Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #45827

Advancing Engineering Economics Instruction Through Open Educational Resources: Implementation, Instructor Feedback, and Student Outcomes

Dr. Tamara R Etmannski, University of British Columbia, Vancouver

Dr. Tamara Etmannski is an Assistant Professor of Teaching in the Department of Civil Engineering at the University of British Columbia (UBC), Canada. She is also the Co-director of the Environmental Engineering program. Her role centers on curriculum development and teaching, with a focus on topics related to engineering impacts, including sustainability, leadership, economics, and entrepreneurship. Her pedagogical expertise emphasizes high-impact educational practices, such as active and experiential learning, with a particular emphasis on applying knowledge to real-world challenges.

Mohosina Jabin Toma, University of British Columbia, Vancouver
Johan Foster, University of British Columbia, Vancouver

Advancing Engineering Economics Instruction Through Open Educational Resources: Implementation, Instructor Feedback, and Student Outcomes

Tamara R. Etmannski, Mohosina Jabin Toma & E. Johan Foster

Abstract

This paper builds upon prior research presented at the previous conference, offering a comprehensive account of the ongoing development of Open Educational Resources (OER) in the field of engineering economics. OER offers a scalable solution to affordability and accessibility challenges in higher education. This paper presents a case study of the implementation and evaluation of newly developed OER in undergraduate Engineering Economics courses at the University of British Columbia (UBC) [1]. By replacing commercial textbooks with comprehensive open-source instructional materials, this study explores instructor adoption, pedagogical effectiveness, and student performance outcomes. Results indicate that OER led to approximately $30,000 in textbook cost savings, while leading to comparable midterm averages across departments. Survey responses from instructors, qualitative feedback, and comparative analysis of student assessment data across three departments are presented. Results indicate that the OER were well-received by instructors and students alike, provided substantial cost savings, and performed comparably to commercial materials in supporting learning outcomes. This work contributes to the growing body of evidence that OER can serve as a viable and pedagogically sound alternative in technical disciplines.

1. Introduction

Engineering students are required to complete an Engineering Economics course as part of program accreditation requirements across the United States and Canada [2][3]. Traditionally taught using commercial textbooks, these courses often present affordability challenges to students, especially considering the relatively static nature of the content. In response, educators are increasingly exploring OER as a viable alternative to improve access and learning equity. Despite growing awareness of OER, their adoption in engineering remains limited. This paper presents the design, implementation, and evaluation of an open-source instructional package developed to support Engineering Economics instruction at UBC. The project aimed to increase accessibility, enhance student engagement, and reduce instructional inconsistencies across departments. The study builds on prior pilot work and aimed to evaluate both the instructional efficacy and institutional viability of the OER materials by looking at how instructors perceive use of OER in Engineering Economics and how the learning outcomes compare to courses using traditional textbooks.

2. Background

Textbooks in Engineering Economics are often priced between $59 and $150 USD, creating barriers for students and prompting the use of informal resources. Research has shown that textbook costs negatively impact student success, with some students opting not to purchase required texts [4][5]. Within engineering disciplines, where consistency in notation and concept

scaffolding is crucial, reliance on fragmented resources can impede learning. OER are free, openly licensed materials designed to be reused, adapted, and shared. Studies have demonstrated that OER can support student learning outcomes equivalent to those achieved with commercial textbooks [4]. In STEM education, OER adoption has been linked to improved accessibility and student satisfaction [6][7]. However, challenges include faculty reluctance due to concerns about quality, time investment, and lack of support [8]. Within engineering education, there is limited but growing interest in OER. A 2019 survey conducted by Allen & Seaman found that only 13% of engineering faculty had adopted OER, compared to 25% across all disciplines [8]. Barriers specific to engineering include the perceived complexity of developing OER for quantitative subjects, lack of alignment with accreditation standards, and concerns over the absence of publisher-provided supplemental materials (test banks and slides).

In 2023-4, a unified set of OER materials was developed at UBC to address the specific needs of Engineering Economics instruction [1][9]. These materials aim to provide clarity, consistency, and accessibility, and were piloted across multiple departments during the Winter 2025 term. This study explores the multi-dimensional impact of that implementation.

3. Methodology

3.1 Institutional Context & Instructor Survey

The University of British Columbia (UBC) is located in Vancouver, BC, Canada and has seven engineering departments, each offering its own Engineering Economics course. Across the seven courses, approximately 800-1,000 students are taught Engineering Economics annually. Instructors vary in experience and teaching approaches, ranging from reliance on publisher-provided materials to custom-compiled resources. The current instructors of those courses participated in a short survey about what kinds of materials they use in their courses, where do they source their materials, and any comments or thoughts about engineering economics textbooks or OER more generally. Out of the seven instructors who currently teach this course at UBC, the author of this paper is one and did not compete the survey, and neither did the instructor who is utilizing the OER materials in their course this year (see section 3.2). The author has taught this course a number of times spanning a decade, has tried using textbooks from two different publishers before developing the OER packaged materials discussed in this paper [1]. The instructor of CHBE 459 also tried two textbooks before piloting the OER material. The 2024-25 academic year was that instructor's third year teaching the content. All five of the other instructors did complete the survey. Three of those instructors have taught this material for 1-3 years, currently use their own materials (developed from scratch and using open-source online materials) and do not require students to buy a textbook. The other two instructors have taught the course for 7-10 years, both have a textbook requirement in their courses, and rely on slides and question-banks developed by the publisher.

3.2 Multi-Course OER Implementation

During the Winter 2025 term, the OER materials were implemented in two departments. The Department of Civil Engineering offered CIVL 403 (155 students), while the Department of Chemical and Biological Engineering offered CHBE 459 (143 students). Both courses are three-credit, core requirements for their respective programs, typically taken by fourth-year students in

their final term. CIVL 403 was taught by the creator of the OER materials, while CHBE 459 was delivered by an instructor who had previously relied on slides provided by a textbook publisher. For many quantitative courses, adopting a textbook often grants instructors access to accompanying teaching materials from the publisher. The newly developed OER slides were designed to serve dual purposes: as a study resource for students, comparable to a textbook, and as a teaching tool for instructors. Aside from the difference in instructors, both courses were conducted in a similar format, with two 1.5-hour lectures per week, using identical slides, midterm questions, and a final project. The fundamental concepts covered were consistent with those taught in all Engineering Economics courses at UBC, emphasizing topics such as cost estimation, the time value of money, economic and engineering decision-making, risk and sensitivity analysis, and the fundamentals of engineering accounting. The students of both courses completed the same midterms. Additionally, two questions from the midterm were included in the exam of a course offered by the Department of Electrical Engineering (ELEC 481) ELEC 481 (91 students), taught by an instructor who used a textbook and the support materials provided by the publisher (the lecture slides, test bank, etc). The results from those two specific questions will serve as a baseline for comparing student outcomes with the two classes who used the developed OER materials.

4. Results

4.1 Instructor Survey

The survey revealed mixed perceptions of textbook utility, with most instructors acknowledging cost as a major concern. The common themes included:

- Student reluctance to purchase expensive textbooks
- Inadequate alignment between textbook examples and course learning objectives
- Desire for more practice problems and flexible content
- Resistance to change due to time constraints or satisfaction with current materials

The below quotes highlight these tensions:

> “The publishers supporting slides are sometimes complicated and unclear; I've had to clean them up a lot. I have found it necessary and relevant to also supplement textbook materials heavily with examples from my work and with other case study opportunities (drawn heavily from the news), to better highlight scoping and analysis difficulties that aren't presented in either textbook I've used.”

> “Students don't buy the textbook even though it’s assigned. Students complain about not enough practice problems even though there are literally thousands in the textbook. I'm not willing to invest a huge amount of time changing my approach to teaching the course. I've taught it for 7 years and what I'm doing I feel like is working. Any change in materials or slide decks that creates more work for me is a non-starter.”

4.2 Multi-Course OER Implementation

Having an instructor who did not contribute to the creation of the OER utilize the materials is a critical step in evaluating their utility, effectiveness, and adaptability in diverse teaching contexts. This approach provides an unbiased perspective on the strengths and potential areas for improvement, offering valuable insights into how the materials perform when implemented by educators with varying instructional styles. Below is the instructor's comprehensive review, which highlights their experiences, observations, and feedback on the use of the OER in their course.

> "As someone teaching engineering economics without a background in the field, these open-source materials were a game-changer. The clarity of the slides, the thoughtful flow of concepts, and the built-in examples and practice problems gave me the confidence to teach this course effectively. The materials didn't just cover the basics, they scaffolded the concepts in a way that made the subject approachable and intuitive, even for students who had never encountered topics like time value of money or depreciation before. My students were extremely enthusiastic about the course, frequently praising the slides and the sample problems for making difficult concepts much easier to grasp. I made only minor modifications to tailor some examples for chemical engineering applications, but the structure was so solid that little customization was needed. It's rare to find teaching resources this polished, flexible, and well-aligned with how students actually learn. I'm excited to continue using and contributing to this open-source effort."

This endorsement indicates that well-designed OER can democratize instructional quality by supporting educators with varying levels of content expertise. Additionally, with an estimated cost savings of approximately $100 per student per year, the adoption of OER materials in these two courses resulted in $29,800 in textbook savings over a single year. If adopted across all courses at UBC, OER usage could lead to student savings of approximately $100,000 annually. Finally, the results presented below suggest that OER materials support learning outcomes comparable to those achieved with traditional commercial textbooks.

Midterm averages were nearly identical across the two OER-using courses:

Courses:	CIVL 403	CHBE 459
Midterm 1	78%	77%
Midterm 2	85%	84%

Performance on shared questions across three courses was also within a range of what would be expected, noting that the section using the textbook (ELEC 481) was lower than the OER groups in one question:

Courses:	CIVL 403	CHBE 459	ELEC 481
Q1	88%	92%	88%
Q2	95%	95%	71%

5. Discussion

The findings underscore the pedagogical viability and institutional relevance of OER in Engineering Economics. Instructor feedback revealed a strong appreciation for the pedagogical structure and adaptability of the materials, particularly by those with limited subject expertise. Equally important, student learning outcomes were not compromised despite the elimination of costly commercial textbooks. In fact, the students in the OER section performed notably better on one question, which suggests the need for a more detailed study comparing learning outcomes between the two groups.

This pilot also highlights broader implications for faculty development and institutional policy. To scale OER adoption, faculty need time, technical support, and recognition for their efforts. Incentives such as course releases, professional development credits, or integration into promotion criteria could increase adoption rates.

An emergent pattern in the survey data and implementation outcomes is the potential relationship between number of years having taught the course and openness to adopting OER. The instructors who expressed the most resistance to switching resources had been teaching the course for 7–10 years and cited concerns related to time investment and confidence in their existing teaching strategies. In contrast, instructors with fewer years of experience teaching the course, especially those newer to the subject matter, were more enthusiastic about the OER and its benefits. This observation aligns with broader findings in OER literature suggesting that newer faculty or those with less investment in established materials may be more open to experimenting with alternative pedagogical tools [8] [10]. For institutions aiming to expand OER adoption, this highlights an opportunity to strategically engage newer faculty, support them with onboarding resources, and incentivize experienced faculty to pilot OER in low-risk contexts.

Beyond pedagogical benefits, the financial implications of OER adoption are significant. By eliminating the need for costly commercial textbooks, OER can substantially reduce the financial burden on students, an outcome particularly critical in disciplines like Engineering where course materials are often expensive. Increased affordability directly translates to greater accessibility, enabling a wider range of students (particularly those from lower-income backgrounds), to fully participate in coursework without financial strain. By lowering material costs, institutions also contribute to a more equitable learning environment, helping to close achievement gaps that are often exacerbated by economic barriers. As demonstrated in this pilot, even partial adoption of OER materials can yield meaningful savings, highlighting the potential for even broader institutional impact if OER strategies are scaled.

The positive results of this pilot suggest opportunities for interdepartmental collaboration. The materials could serve as a foundational package adaptable across disciplines, reducing duplication and fostering pedagogical coherence. Future work will include gathering and analysing student feedback, refining materials based on recommendations, planning a more rigorous study comparing OER-using sections with textbook using sections, and expanding the pilot to additional departments to expand on annual student savings.

6. Ethics

As confirmed by the UBC Behavioural Research Ethics Board (BREB) office, the work is considered "Quality Improvement and Assurance and Program Evaluation", which under Article 2.5 of the Tri Council Policy Statement is exempt from institutional ethics review requirements. This work therefore does not require ethics review for its performance or dissemination.

7. References

[1] T. R. Etmannski, S. Song, J. Sandhu, L. Kim, & A. Wang, "Online Open-Source Engineering Economics Textbook Replacement Materials (include practice problems)" 2024. Available DOI: 10.14288/1.0443965

[2] Accreditation Board for Engineering and Technology (ABET), 2021. Available: https://www.abet.org/accreditation/[Accessed April 25, 2025].

[3] Engineers Canada. Canadian Engineering Accreditation Board, 2023. Accreditation Criteria and Procedures. [online]. Available: https://engineerscanada.ca/sites/default/files/2023-12/Accreditation_Criteria_Procedures_2023.pdf

[4] J. Hilton, "Open Educational Resources and College Textbook Choices: A Review of Research on Efficacy and Perceptions," *Educational Technology Research and Development*, 64(4), 573–590, 2016.

[5] N. B. Colvard, C. E. Watson, & H. Park, "The Impact of Open Educational Resources on Various Student Success Metrics," *International Journal of Teaching and Learning in Higher Education*, 30(2), 262–276, 2018.

[6] N. Delimont, E. C. Turtle, A. Bennett, K. Adhikari, & B.L. Lindshield, "University Students and Faculty Have Positive Perceptions of Open/Alternative Resources and Their Utilization in a Textbook Replacement Initiative," *Research in Learning Technology*, 2016. Available: https://doi.org/10.3402/rlt.v24.29920

[7] D. Hendrix, "The Impact of Replacing Traditional Textbooks with Open Educational Resources on Undergraduate Student Achievement and Engagement," *The International Review of Research in Open and Distributed Learning*, 19(2), 263–276, 2018.

[8] I. E. Allen, & J. Seaman, "Digital Texts in the Time of COVID: Educational Resources in U.S.," *Higher Education*, 2018–2019. Babson Survey Research Group. Retrieved from https://www.onlinelearningsurvey.com/reports/digitaltextsin2020.pdf

[9] T. R. Etmannski, "Creation of Open-Source Course Materials for Engineering Economics Course with Help from a Team of Students—Lessons Learned," *American Society for Engineering Education (ASEE) Conference*, June 2024, in Portland, OR. Available: https://nemo.asee.org/public/conferences/344/papers/41314/view

[10] V. Rolfe, "Open educational resources: Staff attitudes and awareness," *Research in Learning Technology*, 25, 2017. https://doi.org/10.25304/rlt.v25.1858