practice: 6 from AEE, 9 from EJEE, and 39 from IJEE. For each of the selected articles, we extracted the following information:

- Effective practice / intervention
- Purpose / research questions
- Theory / theoretical perspectives
- Research design / approach, including data source and analysis methods
- Key findings

These components of the articles were included in our review because we intend to present both the practice aspect (i.e., effective practice / intervention) and the research aspect (i.e., research purpose / questions, use of theory, research design); and key findings are included to report the impact of the effective practice. In our analysis, we marked down quantitative or/and qualitative methods, and annotated the research design using methodological

terminologies as per research design literature (Bell, 2010; Marsdena & Torgerson, 2012; Rosenthal & Rosnow, 1991; Salkind, 2010).

Results

In this section, we will first present our observations about the six AEE articles and the nine EJEE articles that studied teaching practice. Our summaries of the effective practice / intervention, research purpose or questions, any theoretical perspectives involved, research design or approach, and key findings in these 15 articles can be found in two tables in the appendix of the pre-print version of this paper (Liu, 2025). Regarding the results from our review of the IJEE articles, we cite those articles that provide additional characteristics associated with projects on teaching practice.

The following can be observed about the research designs in the six AEE and nine EJEE articles.

- 14 of these articles involved an educational intervention, with one exception (Bekar et al., 2024) that proposed a new instructional method.
- Of these articles, 11 used a *One-Group Posttest-Only Design*, in which data were collected from one student group who was exposed to an intervention and was subject to some kind of post-test that was administered after the intervention (e.g., Schauer et al., 2024 in AEE and Agrawal & Heydenrych, 2024 in EJEE). Two articles (Martin et al., 2024; Picho-Kiroga et al., 2024) employed a *One-Group Pretest-Posttest Design*, in which one student group was assessed before and after the intervention. One article (Melville et al., 2024) utilized the *One-Group Time-Series Design*, in which the same group of individuals were tested multiple times when they were exposed to the intervention (i.e., virtual labs in this study) at different points in time. One article (Brandimartea et al., 2024) used the *Alternative Treatment Postest-Only Design*, in which two comparison groups were exposed to two different interventions (i.e., different interdisciplinary activities interacting with circus students in this study) and then were assessed after the exposure. Note that neither authors of these articles specified their research design using those terminologies. However, these studies demonstrated the characteristics of those research designs, which Salkind (2010) call as "*pre-experimental designs*."
- Seven of these studies were quantitative using student survey and test data while five of them were qualitative, using interviews, responses to open-ended survey questions, or student reports data. Three studies (Bekar et al, 2024; Grigg & Verleger, 2024; O'Mahony et al., 2024) used both qualitative and quantitative methods. Note that these studies may not be "mixed methods" studies as defined in mixed methods research literature (see the distinction in Creamer, 2018) as they simply used quantitative and qualitative data for analysis without necessarily involving an integration.
- One study (Hammoda & Winkler (2024) indicated "case study" in the article as a writing genre, instead of a methodological approach in research design literature (Stake, 2006; Yin, 2009).
- Nine articles explicitly used theoretical perspectives to inform their studies, and three articles (Agrawal & Heydenrych, 2024; Dutra & Calvao, 2024; O'Mahony et al., 2024) included an in-depth literature review section to explain the key concepts for the studies, which also serve the purpose of providing solid conceptual foundations for the studies.

Thirty-nine of the 116 IJEE articles published in 2024 focused on teaching practice. We highlight the following distinctive types of articles within the IJEE publications as some of these are not as notable in the articles we reviewed in AEE or EJEE.

- Literature reviews, which were not captured in the EJEE or AEE samples. In the semi-systematic literature review paper published by IJEE (Teckmen-Araci, 2024), the authors identified 60 papers published or presented between 1995 and 2019 about various approaches to teaching creativity within engineering schools in different universities. The review showed progressively increased endeavours to foster creativity in engineering education over time.

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- Case studies, which were identified as a writing genre in six IJEE papers. For example, in one of them an investigation was conducted on the impact of a series of in-class group quizzes on students' class attendance and academic performance in a civil engineering course at a university in the United States, with the results showing that students' attendance improved and written survey responses revealed positive feedback (Jin & Daher, 2024). This kind of "case study" aligns with what Lauri Malmi et al. (2018) called "case reports" that describe an educational intervention (e.g., a new instructional or assessment method or a new learning resource or tool), in a specific educational setting, sometimes accompanied with an evaluation study. Another "case study" example was designing a closed-loop teaching model in the field of Internet of Things based on principles of outcomes-based education and the CDIO (conceive-design-implement-operate) framework, followed by a validation study that involved comparisons of the performance of an experimental group that was exposed to the new teaching method and that of a control group at a technical college in China (Li et al., 2024).
- Empirical studies that focused more on instructional or curriculum design than assessment. These papers may also be called "case reports" although their authors may not use this language to define the nature of their studies. What makes these articles distinctive is that they typically do not include an evaluation study. Here are two examples. In one example, the descriptions of 78 industry cases were analyzed via a thematic analysis to identify dominant trends that informed the design of an interactive digital tool to support instructors and students of two graduate-level engineering courses in ideation and solutions development activities (Kunratha et al., 2024). In another example, interviews with 38 elevator industry experts and open-ended survey data were analyzed using the grounded theory to elucidate the key elements and structure of a curriculum framework in Chinese vocational colleges (Tao et al., 2024). Neither of these studies involved any evaluation of the tool or framework designed. Interestingly, this type of study appears to often use qualitative data as evidence.
- Qualitative studies. Qualitative studies are worth additional attention because many engineering or STEM educators are often better versed in conducting studies that involved quantitative data and may hesitate to conduct a study that only used qualitative data. As shown above, qualitative data such as interviews and responses to open-ended survey questions were used to construct an instructional tool (Kunratha et al., 2024) or a curriculum framework (Tao et al., 2024). Interviews can also be the primary data source for evaluating an instructional intervention. For example, semi-structured interviews with 24 students who took a Mathematics' Foundations Applied Engineering course that integrated purposefully designed Computational Thinking sessions were thematically analyzed to illuminate the strengths of the approach and areas for improvement (Diaz et al., 2024).
- Studies using *a "quasi-experimental design*," which were not captured in the EJEE or AEE samples. Two IJEE papers employed this research design. One study (Galan-Diaz et al., 2024) assessed the impact of computer simulations on student learning in a civil engineering course, by involving two existing student groups as an experimental group and a control group over a period of 8 years through a pre-test, a post-test, and a survey in addition to the final examination data. The results showed that the experimental group consistently outperformed the control group in the final exam and reported a higher satisfaction level and better clarity about subject matters of the course. The other study (Sha et al., 2024) actually used *an experimental design* because students taking the same mechanics of materials course were randomly assigned to two classes, and compared in the final exam scores, psychological scales, and structured interviews after one class purposefully engaged in peer learning whereas the other class did not. The results showed that the experimental class did significantly better in the final examination, the deep approach to learning, critical thinking, teamwork, and relieving social avoidance.

Discussion and Conclusions

The purpose of this paper is to use published EER papers as examples to illustrate how the gaps between teaching practice and engineering education research can be bridged, or in other words, how to turn effective teaching practice into an engineering education research project for an academic paper. To address this, we reviewed a sample of 54 articles focusing on teaching practice that were published in 2024 by three journals on engineering education—AEE, EJEE and IJEE. Although we cannot claim that this sample is representative of all the studies that investigated teaching practice in engineering education settings, these papers, when examined as a whole, poignantly reveal three strategies for engineering educators:

- Utilizing various research designs for studying teaching practice.
- Applying various genres to academic writing on teaching practice.
- Embracing diversity and rigour in studies on teaching practice.

These strategies are not only well supported by the papers we reviewed but also align with those ones in Table 3 that are derived from the three frameworks guiding SoTL studies, thus demonstrating interpretative and theoretical validity in reference to Maxwell's (1992) typology.

Utilizing Various Research Designs

The articles we reviewed for the purpose of this paper offer examples for a range of research designs that are associated with various levels of rigour, namely, low, medium, and high, in general terms. This association can be illustrated in Table 5.

The pre-experimental designs have a low research rigor because these designs are subject to various threats to the internal validity, including history (i.e., the effects of "normal" education experience on the effected changes), maturation (i.e., learner may improve over time due to increasing maturity), and design issues for lack of an initial baseline for measuring changes (Marsdena & Torgerson, 2012). When changes are observed from pre- to post-tests and comparisons between two groups are made, the group differences can be ascribed to the intervention that one of the groups was exposed to. However, when no randomization strategy is used to create the two groups, the two-group design is quasi-experimental. Randomization helps strengthen the internal validity of an experiment and mitigate biases (Cox, 2009). As such, an experimental design affords a high level of rigour.

Table 5. Three levels of rigour in research designs for studying teaching practice

Rigour	Types of Design	Research Designs	Notations (R: randomization; X: intervention; O: Observation)
Low	Pre-experimental	One-Group Posttest-Only Design	One group: X ———— O
		One-Group Pretest-Posttest Design	One group: O_1 —— X —— O_2
		Posttest-Only Control-Group Design	Group 1 (Experimental): X ——— O Group 2 (Control): ——— O
		Alternative Treatment Posttest-Only Design	Group 1: X_1 ———— O Group 2: X_2 ———— O
Medium	Quasi-experimental	Pretest-Posttest Control-Group Design	Group 1 (Experimental): O_1 —— X —— O_2 Group 2 (Control): O_1 ————— O_2

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		One-Group Time-Series Design	One group: O_1 — X —O_2 — X —O_3
High	Experimental	Pretest-Posttest Control-Group Design, with randomization for group creation	Group A (Experimental): R —— O_1 —— X —— O_2 Group B (Control): R —— O_1 ———— O_2

Although an experimental design is like a "holy grail", very often it is not feasible to implement. An ethical challenge is that an instructor cannot randomly split their students into two groups, while asking one group to be exposed to a conceptually more effective pedagogical approach than what the other group would be taught. This may explain why most of the studies we reviewed employed one-group designs. It is worth noting that the One-Group Time-Series Design appears to be ethically feasible while promising reasonable methodological rigor. In this design, the instructor starts with a pre-test for obtaining the "baseline," and then intentionally expose the whole class of students to an intervention once, or more than once, while assessing the students multiple times through learning assessment methods to evaluate the effectiveness of the intervention. The study conducted by Brandimartea et al. (2024) offers a good example for this design. In addition, to strengthen the rigour of a study, theories will help strength the research design when an experimental study is not a feasible option (Gibson et al., 2002). For this reason, engineering instructors should include theoretical perspectives to inform and complement the design of their studies on teaching practice.

Further, engineering educators should not be hesitant to use qualitative methods alone in their studies. Qualitative methods such as interviews, focus groups, observations, and student reports offer rich insights about students' experiences and perceptions. Students' own words provide powerful evidence for the impacts of the instructional innovation introduced to the class, as shown in several examples we reviewed (Diaz et al., 2024; Kunratha et al., 2024; Tao et al., 2024).

Applying Various Writing Genres

As shown earlier in Table 2, Healey et al.'s (2020) writing guide offers five academic writing genres for preparing manuscripts on teaching practice. The articles reviewed for this paper provide examples for three of those writing genres: empirical research articles, case studies, and literature reviews. Beyond these three, there are theoretical and conceptual articles and reflective essays. An example for "theoretical and conceptual articles" (not encountered in our review in this paper) is a conceptual paper that addresses the question "Is artificial intelligence really the new big thing that will revolutionise learning and teaching in higher education?" (O'Dea & O'Dea, 2023).

While most of the studies on teaching practice have focused on presenting the effective or innovative pedagogical methods used in courses, as found in this review paper, a small number of papers published by IJEE also showcase another aspect of teaching practice—curriculum or instructional design. Specifically, examples we reviewed include the creation of a curriculum framework (Tao et al., 2024) and the design of a learning tool (Kunratha et al., 2024) or a novel course design method (Bekar et al., 2024). This distinctive focus provides another way to diversify academic writing about teaching practice.

In addition, the diversity of genres in writing about teaching practice is also reflected in the versatility in the formats in which papers are written in the field of SoTL. For example, the *Journal of Scholarship of Teaching and Learning* (JoSoTL) accepts three types of submissions: articles ("data-driven formal research projects with appropriate analysis, formal hypotheses and their testing, etc."), case studies ("focuses on an intense analysis of a specific teaching situation or problem that led to a solution"), and reflective essays ("essays that are philosophical in nature and challenge current practice, encourage experimentation, or draw

novel conclusions."). An example of a "reflective essay" is one that offered an alternative layout of rubrics from concept development and design thinking perspectives (Furman, 2024). Similarly, the *International Journal of Teaching and Learning in Higher Education* accepts three types of submissions: (a) "research articles;" (b) "instructional articles", which are shorter than "research articles" but resemble what JoSoTL calls "case studies"; and (c) "review articles."

It is noteworthy that the writing genres may be associated with stages of a project on teaching practice. For example, a stand-alone literature review can be prepared at the early stage of a project. A "case study" paper can be written for a project that is completed. A reflective essay can be crafted to demonstrate critical reflections on existing teaching practice.

Embracing Diversity and Rigour

The third strategy—embracing diversity and rigour—is related to, and extends beyond, the first two strategies. It is a mindset that is appreciative of both diversity and rigour in the academic work for transferring practice to research. The range of research designs and writing genres that could apply to papers on teaching practice in engineering has opened up a myriad of possibilities for engineering educators who aim to write about their teaching practice. This diversity does not mean that papers on teaching practice are like a "melting pot" and can be "wishy-washy" or less rigorous than engineering education research on other topics. Rigour and quality can, and should, be maintained by grounding the study in relevant literature and theory, and choosing a research design that is subject to scrutiny within the engineering education communities. With this mindset to recognize both diversity and rigour, engineering educators are better prepared to contribute to the evolving field of scholarship of teaching and learning in engineering education.

In closing, this paper identifies intellectual gaps and ways to bridge the gaps for engineering instructors who aspire to turn their purposeful teaching practice into publishable academic papers. Here are some concrete actions that they could take:

- Develop understandings about various research designs and their association with levels of rigour (gap), and choose to use a research design that is ethically feasible to the teaching context (solution).
- Develop understandings about various genres for writing about teaching practice (gap), and use genres that fit in with the stages of a project (solution).
- Beware that diversity and rigour are not necessarily in tension (gap), and appreciate both diversity and rigour in one's own work and in others' work (solution).

Finally, it is highly important for engineering instructors to familiarize themselves with literature on pedagogy. This is not only because using literature to inform practice is another critical component of scholarship of teaching and learning but also because learning theories play a significant role in enhancing the research design and rigour in projects on teaching practice. Therefore, for those instructors who are interested in conducting research on teaching practice in their engineering classrooms, start the journey with searching and reading literature relevant to their own teaching.

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References

Advances of Engineering Education [AEE]. (n.d.). *Missions & Purpose*. Advances of Engineering Education. https://advances.asee.org/mission-vision/

*Agrawal, A., & Heydenrych, H. (2024). An epistemic shift: exploring students' learning experiences with a decolonisation initiative in an engineering course. *European Journal of Engineering Education, 49*(4), 700-715. https://doi.org/10.1080/03043797.2024.2303023

Bell, B. A. (2010). Pretest-posttest design. *SAGE Encyclopedia of Research Design*. SAGE. https://methods.sagepub.com/ency/edvol/encyc-of-research-design/chpt/pretest-posttest-design

*Bekar, E. T., Skoogh, A., Bokrantz, J. (2024). Involving students in engineering course design: A combined approach based on constructive alignment and multi-criteria decision-making. *European Journal of Engineering Education, 49*(4), 647-666. https://doi.org/10.1080/03043797.2023.2279055

Bishop-Clark, C., & Dietz-Uhler, B. (2012). *Engaging in the scholarship of teaching and learning: A guide to the process, and how to develop a project from start to finish*. Stylus Publishing, LLC. https://doi.org/10.4324/9781003444497

Borrego, M. (2007). Conceptual difficulties experienced by engineering faculty becoming engineering education researchers. *Journal of Engineering Education, 96*(2), 91–102. https://doi.org/10.1002/j.2168-9830.2007.tb00920.x

Borrego, M., & Streveler, R. A. (2014). Preparing Engineering Educators for Engineering Education Research. In A Johri & B. M. Olds (eds.), *Cambridge Handbook of Engineering Education Research* (pp. 457-473). Cambridge University Press. https://doi.org/10.1017/CBO9781139013451

*Brandimarte, L., Funkb, A., Richterb, B. (2024). Mixing fluid mechanics with circus: how the performing arts can enhance learning in an undergraduate engineering course. *European Journal of Engineering Education, 49*(5), 889–910. https://doi.org/10.1080/03043797.2024.2329949

Cox, D. R. (2009). Randomization in the design of experiments. *International Statistical Review, 77*(3), 415-429. https://doi.org/10.1111/j.1751-5823.2009.00084.x

Creamer, E. G. (2018). Striving for methodological integrity in mixed methods research: The difference between mixed methods and mixed-up methods. *Journal of Engineering Education, 107*(4), 526-530. https://doi.org/10.1002/jee.20240

*Diaz, J. L., Ontiveros, Y. O., Gonzalez, J. R. (2024). Application of computational thinking for teaching and learning of undergraduate engineering numerical calculus. *International Journal of Engineering Education, 40*(2), 410–422.

*Dutra, J. C., & Calvão, P. S. (2024). Transmedia storytelling in materials selection design: an interdisciplinary experience with undergraduate engineering students. *European Journal of Engineering Education, 49*(4), 716–733. doi:10.1080/03043797.2024.2311166

European Journal of Engineering Education [EJEE]. (n.d.). *About this journal*. European Journal of Engineering Education. https://www.tandfonline.com/journals/ceee20/about-this-journal#aims-and-scope

Furman, W. (2024). Rubric design: A designer's perspective. *Journal of the Scholarship of Teaching and Learning, 24*(4). https://doi.org/10.14434/josotl.v24i4.35789

Galán-Díaz, J. J., Garrido, S. F., García-Diez, A. I., Grana-Lopez, M. A., Filgueira-Vizoso, A., & Castro-Santos, L. (2024). Assessment of engineering undergraduates active learning experience using Computer simulations. International Journal of Engineering Education, 40*(2), 358-367.

Gibson, J. L., Caldeira, G. A., & Spence, L. K. (2002). The role of theory in experimental design: Experiments without randomization. *Political Analysis, 10*(4), 362-375.

Grant, K. A. (2018). Educational research and SoTL: converging in the commons. In N. L. Chick (ed.) *SoTL in action: Illuminating critical moments of practice*. Sterling, Virginia: Stylus Publishing. https://doi.org/10.4324/9781003447047

*Grigg, S., & Verleger, M. (2024). How iLEARN modular scaffolding supports student outcomes and accessibility in a first-year graphical communication course. *Advances in Engineering Education, 12*(4), 42-57.

*Hammoda, B., & Winkler, C. (2024). Active methods in entrepreneurship education: A case study with engineering students. *European Journal of Engineering Education, 49*(6). 1203–1226. https://doi.org/10.1080/03043797.2024.2384893

Healey, M., Matthews, K. E., & Cook-Sather, A. (2020). *Writing about Learning and Teaching in Higher Education: Creating and Contributing to Scholarly Conversations across a Range of Genres*. Elon, NC: Elon University Center for Engaged Learning. https://doi.org/10.36284/celelon.oa3

Hutchings, P., & Shulman, L. S. (1999). The scholarship of teaching: New elaborations, new developments. *Change*, *31*(5), 10–15. https://doi.org/10.1080/00091389909604218

*Jin, C., & Daher, T. (2024). Group Quizzing to Improve Attendance and Performance in a Civil Engineering Classroom – A Case Study. *International Journal of Engineering Education, 40*(1), 144–153.
*Kunratha, K., Leka, S., Vestergaard, L. S., Presser, M., & Ramanujan, D. (2024). A digital tool for scaffolding innovation learning in engineering education with local industry needs. *International Journal of Engineering Education, 40*(4), 801–814.
Lauri Malmi *et al.* (2018). How authors did it – A methodological analysis of recent engineering education research papers in the European Journal of Engineering Education. *European Journal of Engineering Education, 43*(2), 171-189. https://doi.org/10.1080/03043797.2016.1202905
*Li, J., Wu, X., Zhang, X., Nie, Q., Yang, M., Li, Q., Zhao, H., Ren, J., & Chen, R. (2024). An OBE-CDIO closed-loop teaching model to advance the quality of instruction in an Internet of Things program. *International Journal of Engineering Education, 40*(4), 788–800.
Liu, Q. (2019). A snapshot of methodological review of journal articles in engineering education research. *Proceedings of the Canadian Engineering Education Association conference*, Ottawa, ON. https://doi.org/10.24908/pceea.vi0.13795
Liu, Q. (2025). *From effective teaching practice to engineering education research: Where are the gaps, and how can the gaps be bridged?* Pre-print.for the Proceedings of the Conference of Research in Engineering Education Symposium, Regional Conference in Engineering Education & Research in Higher Education. Johor, Malaysia. University of Toronto TSpace. https://hdl.handle.net/1807/149281
Marsden, E., & Torgerson, C. J. (2012). Single group, pre- and post-test research designs: Some methodological concerns. *Oxford Review of Education, 38*(5), 583-616. https://doi.org/10.1080/03054985.2012.731208
*Martin, K. M., Elmer, A. H., Devera, L. P., Busato, J., Landon, P., Guzzetti, D., & Miskoglu, E. E. (2024). Massive Open Online Courses as a tool for developing high-level engineering expertise. *Advances in Engineering Education, 12*(2), 53-81.
Matusuvich, H. & Benson, L. (2022). Roles of *Advances in Engineering Education* and *Journal of Engineering Education* for the engineering education community. *Journal of Engineering Education, 111,* 5-8. https://doi.org/10.1002/jee.20446
Maxwell, J.A. (1992). Understanding and validity in qualitative research. *Harvard Educational Review, 62*, 279–300. https://doi/10.17763/haer.62.3.8323320856251826
*Melville, M. C., & Hershock, C., & Reeja-Jayan, B. (2024). Virtual engineering in Minecraft: Helping students visualize and manipulate the properties of materials. *Advances in Engineering Education, 12*(2). https://doi.org/10.18260/3-1-1153-36059
Miller-Young, J., & Yeo, M. (2015). Conceptualizing and communicating SoTL: A framework for the field. *Teaching & Learning Inquiry, 3*(2), 37-53. https://doi.org/10.20343/teachlearninqu.3.2.37
O'Dea, X. & O'Dea, M. (2023). Is artificial intelligence really the next big thing in learning and teaching in higher education? A conceptual paper. *Journal of University Teaching and Learning Practice, 20*(5), 1-17. https://doi.org/10.53761/1.20.5.06
*O'Mahonya, M., Hill, M., Onet, R., Neagb, M., de la Torre Cubillo, L., & Zhoud, D. (2024). The impact of take-home laboratories on student perceptions of conceptual and professional learning in electronic engineering across four European universities. *European Journal of Engineering Education, 49*(6), 1376–1396. https://doi.org/10.1080/03043797.2024.2407480
*Picho-Kiroga, K., Serrano, M. V., Bourne, N., & Hall, J., (2024). Improving judgements of performance among Black engineering students highly susceptible to stereotype threat: An intervention. *Advances in Engineering Education, 12*(4), 14-41.
Rosenthal, R., & Rosnow, R. L. (1991). *Essentials of behavioral research: Methods and data analysis*. McGraw-Hill.
Salkind, N. J. (2010). Pre-experimental designs. *SAGE Encyclopedia of Research Design*. SAGE. https://doi.org/10.4135/9781412961288.n330
*Schauer, S., Pakala, K., & Bairaktarova, D. (2024). Virtual "happy" office hours: The student experience. *Advances in Engineering Education, 12*(1), 3-24.
*Sha, B., Guo, X., & Zhong, Q. (2024). Impact of peer learning on students academic achievement and personal attributes. *International Journal of Engineering Education, 40*(2), 400-409.
Shuman, L., Besterfield-Sacre, M., & Litzingerb, T. (2013). AEE and JEE: Where are the boundaries? Should there be boundaries? Do we need boundaries? *Journal of Engineering Education, 102*(2), 224–226. https://doi.org/10.1002/jee.20008
Stake, R. E. (2006). *Multiple case study analysis*. Guildford Press.

https://doi.org/10.52202/086293-0011

Streveler, R. A., Borrego, M., & Smith, K. A. (2007). Moving from the 'scholarship of teaching and learning' to 'educational research': An example from engineering. In D. R. Robertson (Ed.), *To Improve the Academy* (Vol. 25, pp.139-149). Bolton, MA: Anker.

*Tao, L., Ruannakarn, P., Cheng, H., Luo, F., Feng, X., & Ma, Z. (2024). Reconstruction of a curriculum framework in vocational colleges for comprehensive competence development. *International Journal of Engineering Education, 40*(3), 656–668.

*Tekmen-Araci, Y. (2024). Teaching creativity in engineering schools: A review of the literature. *International Journal of Engineering Education,* 49(1), 126–143.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Sage.

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