

Incorporating Scholarly Literature into Civil Engineering Electives: A Pedagogical Approach to Strengthen Research Literacy

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1. Introduction

Undergraduate education serves as a critical foundation for developing intellectual skills and preparing students for advanced study or professional practice. The integration of peer-reviewed journal articles (PRJs) into coursework has emerged as an innovative approach to achieving these objectives. PRJs represent the forefront of knowledge in various fields and provide students with opportunities to engage directly with the methodologies, discussions, and findings of active research. The inclusion of PRJs in undergraduate curricula has become increasingly recognized as a pedagogical strategy to cultivate critical thinking, research literacy, and discipline-specific knowledge. This paper explores the pedagogical implications of incorporating such articles into undergraduate curricula, focusing on their impact on student learning and strategies for effective implementation.

Information literacy skills, such as the ability to locate, comprehend, evaluate, and apply information from scientific literature and web resources, are essential for undergraduate students [1]. A substantial body of literature indicates that engaging with PRJs can enhance undergraduates' scientific process skills and boost their confidence in scientific reasoning [2-4]. For example, Brownell et al. found that a writing-intensive course enhanced undergraduates' confidence and perception of their ability to read scientific literature and communicate science effectively. [5]. Studies have shown that gradually introducing students to PRJs enhances their confidence and their ability to comprehend research articles and interpret tables and graphs [6]. Another study found that an intensive, literature-based training program, which focused on presenting and critically analyzing scientific journal articles alongside students' own research, enhanced scientific literacy, boosted student confidence during their undergraduate years, and eased their transition to postgraduate study [3].

The principles of backward design [7, 8] could be useful for instructors wishing to include scientific literatures in their classes. Goudsouzian and Hsu proposed a systematic framework for integrating scientific literature into coursework. This framework involves defining learning objectives, carefully selecting relevant literature, designing assessment tools to measure intended outcomes, and identifying effective pedagogical methods for instruction [9]. Different published approaches in literature had different aims, such as to enhance content knowledge, develop specific competencies like formulating scientific questions and evaluating hypotheses, or positively influence student affect, such as increasing student motivation and interest in STEM

[9]. Another approach to integrating scientific literature into coursework involves carefully selecting peer-reviewed journals for use in class. [10]. Instructors should select papers that align with their course learning outcomes and the educational goals of incorporating scientific literature. If the goal is to enhance conceptual understanding or data analysis skills, the chosen paper should include relevant techniques and analyses. Factors like length, complexity, and required background knowledge should also be considered to ensure students can effectively engage with the material and achieve the intended learning objectives.

There are several benefits of Incorporating PRJs in the undergraduate courses.

- a) Fostering Critical Thinking: Engaging with peer-reviewed literature requires students to analyze arguments, evaluate evidence, and synthesize complex information. This process cultivates critical thinking, enabling students to assess the validity and relevance of information.
- b) Developing Research Literacy: Reading and interpreting journal articles enhances students' understanding of research design, data analysis, and scholarly writing. These skills are essential for students considering graduate studies or careers in research-intensive fields.
- c) Bridging Theory and Practice: Peer-reviewed articles often discuss cutting-edge research and real-world applications, helping students connect theoretical concepts taught in the classroom with practical implications.
- d) Encouraging Lifelong Learning: Exposure to academic literature fosters a culture of inquiry and continuous learning as students become accustomed to seeking out and critically evaluating new information throughout their careers.

This paper examines the rationale, benefits, and implementation strategies for integrating scholarly articles into undergraduate teaching. It draws on existing educational research and case studies to demonstrate how exposing students to peer-reviewed literature fosters analytical skills, enhances engagement with current research, and prepares them for professional or academic careers. The paper also explores challenges, including accessibility and students' varying levels of preparedness, offering practical solutions for instructors. The findings underscore the transformative potential of this approach in bridging the gap between teaching and research, equipping students with competencies vital for academic and professional success.

2. Methodology:

This research was conducted in upper-level elective courses within the Civil Engineering department (Aquatic Chemistry - CE564, Groundwater Hydrology - CE573). Due to the small class sizes ($n \leq 10$) in elective courses, they provide an ideal setting for incorporating peer-reviewed journals, offering ample opportunities for in-class discussions and one-on-one

interactions between instructors and students. The integration of peer-reviewed journals into two courses began in the 2024-25 academic year (Fall quarter - CE564 and Spring quarter - CE573). Two distinct models for incorporating peer-reviewed journals were implemented during this study.

1) Presentation focused model:

This model consisted of two rounds of student presentations. In the first round, students individually selected and presented peer-reviewed journal articles relevant to the course material. Their chosen articles had to be research-based, aligned with the current class topics, and pre-approved by the instructor for relevance and suitability. The second round involved collaborative group presentations, where pairs of students introduced and analyzed a new peer-reviewed article. Each presentation was followed by a peer-led class discussion to foster critical engagement. Additionally, students submitted a one-page reflective summary highlighting the article's key points and their insights from the presentation.

This model was implemented in the CE564 course during the fall quarter, with a total sample population of 10 students. To assess its effectiveness, we incorporated feedback from course evaluations. Before the formal evaluation, students were encouraged to provide constructive feedback, sharing their insights on the inclusion of peer-reviewed journal articles in the course.

2) Research question-based model:

In this model, instructors carefully selected journal articles to introduce students to a systematic approach to laboratory research, including hypothesis development and research question formulation. The selected articles aligned with the course concepts and topics. Students learned to read and critically analyze literature, conduct reviews, and interpret research findings. As a final deliverable, students proposed a research question and developed a research plan. They also crafted an abstract for submission to small local venues, such as the campus research day or a regional conference.

This model was implemented in the CE573 course during the winter quarter, with a total sample population of seven students. To assess students' perceptions of the peer-reviewed journal component, a survey was conducted at the end of the quarter, supplemented by feedback from course evaluations. Approval has been received from the IRB for the research and students were invited to complete the confidential online feedback survey administered through the Office of Institutional Research, Planning, and Assessment (IRPA).

The survey questions used are listed below.

For each statement, a Likert scale (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree) was used.

- 1) I find peer-reviewed journal articles accessible and easy to understand.
- 2) I feel confident in my ability to locate peer-reviewed journal articles relevant to my studies.
- 3) Using peer-reviewed journal articles has enhanced my understanding of the subject matter.
- 4) Peer-reviewed journal articles are more useful than other resources (e.g., textbooks, websites) for my assignments.
- 5) I enjoy reading peer-reviewed journal articles.
- 6) I am interested in learning more about how to read and evaluate peer-reviewed journal articles.
- 7) I consider peer-reviewed journal articles to be more credible than other types of sources.
- 8) I trust the information I find in peer-reviewed journal articles.
- 9) I find it challenging to understand the content of peer-reviewed journal articles.
- 10) I feel that the language and structure of peer-reviewed articles make them difficult to read.
- 11) Using peer-reviewed journals has helped me develop my critical thinking skills.

Open-Ended Qualitative Questions

- What do you find most challenging about using peer-reviewed journal articles?
- How do you think using peer-reviewed journal articles has impacted your learning in this course?
- What additional support or resources would help you make better use of peer-reviewed journal articles?
- Have you used peer-reviewed journal articles in other courses before?

3. Result and Discussion

Although some literature suggests that PRJs are too difficult for undergraduates [6, 10], we found that students enjoyed their experience of using the PRJs. Below are some of the student comments from the course evaluations for both fall and winter quarters are listed below.

- *I liked having the journal article presentations towards the start of the quarter since it was interesting to see how what we were learning in the course applied to current projects and issues.*
- *One strength of the course is that the paper reviews brought an interesting topic to the class. It gave outside information on how scientists and experts go about groundwater analysis and what we need to do in the future.*

- *One of the strengths of this course was the research paper at the very beginning of the course where we had to present our findings to the class. It prepared me for my senior design presentation in the spring.*
- *I liked the use of journal articles for presentations. As a student, it allowed me to understand the applications of the in-class content. I think the use of these articles also keeps the class current and up to date with new findings in the world of water chemistry.*
- *I believe that one strength of this course was the use of presentations to discuss research papers. By giving these presentations, I was able to better understand the information that the papers were trying to convey, and I learned a lot of valuable information while reading the research papers. Also, by giving the presentations, I was able to get a little bit of practice with presenting and was able to get valuable feedback on how I can improve my future presentations.*

Survey responses from the end of winter quarter further supported the student's positive attitude toward peer-reviewed journal articles, highlighting that they are accessible, easy to understand, and contribute to a deeper understanding of the subject. We believe that, in both the models of implementing PRJ, the instructor's guidance in helping the students select an appropriate paper has created this positive attitude towards the PRJs. Of the seven students who took the survey, most had a prior exposure to peer-reviewed journals through assignments, homework, projects etc. in their earlier courses. Survey responses also highlighted that students felt confident in finding relevant articles and considered them more useful than other resources, such as textbooks or websites, for assignments (Figure 1).

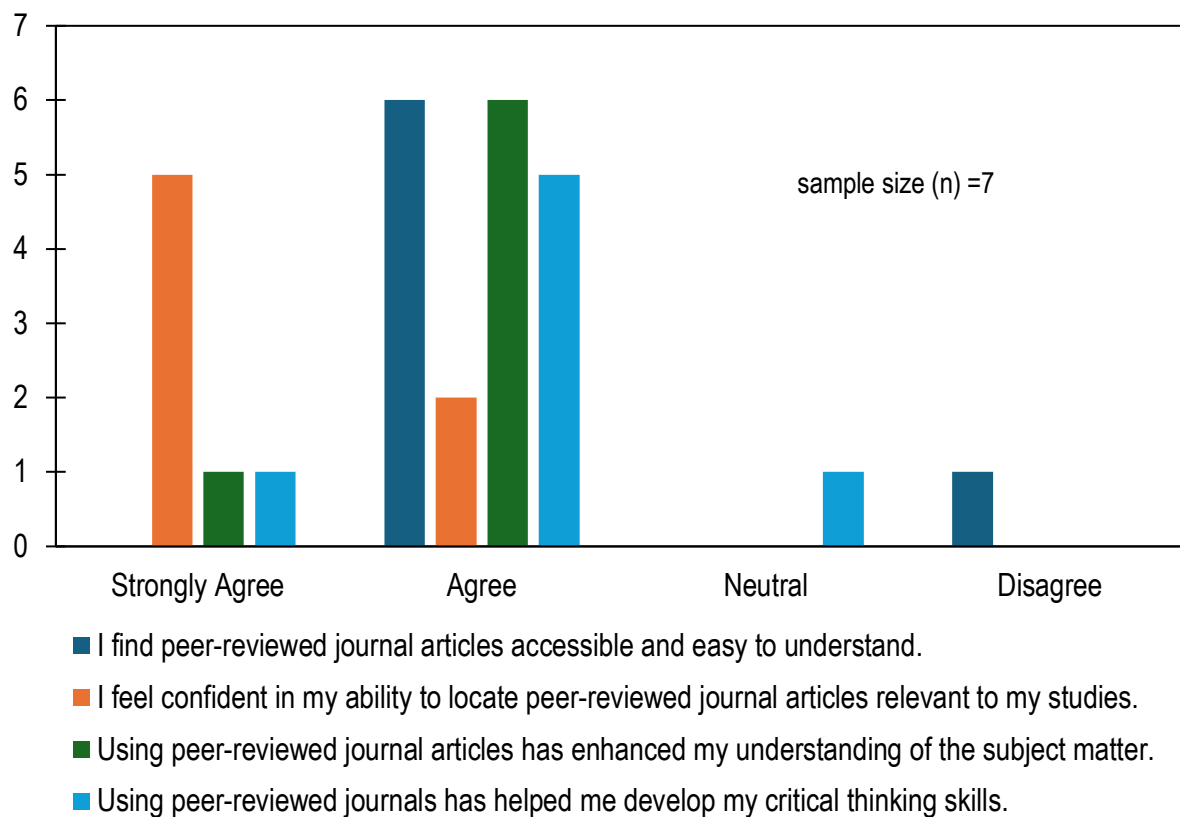


Figure 1. Students' perception of peer-reviewed journal in courses

Student survey responses also indicate an interest in learning how to read and evaluate peer-reviewed journal articles, with a belief that they are more credible and trustworthy than other sources (Figure 2). This might be due to constant reminders from the instructors that one of the expectations of an engineering profession is that practitioners within it will not only possess the appropriate knowledge, skills, and attributes for their profession but, equally important, that they will keep up to date with developments in their field to both confirm and inform their practices.

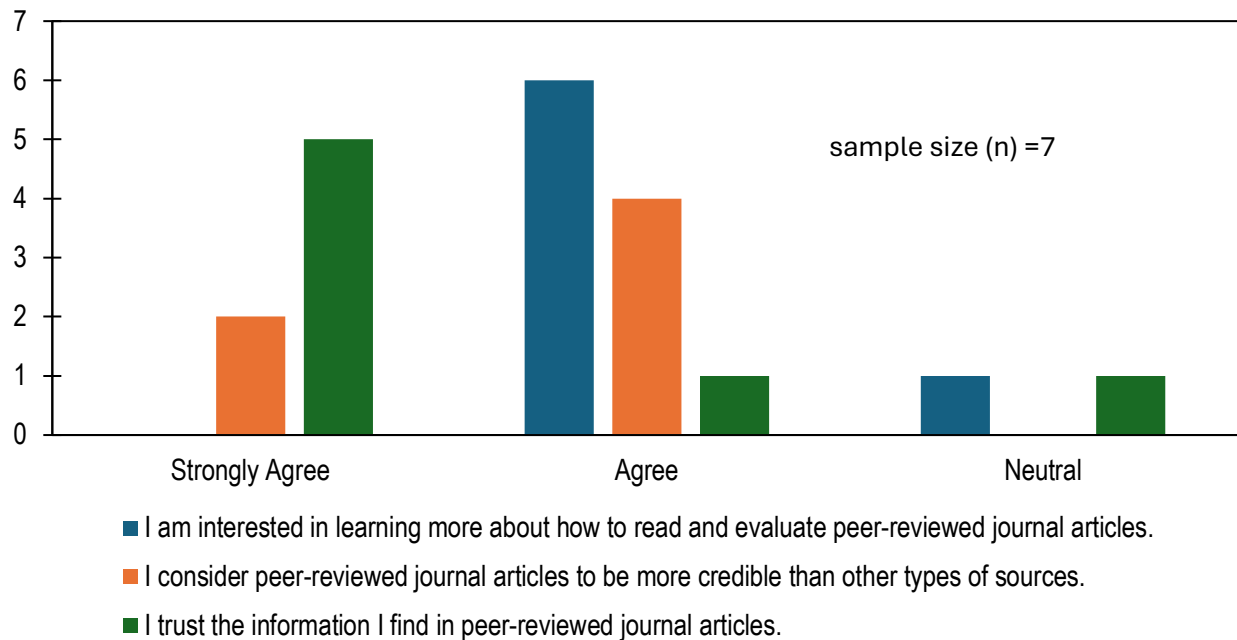


Figure 2. Student's confidence in the credibility of peer-reviewed journal content

Based on the survey students identified several challenges associated with peer-reviewed journal articles, including the frequent use of acronyms, complex terminology, and high-level topics that can be difficult to follow. They noted that unclear practical applications and dense wording often require multiple readings for comprehension. Additionally, the technical nature of data analysis and discussion sections can make them harder to grasp, and some articles tend to be repetitive in content.

Students found that engaging with peer-reviewed journal articles helped them connect course material to real-world applications, deepening their understanding. They appreciated how the articles encouraged critical thinking and problem-solving. However, some felt that while these articles provided valuable insights, they were best used alongside textbooks and other resources rather than as a replacement.

4. Challenges and Solutions

Based on the instructor's experience, some of the challenges and potential solutions to implementing PRJs are discussed below.

4.1. Accessibility and Comprehension Students may find peer-reviewed articles difficult to access or understand due to technical jargon and complex methodologies. To address this, instructors can:

- Provide guidance on how to read scholarly articles, such as focusing on abstracts, key findings, and discussion sections initially.
- Curate articles that align with students' knowledge levels and gradually introduce more complex materials.

4.2 Student Engagement Some students may view academic articles as irrelevant or uninteresting. Instructors can increase engagement by:

- Selecting articles that address current, real-world issues or controversies.
- Facilitating discussions and activities that connect article content to students' experiences and career aspirations.

4.3 Time Constraints Integrating journal articles into an already packed curriculum may pose time challenges. Solutions include:

- Assigning articles as supplementary reading with guided discussion questions.
- Incorporating brief article summaries or critiques as part of existing assignments.

5. Implementation Strategies

Instructors recommend following strategies to others looking implement PRJs into their courses.

5.1 Scaffolded Learning Approaches Introduce students to peer-reviewed literature gradually, starting with simplified summaries or review articles before progressing to primary research articles.

5.2 Active Learning Techniques Encourage active engagement through methods such as:

- Group discussions analyzing an article's methodology and findings.
- Journal clubs where students present and critique selected articles.
- Assignments that require students to synthesize multiple articles on a given topic.

5.3 Assessment and Feedback Design assessments that measure students' ability to understand and critique scholarly articles, providing constructive feedback to improve their skills.

6. Future works

This work is ongoing, and we will continue the survey for at least five more years to gather data and analyze the results.

6. Conclusion Incorporating peer-reviewed journal articles into undergraduate curricula offers significant benefits, including the development of critical thinking, research literacy, and an appreciation for scholarly inquiry. While challenges exist, they can be addressed through thoughtful implementation strategies that align with students' needs and course objectives. As higher education continues to evolve, integrating research and teaching will be pivotal in preparing students for the demands of an increasingly complex and knowledge-driven world.

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