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Systematic Review of Faculty Adoption and Implementation of Artificial Intelligence in Engineering Education

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Introduction

The growing integration of Artificial Intelligence (AI) into higher education has sparked increased interest in understanding how faculty adopt and implement these technologies in their teaching and assessment practices. This paper aims to systematically review how engineering faculty engage with AI tools and practices to support and transform engineering education. By synthesizing existing research, we provide insights that can inform educators, curriculum designers, and researchers on emerging trends, opportunities, and challenges in AI adoption within the engineering context.

While AI has existed for over six decades, recent exponential advancements in its capabilities have driven a significant shift in how it is perceived and utilized, especially in academic contexts. AI is increasingly being integrated into pedagogy, shaping assessment practices and enabling new instructional approaches to enhance teaching and learning in educational settings. In higher education, AI has influenced classroom instruction, laboratory learning, research productivity, and administrative processes [1, 2].

Within engineering education, the momentum toward AI adoption is accelerating. Traditionally limited to robotics, automation, and control systems, AI is now being adopted more broadly, facilitating curriculum design, enabling automated assessments, and providing personalized feedback mechanisms [3, 4]. As faculty expand their exploration of AI's pedagogical potential, the discourse has also highlighted concerns, such as the risk of student overreliance and the readiness of faculty to adopt AI responsibly and effectively [5]. Yet, the overall recognition of AI's potential continues to drive its integration into engineering curricula.

Despite this growing interest, the landscape of AI adoption in engineering education remains fragmented. There is a pressing need for a comprehensive synthesis of existing literature to map current practices and identify gaps. Understanding how faculty perceive, adopt, and implement AI in their teaching is critical for supporting informed decision-making and guiding future AI research and development in education.

To this end, our review asks: *How has AI in engineering education been adopted and implemented by faculty?* Exploring this question is essential for capturing both the promise and the practical realities of AI integration in engineering instruction.

Methods

We conducted the systematic review in this study using the steps outlined by Borrego et al. [6], which include deciding to do a systematic review, identifying the scope and research questions, defining the inclusion criteria, finding and cataloging sources, critiquing, appraising, and synthesizing. We have completed the first four out of these seven steps. Below, we briefly discuss the completed steps.

In deciding to do a systematic review, our motivation aligns with that described by Borrego, et al. [6]; an overall picture of the available evidence on faculty AI adoption and implementation in engineering education is needed to direct future research efforts for adequate advancements. This guided our scope and, in turn, our research questions. The inclusion criteria for our study were articles: full text written in English, peer-reviewed, published between 2000 and 2024, within higher education, with engineering faculty as a population, on empirical studies of AI implementation in engineering education. Articles that reported on engineering classroom practices on AI implementation were included even if they did not identify faculty as a population of interest. To ensure a comprehensive review, we categorize computer science as a part of engineering and include articles from the field.

Guided by our inclusion criteria, we developed keywords to search through six databases. Appendix A includes a detailed breakdown of search terms, Boolean operators, and the number of articles extracted for each database. We downloaded an RIS file for generated articles from each database and exported them to Rayyan AI for screening. In screening the articles, we used PRISMA 2020 as a guide. Our PRISMA work-in-progress flow diagram is included in Appendix B. So far, we have completed the title and abstract screening. For articles where we were unsure whether they met the inclusion criteria, we assumed that they met them and included them at this stage, intending that a clear decision would be made on their eligibility during the full-text screening [7].

Preliminary Results

Our initial search across the six databases yielded 1,471 articles, 92 of which were removed as duplicates. The title and abstract of the remaining 1379 articles were screened based on our review's inclusion criteria. We excluded 1,172 articles that did not meet the inclusion criteria, leaving us with 207 studies that did. Although our inclusion criteria specified articles with publication dates from 2000 to 2024, we observed the first eligible article to have been published in 2002. Figure 1 shows that the first publication appeared in 2002, and there was a slow growth in published articles on AI in engineering education until 2020, with a sudden spike in 2024. This is not surprising as our literature review above highlighted the focus of engineering on the application of AI in educational contests as a recent advancement owing to the proliferation of AI.

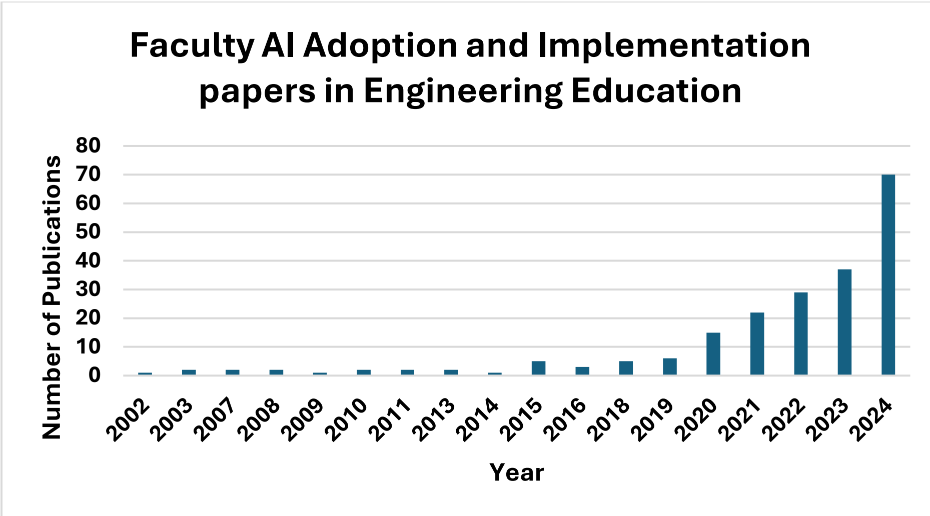


Figure 1: Publication years of eligible faculty AI adoption and implementation papers in engineering education.

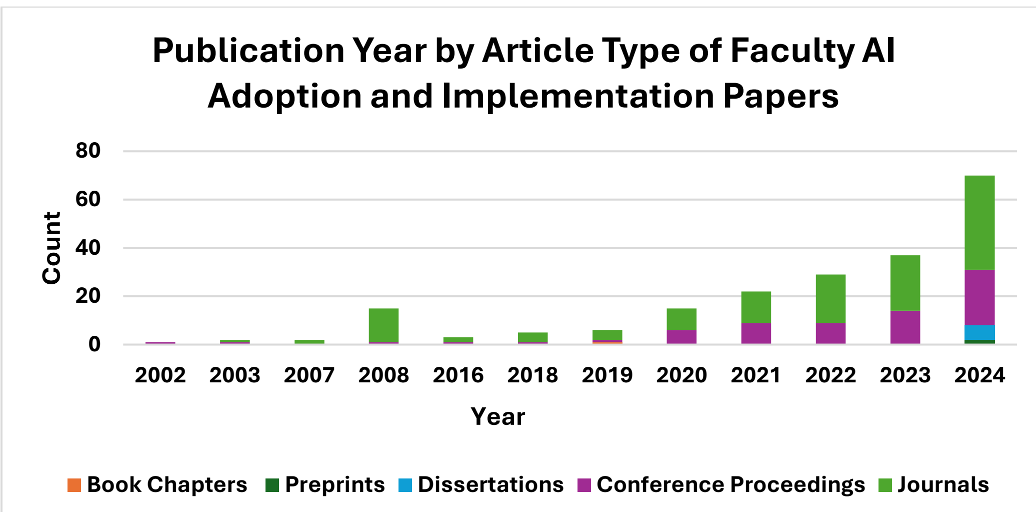


Figure 2: Publication year by article type of faculty AI adoption and implementation papers in engineering education.

Furthermore, student research on faculty AI adoption and implementation in engineering education is in its early stages. This is evidenced by the fact that the first published dissertation work was in 2024. Also, from Figure 3, we observe that journal publications followed by conference proceedings are the most utilized channels by researchers for disseminating their work on faculty AI adoption and implementation attitudes, practices, and pedagogical strategies in engineering education. The top journal outlets were IEEE Transactions on Learning Technologies and Transactions on Education. Only one book chapter was published, indicating that researchers are currently focusing on utilizing journal and conference outlets for AI in engineering education.

Discussion

Our preliminary analysis up to this point provides tentative suggestions on our research objectives; there has been an increase in studies within faculty AI adoption and implementation research within the past year, with a projected increase in the coming years. However, it is yet to be seen if the rise in research reflects a positive impact on faculty pedagogical strategies on AI utilization in engineering classrooms. We had expected a higher number of publications in conference proceedings owing to the fast-paced nature of AI. However, we observed that most AI conference publications focused on student outcomes and perspectives with a lesser focus on faculty practices, attitudes, and pedagogies.

Also, it is expected that more graduate students could be encouraged to pursue dissertation research on faculty AI adoption and implementation in engineering to capture more in-depth nuances in this research area. As technologies are ever-changing, these dissertation studies could focus more on how the utilization of other technologies translates into the usage of AI to avoid the repetition of research investigations with no novel insights or advancements. Additionally, in our first stage screening, we observed a higher focus of engineering faculty on AI's potential for automated assessment with faster turnaround time for improved student satisfaction and learning outcomes. Specifically, the first eligible paper in our study from 2002 [8] was on an AI-based learner assessment application in an engineering course.

Future Work

For the full-text screening, we would individually review each eligible article and conduct an in-depth analysis based on our research question and objectives. Following this, we would synthesize findings and report on challenges, motivators, beliefs, and pedagogical strategies reported in the literature on engineering faculty in adopting and implementing AI. To answer our research question, we would create a coding sheet that captures the different factors on faculty AI adoption and implementation in engineering education that the scope of our study covers. We intend to search in the gray literature, such as conference databases, reference lists of other reviews, and reports [6] to identify quality studies that could enhance our understanding of our research goal. We also aim to review studies that discuss AI use in the classroom with student outcome measures that could provide insight into practices and strategies.

Upon in-depth analysis and synthesis, we aim to uncover findings that could inform engineering educators and researchers about the existing body of knowledge and identify areas for future exploration toward ensuring equitable and effective AI integration. By carrying out this comprehensive review, our study will guide future research, inform policy decisions, and support the development of AI-enhanced educational practices that are both innovative and inclusive.

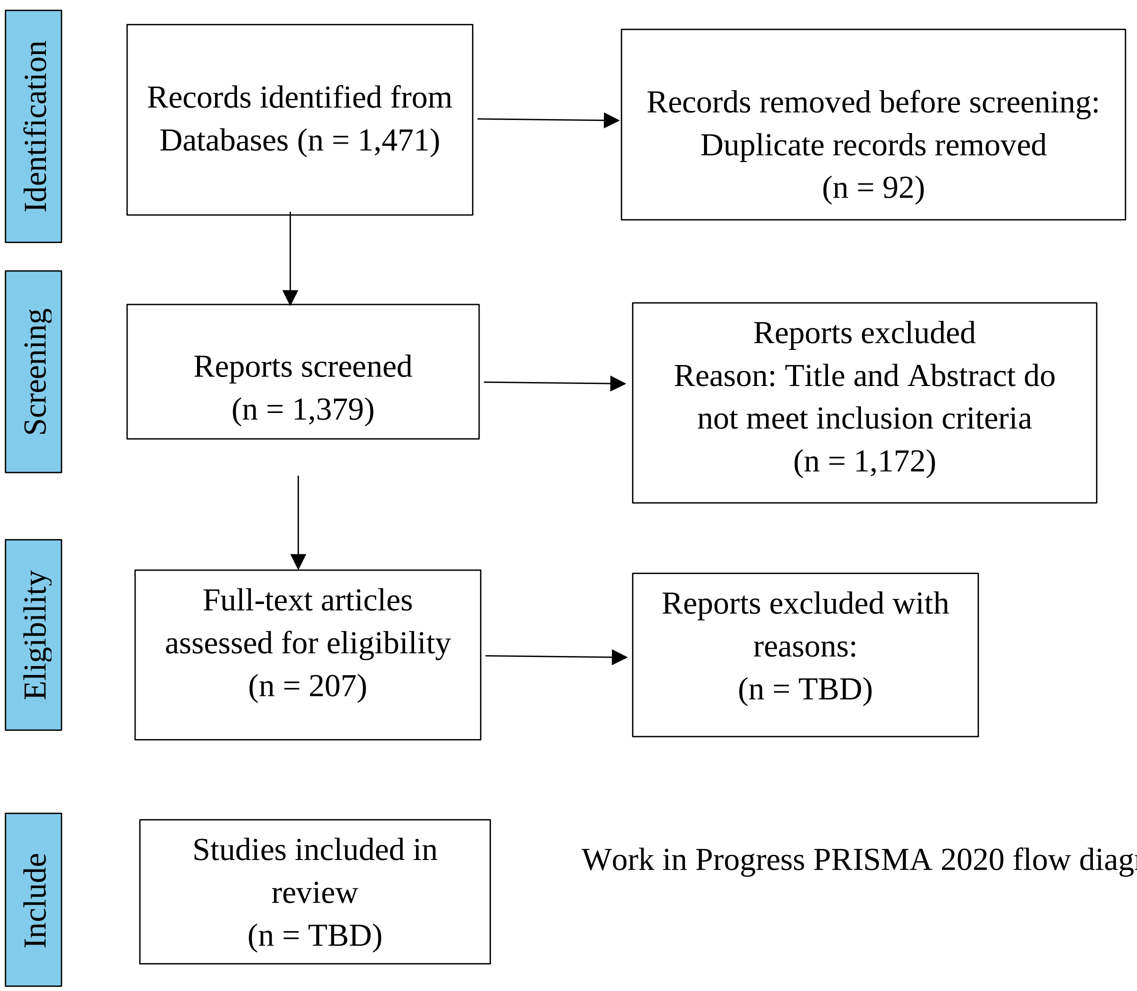
Appendices

Appendix A

Database	Search Term Using Inclusion Criteria	Number
ERIC (Via EBSCO)	(Belief* OR attitude* OR perception* OR behavior OR teaching OR assessment OR pedagogy OR practice* OR challenge* OR adoption OR implementation) AND (Engineer*) AND (("generative artificial intelligence" OR "generative AI" OR "Gen AI") OR (chatbots OR ChatGPT OR "Microsoft Copilot" OR Gemini or LLaMA) OR (LLM OR "Large Language Model") OR ("Artificial Intelligence" OR AI)) AND (Faculty OR instructor OR teacher)	116
APA PsyInfo	(Belief* OR attitude* OR perception* OR behavior OR teaching OR assessment OR pedagogy OR practice* OR challenge* OR adoption OR implementation) AND (Engineer*) AND (("generative artificial intelligence" OR "generative AI" OR "Gen AI") OR (chatbots OR ChatGPT OR "Microsoft Copilot" OR Gemini or LLaMA) OR (LLM OR "Large Language Model") OR ("Artificial Intelligence" OR AI)) AND (Faculty OR instructor OR teacher)	759
Engineering Village	(Belief* OR attitude* OR perception* OR behavior OR teaching OR assessment OR pedagogy OR practice* OR challenge* OR adoption OR implementation) AND (Engineer*) AND (("generative artificial intelligence" OR "generative AI" OR "Gen AI") OR (chatbots OR ChatGPT OR "Microsoft Copilot" OR Gemini or LLaMA) OR (LLM OR "Large Language Model") OR ("Artificial Intelligence" OR AI)) AND (Faculty OR instructor OR teacher) *N.B. Initial search term resulted in over 5,000 articles. Refined search term to subject/title/abstract for the search strings.*	149
Web of Science	(Belief* OR attitude* OR perception* OR behavior OR teaching OR assessment OR pedagogy OR practice* OR challenge* OR adoption OR implementation) AND (Engineer*) AND (("generative artificial intelligence" OR "generative AI" OR "Gen AI") OR (chatbots OR ChatGPT OR "Microsoft Copilot" OR Gemini or LLaMA) OR (LLM OR "Large Language Model") OR ("Artificial Intelligence" OR AI)) AND (Faculty OR instructor OR teacher) *N.B. Initial search term resulted over 7000 articles. Refined search term to title for the search strings.*	237

ProQuest Dissertations	(Belief* OR attitude* OR perception* OR behavior OR teaching OR assessment OR pedagogy OR practice* OR challenge* OR adoption OR implementation) AND (Engineer*) AND (("generative artificial intelligence" OR "generative AI" OR "Gen AI") OR (chatbots OR ChatGPT OR "Microsoft Copilot" OR Gemini or LLaMA) OR (LLM OR "Large Language Model") OR ("Artificial Intelligence" OR AI)) AND (Faculty OR instructor OR teacher) *N.B: over 1000 without refinement*	32
Education Research Complete	(Belief* OR attitude* OR perception* OR behavior OR teaching OR assessment OR pedagogy OR practice* OR challenge* OR adoption OR implementation) AND (Engineer*) AND (("generative artificial intelligence" OR "generative AI" OR "Gen AI") OR (chatbots OR ChatGPT OR "Microsoft Copilot" OR Gemini or LLaMA) OR (LLM OR "Large Language Model") OR ("Artificial Intelligence" OR AI)) AND (Faculty OR instructor OR teacher) *N.B: over 5000 without refinement*	178

Appendix B



Work in Progress PRISMA 2020 flow diagram

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