

Experiential Learning in Engineering Education: A Book Review

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Abstract

"Experiential Learning in Engineering Education" by Alan L. Steele offers an in-depth exploration of experiential learning (EL) within engineering education, uniquely enriched by global research, case studies, and the author's extensive experience and theoretical grounding. Steele's work stands out for its comprehensive coverage of EL applications, addressing the evolving landscape of post-pandemic education and emphasizing the expansive nature of EL. The book is invaluable for faculties, educators, and researchers, providing practical strategies, insights, and a solid theoretical foundation. Its eleven chapters are grounded in educational theories like Kolb's Cycle and reflective practice, and are enriched by Steele's extensive experience in education and practical application. The book particularly stands out for its incorporation of evident-based EL strategies, including innovative laboratory methods, flipped classrooms and best practices from cross-disciplines. However, it could benefit from a more balanced chapter depth, a broader narrative perspective, clearer guidance on student reflection, and addressing the implications of AI tools in assessments. Future editions should aim for a more equitable exploration across chapters, inclusion of diverse stakeholder perspectives, and enhanced visual content. By addressing these areas, the book has the potential to solidify its position as a pivotal resource in engineering education, shaping future generations of engineering educators.

Keywords: Experiential learning, engineering education, situated learning, reflection, education post-COVID

Introduction

Experiential learning (EL) has established itself as a crucial component in engineering education, recognized for its significant contributions to enhancing students' critical thinking, problem-solving abilities, and practical skills over an extended period (Hernández-de-Menéndez et al., 2019).

Alan L. Steele's 'Experiential Learning in Engineering Education' published in 2023 breaks new ground, extending the traditional boundaries of EL in engineering education, and offering a diverse array of strategies for integrating EL into undergraduate programs. Steele challenges engineering faculties to broaden their pedagogical horizons and adopt innovative teaching practices.

Steele's work serves as both a practical guide and a catalyst for change in engineering education including the adaptation to the evolving landscape of education post-COVID-19 pandemic which other books on EL do not offer. He seamlessly integrates 'learning by doing' and 'reflecting on work' into the book's

narrative, emphasizing the development of deep technical knowledge, essential soft skills, and the cultivation of the right attitudes through genuine and engaging EL activities.

The book comprises of 11 chapters, each offering in-depth insights into integrating EL within the engineering curriculum. The following section presents summaries of these chapters, providing a comprehensive overview.

This review aims to present a balanced evaluation of Steele's work, acknowledging its considerable contributions to the field of EL in engineering education while identifying areas for potential further development. The goal is to provide readers with an in-depth and sophisticated perspective on the book's merits and its potential to influence the field of engineering education.

Chapter Summaries

This book consists of 11 chapters where each chapter is further dissected into subchapters. The summary of each chapter is as follows:

Table 1. Summary of Chapter

Chapter	Summary
Chapter 1: Introduction	The chapter sets the context for EL within engineering education by defining EL, builds reader interest by highlighting the growing trend of EL and its relevance, and establishing continuity by providing teaser of the book features, chapter-by-chapter.
Chapter 2: Education Theory and Experiential Learning	This chapter primarily explores the connection between educational theories and frameworks that underpin EL. This established theoretical foundation sets the stage for in-depth discussions in each of the subsequent chapters.
Chapter 3: Laboratories	The chapter leads readers to understand the vital role of laboratory work in education, offering a critical comparison between structured 'cookbook' labs and more exploratory 'open' labs. It emphasizes the importance of designing learning spaces that foster creativity and innovation, and it covers the shift toward online learning, a transition accelerated by the post-COVID-19 era.
Chapter 4: In-class Experiential Learning	The chapter critiques traditional lecture-based in-class learning while introducing innovative in-class EL methods, such as flipped classrooms and peer instruction. Additionally, it underscores the role of technology and classroom design in supporting these approaches.
Chapter 5: Problem-Based Learning, CDIO and Project-Based Learning	From theoretical to practical perspectives, this chapter offers a broad implementation overview of popular EL approaches in engineering education, specifically problem-based learning (PBL), Conceiving-Designing-Implementing-Operating (CDIO), project-based learning (PjBL), and challenge-based learning (CBL).
Chapter 6: Projects	This chapter goes deeper into the crucial role of PjBL in engineering education, exploring a variety of project formats including capstone and design courses, and highlighting their unique impacts on student learning. It offers insights into implementation strategies, features the distinctive learning experiences

	that projects provide, and discusses advanced approaches to assessment.
Chapter 7: Cooperative Education	The chapter provides an in-depth exploration of cooperative education in engineering, revealing its integral role in EL and highlighting the reciprocal gains for both students and employers. Additionally, it vividly illustrates students' learning experiences during co-op placements through the lens of the situated learning framework.
Chapter 8: Beyond the Curriculum. Undergraduate Research and Student Societies	This chapter explores EL beyond the formal curriculum in engineering, emphasizing the vital role of faculty advisors in guiding students through research, societies, and competitions. It highlights the benefits of engagement, including enhanced technical skills, leadership, and practical experience, while addressing the challenges and need for adequate support.
Chapter 9: Lesson from Other Professional Programs	The chapter explores EL practices in medicine, business, and social work, showcasing unique approaches like role-reversal, performance-based assessments, and immersive simulations. It suggests these innovative strategies could enrich EL in engineering education, advocating for a collaborative exchange of educational strategies to benefit students in all professional fields.
Chapter 10: Engineering and Society	This chapter addresses the intersection of engineering and society, emphasizing the importance of integrating societal challenges related to diversity, indigenous contributions, and ethics into EL. It underscores the necessity of embedding these themes within EL activities, aiming to cultivate a generation of engineers who are not only technically proficient but also socially conscious and ethically grounded.
Chapter 11: Final Pieces and Conclusion	This final chapter synthesizes various aspects of EL in engineering education, zooming at key topics like assessment, accreditation, and learning models. It emphasizes the need for continuous adaptation and innovation in EL practices, notably considering recent global encounters like the COVID-19 pandemic. The chapter also underlines the

	importance of faculty support and resource allocation in fostering EL, and it envisions a future where EL is more integrated, interdisciplinary, and aligned with societal needs and ethical standards.
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Strengths and Highlights of the Book

'Experiential Learning in Engineering Education' by Alan L. Steele offers a range of unique strengths from which readers stand to gain significantly. Below are the primary highlights, among others:

Author's Background and Expertise

The author's diverse experiences, encompassing roles as an administrator, curricular designer, educator, supervisor, and former engineering student, brings a wealth of experience and expertise to the table, not just in theory but also in practical application, ensuring that the content is enriched with personal anecdotes and insights, making the book relatable and consumable to readers from various backgrounds. For instance, on pages 218-219, the author shares his personal invaluable best practices for supervising student group projects, highlighting the importance of evaluation rubrics. This section not only demonstrates the author's commitment to effective teaching and assessment in EL but also provides educator readers with practical strategies for immediate application.

Solid Theoretical Foundation

Chapter 2 stands out as the book's core, thoroughly discussing and linking educational theories to EL. The author provides a robust theoretical foundation, incorporating established frameworks like Kolb's (1984) Cycle, situated learning (Lave & Wenger, 1991), and Schön's (1983) Reflective Practice, ensuring academic soundness and practical relevance. This positions Steele's work as a valuable guide and catalyst for innovation in engineering education. Particularly noteworthy is Subchapter 2.7, which introduces varied student learning approaches, highlighting the need for adaptable group work guidelines. Additionally, Chapter 2 serves as an invaluable asset for researchers in engineering education, showcasing exemplary synthesis of theories, and setting a high standard for academic rigor and comprehensive analysis.

Evidence-Based Practical Strategies

The book stands out for its provision of Evidence-Based Practical Strategies, masterfully integrating theory with actionable advice for implementing EL. Drawing upon a wealth of experience, extensive reference, and worldwide universities visits, the author offers a pragmatic approach. A standout section

is Subchapter 4.3 on Flipped Classrooms, where the author highlights, "The previously mentioned paper by Furse and Ziegenfuss (2020), can be a good starting point for anyone wanting to move a class to a flipped approach. There are practical details and advice given, including move over to a flipped approach in stages. One example they suggest works around splitting a term into three parts and starting in the first term with active learning approaches in class. In the second term video examples could be provided and in the final third video lectures can be provided". This citation underscores a strategic method for transitioning from traditional to flipped classrooms, emphasizing a gradual shift to foster effective learning environments in an engineering context.

Post Pandemic Insights

According to Badiru (2020), the challenges posed by the COVID-19 pandemic have demanded fresh, innovative approaches and creative solutions in the field of engineering education. Steele responds to this urgent need in his book, weaving this critical theme throughout his narrative. Particularly in Chapter 3, "Laboratories", Steele examines the emerging opportunities post-pandemic, discussing a variety of laboratory formats including remote, virtual, recorded, and simulation-based labs. He meticulously evaluates their pros and cons, offering tangible deliveries for their integration into EL. Beyond this chapter, Steele consistently highlights the role of technology in adapting to the post-pandemic era, emphasizing the utilization of online video meeting and conferencing (Chapter 6 and 7), digital access to course materials (Chapter 4 & 5), and online file sharing facilities (Chapter 11).

Comprehensive Coverage

The book offers an extensive examination of EL in engineering education, covering a wide array of topics and incorporating diverse case studies from both engineering and non-engineering disciplines. This ensures its relevance and applicability across various contexts, making it a valuable resource for numerous stakeholders. Faculty members dealing with the resource demands of EL, course designers working to integrate EL principles, educators looking for practical implementation tips, researchers exploring theoretical foundations, and students aiming to understand their educational journey will all find this book beneficial. Industry professionals can also gain insights into the advantages of EL for workforce development. Chapter 10 stands out as it covers the societal aspects of engineering, challenging the typical technical perspective and offering valuable considerations for minority groups, indigenous communities, and ethical philosophers.

Opportunities for Enhancement

While 'Experiential Learning in Engineering Education' by Alan L. Steele presents numerous strengths, there are areas that could benefit from improvement. The following sections outline key areas that could be improved upon:

Inconsistent Depth Across Chapters

While the book offers a rich overview of EL in engineering education, there is a noticeable disparity in the depth of coverage across different chapters. Some sections provide extensive, in-depth discussions, while others only skim the surface of the topic at hand. The author occasionally directs readers to external resources for further reading, which, while helpful, highlights the uneven distribution of content within the book itself. This inconsistency might leave readers seeking a more balanced and uniformly detailed exploration of EL. This contrast is noticeable when comparing the detailed exploration of laboratories in Chapter 3 to the succinct overview of PBL, CDIO, and PjBL, which are all swiftly addressed within Chapter 5, which might hinder a full appreciation of these approaches.

Narrative Bias Towards Educators

The book aims to cater to a diverse audience, but the narrative predominantly favours educators, focusing extensively on the implementation of EL and the challenges educators might face. While other stakeholders are mentioned, their needs and perspectives are not explored in as much detail. This bias could potentially limit the book's appeal and utility for a broader audience, such as students, industry professionals, and others who might be interested in EL from different viewpoints. Addressing these areas would not only enhance the book's comprehensiveness but also its applicability across various audiences.

Insufficient Guidance on Student Reflection

Reflective practice is highlighted as a crucial element in EL, and while the book acknowledges the challenges associated with encouraging students to reflect deeply, it falls short of providing concrete strategies, such as in the work of Veine et al. (2020), to address these issues. Additionally, it lacks the inclusion of student perspectives, which are crucial for a holistic understanding of the reflection process in EL. The scattered mentions of incorporating reflection into EL assessments and activities throughout the book do not coalesce into a clear, actionable framework for educators. Given the importance of reflection in EL, a more focused and detailed discussion on this topic would have strengthened the book.

Potential Treat of Artificial Intelligence (AI)

While the book explores the role of technology in EL, especially in light of the COVID-19 pandemic, it does not adequately address the implications of the Fourth Industrial Revolution (4IR) in Engineering Education, such as additive manufacturing, 3D printing and particularly the rising use of AI tools such as ChatGPT. There is a looming threat of students potentially misusing AI tools in EL assessments, especially in written reflections, which poses a significant challenge for educators (Rahman & Watanobe, 2023). The book could have seized the opportunity to discuss these issues and offer strategies to ensure assessment integrity and effectiveness, but this aspect remains unexplored.

Technical Errors and Need for More Visuals

The presence of technical errors, as described in Table 2, and the need for more visual content in the book, while minor, should not be overlooked. These issues could pose challenges, particularly for non-native English speakers (Brooks et al., 2021), and might detract from the overall learning experience. A more rigorous proofreading process for future editions is recommended to eliminate these errors. Additionally, incorporating a greater variety of visual aids such as infographics, diagrams, and charts could significantly enhance the book's accessibility and appeal, especially for visual learners. This is crucial in today's educational landscape, where learners are increasingly drawn to visual content (Guo et al, 2020). By addressing these aspects, the book could maintain its relevance and competitiveness amidst a plethora of multimedia educational resources.

Table 2. Example of Technical Errors

Technical Error	Page
Original: "The also found that the impact was equally beneficial across genders." Correction: "They also found that the impact was equally beneficial across genders."	142
Original: "This second set of objectives can can be seen to be including..." Correction: "This second set of objectives can be seen to be including..."	188

Conclusion and Recommendations

In conclusion, "Experiential Learning in Engineering Education" by Alan L. Steele stands as a seminal guide, rich in insights for weaving EL into engineering education. Steele's extensive experience and robust theoretical foundation render this book

invaluable, particularly for faculties, educators, and researchers.

The book shines in its broad coverage, practical strategies, and insights into the evolving post-pandemic educational landscape, underscoring the critical role of learning by doing and reflection. The author's intention to highlight EL's versatility is evident, as he states, "If you read through this book and reached this point, I expect that you realize that experiential learning goes beyond running the labs that have run for the past few decades and liaising with the university's co-op office for getting students into relevant work placements."

Nevertheless, the book could be enhanced by addressing the inconsistency in chapter depth and the narrative's educator-centric focus, alongside providing clearer guidance on student reflection. The emerging threat of artificial intelligence tools in assessments also necessitates attention.

Future editions would benefit from a more balanced exploration across chapters, inclusion of diverse stakeholder perspectives, concrete strategies for student reflection, and strategies to address the implications of AI in assessments. Addressing these areas, alongside eliminating technical errors and enriching visual content, would solidify the book's standing as a pivotal resource in shaping future engineering education and nurturing well-rounded engineers.

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