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A Bibliometric Analysis of Global Trends in Engineering Education Research

Aay Susilawati

Universitas Pendidikan Indonesia, Bandung, Indonesia
Correspondence: E-mail: aaysusilawati@gmail.com

ABSTRACT

Engineering education has emerged as a key driver of innovation and economic development in the 21st century. As global educational systems evolve, understanding the trajectory of research in engineering education becomes crucial for policy and curriculum reform. This study provides a comprehensive bibliometric analysis of global trends in engineering education research by examining 195,601 documents indexed in Scopus from 1877 to 2023 using the search string TITLE-ABS-KEY(engineering AND education). The analysis focused on annual publication trends, subject area distributions, and thematic evolution. Tools such as Microsoft Excel, VOSviewer, and Bibliometrix (R) were used for data processing and visualization. Results indicate exponential growth in publications from the early 2000s, with notable contributions from engineering, computer science, and social sciences. These findings highlight the interdisciplinary nature of engineering education and underscore the increasing attention to digital tools, pedagogical innovation, and policy development. The study contributes to strategic planning for future research directions in the field.

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1. INTRODUCTION

Engineering education plays a pivotal role in the advancement of global industries, infrastructure, and innovation. As nations navigate the complexities of the digital age and sustainable development, the demand for competent engineers equipped with both technical expertise and adaptive skills has increased significantly. This paradigm shift has spurred ongoing transformations in the structure, pedagogy, and evaluation methods within engineering education. The integration of new technologies, interdisciplinary collaboration, and learner-centered approaches now defines modern engineering curricula, prompting scholars and institutions to engage in rigorous research to optimize teaching and learning outcomes in the field. Over the past few decades, scholarly interest in engineering education has expanded, reflecting the increasing recognition of its strategic importance in national development and global competitiveness. Researchers have explored diverse aspects ranging from curriculum reform and educational policy to instructional design, equity and inclusion, digital learning tools, and competency-based frameworks. The global landscape of engineering education research is thus marked by its multidimensionality and rapid growth, supported by the proliferation of publication platforms and international collaborations. This condition makes many reports regarding engineering education, as presented in **Table 1**.

Despite this growth, there remains a lack of comprehensive mapping of the trends, thematic structures, and knowledge networks that define this field. Existing literature reviews often focus on specific themes, such as gender participation in engineering or the use of simulations in instruction, but rarely offer a macroscopic view of the research ecosystem. This gap underscores the need for a bibliometric analysis that systematically examines the evolution, volume, distribution, and impact of research in engineering education.

Bibliometric analysis provides valuable insights into the intellectual structure of a discipline by quantifying publication patterns, identifying key contributors, and mapping thematic developments. It enables researchers to assess the maturity of the field, detect emerging topics, and inform future research directions.

This study aims to present a comprehensive bibliometric analysis of global trends in engineering education research by examining publications indexed in the Scopus database from 1877 to 2023. The novelty of this paper lies in its longitudinal scope and its interdisciplinary lens, which captures the convergence of engineering, computer science, and social sciences in shaping the educational discourse. The findings are expected to contribute significantly to the understanding of how engineering education has evolved and where it is headed, providing a strategic foundation for academics, policymakers, and practitioners to enhance the quality and relevance of engineering instruction worldwide

Table 1. List of engineering education articles and references.

No	Title	References
1	The integration of the engineering design process in biology-related STEM activity: A review of Thai secondary education	(Tipmontiane & Williams, 2022)
2	How to read and calculate diameter size from electron microscopy images	(Yolanda & Nandiyanto, 2022)
3	Constructive alignment approach for capstone project with industry involvement: Case study in Malaysia University	(Nugroho, 2022)
4	Teaching programming to chemical engineering students	(Andika & Putra, 2022)
5	Barriers limiting the use of google classroom for learning vocational and entrepreneurship courses	(Joshua *et al*., 2022)

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Table 1 (continue). List of engineering education articles and references.

No	Title	References
6	Application of scrabble game in improving learning of simple sentence structure on the student with hearing impairment	(Rusyani *et al*., 2022)
7	Permissive parenting style and maladaptive behavioral tendencies among junior high school students of Notre Dame of Tacurong College, Mindanao, Philippines	(Cabanatuan & Ahmad, 2022)
8	Effect glogster on students' academic achievement in selected basic technology concepts in Ilorin metropolis	(Asuquo *et al*., 2022)
9	Attitudes and perceptions towards cultured meat among general population in Pakistan	(Ahsan *et al*., 2022)
10	Construction process of robotic devices to teach aspect of auto mechanic in Nigeria Basic Schools	(Babalola & Omolafe, 2022)
11	Earthquake disaster preparedness for students of junior high school	(Widdyusuf *et al*., 2022)
12	Earthquake disaster preparedness for students of junior high school	(Ngag *et al*., 2022)
13	Rice tariffication law: Education and views of farmers in the Southern Philippines	(Nueva *et al*., 2022)
14	Earthquake disaster mitigation explanation to prepare a disaster response generation for students in 3th-grade of elementary school	(Nurfalah *et al*., 2022)
15	Study the relationship of earthquake and ionosphere using IRI TEC for education	(Phansori *et al*., 2022)
16	Real-time air quality index app: The use of e-weather HDF app for education in monitoring of pollutants and meteorological parameters in Nigeria	(Abulude *et al*., 2022)
17	Short play approach for analytical chemistry class	(Wirzal & Halim, 2022)
18	Detail experimental procedure for the construction process of robotic devices to teach aspect of auto mechanic	(Babalola & Omolafe, 2022)
19	A study on attitude of urban and rural college students towards science	(Shah, 2022)
20	Numerical minimum competence assessment for increasing students' interest in mathematics	(Wijaya *et al*., 2022)
21	Improved information literacy of elementary school students about living pharmacies through information and communication media (ICT)	(Dwiana *et al*., 2022)
22	Problems of teaching practical biology in senior secondary schools	(Abdussemiu, 2022)
23	The effectiveness of using a virtual laboratory in distance learning on the measurement materials of the natural sciences of physics for junior high school students	(Azizah *et al*., 2022)
24	Effect of developed mobile application on undergraduates academic performance in computer science	(Babalola & Omolafe, 2022)
25	Models for interactions in boundary layers at rotational motions in noncircular orbits: The concept for teaching science	(Strömberg, 2022)
26	The challenges of remote e-assessments during covid-19 outbreaks among undergraduate engineering programs	(Minghat *et al*., 2022)
27	A case study at the University of West Florida on improving recruitment and retention of female students in engineering	(Ramachandran *et al*., 2022)
28	Awareness and acceptability of the university's vision, mission, goals, and objectives in bachelor of science in electrical engineering program	(Cruz *et al*., 2022)

2. METHODS

This study employed a quantitative bibliometric approach to systematically analyze global trends in engineering education research. Bibliometric analysis is a well-established method for mapping the intellectual structure, research productivity, and thematic evolution within a

specific field using publication metadata such as authorship, keywords, citations, and source titles. Detailed information for getting this data using bibliometric analysis is explained elsewhere (Rochman *et al*., 2024; Al Husaeni & Nandiyanto, 2022; Al Husaeni & Al Husaeni, 2022). The data were retrieved from the Scopus database, which is one of the largest abstract and citation databases of peer-reviewed literature. The search was conducted using the query: TITLE-ABS-KEY (engineering AND education). This search string was applied to the title, abstract, and keywords fields to capture a broad range of documents that integrate the themes of engineering and education. The search covered publications from 1877 to 2023, yielding a total of 195,601 documents. All document types indexed by Scopus (e.g., articles, conference papers, reviews, book chapters) were included to ensure a comprehensive overview of the field. No language restrictions were applied. Duplicates and irrelevant records were excluded during the data cleaning process. By applying these methods, the study aimed to provide a comprehensive overview of the scope, growth, and research patterns in the global landscape of engineering education.

3. RESULTS AND DISCUSSION

Figure 1 illustrates the annual trend in the number of publications related to engineering and education indexed in Scopus from 1877 to 2023. A total of 195,601 documents were identified using the query TITLE-ABS-KEY (engineering AND education). From 1877 until the late 20th century, publication activity was relatively minimal, with gradual growth observed throughout the 20th century. However, a significant surge in research output became evident around the early 2000s, with exponential growth continuing into the 2010s and 2020s. Notably, the number of publications sharply increased after 2015, reaching over 12,000 documents in 2023 alone. This trend reflects the growing global emphasis on engineering education, technological advancement, and the increasing importance of interdisciplinary research combining engineering and pedagogical practices. This upward trajectory may be attributed to various factors including increased academic interest in STEM education, global educational reforms, digital transformation in teaching methods, and expanded access to publication platforms. The trend also underscores the need to further examine specific thematic evolutions and collaborative patterns within this expansive body of literature.

Figure 2 displays the subject area classification of the 195,601 documents retrieved using the keyword combination "engineering AND education" in Scopus. The results highlight the multidisciplinary nature of engineering education research, with contributions spanning across multiple domains. The Engineering subject area dominates the dataset, accounting for 32.3% (110,931 documents), underscoring the core focus on technical education and curriculum development in engineering disciplines. Following closely is Computer Science with 20.8% (71,304 documents), reflecting the increasing integration of digital tools, software platforms, and computational thinking in engineering pedagogy. The Social Sciences rank third with 19.7% (67,583 documents), indicating significant engagement with educational theory, policy, and human-centered approaches within engineering education. Other contributing fields include Mathematics (4.0%), Business, Management, and Accounting (2.7%), Physics and Astronomy (2.7%), Decision Sciences (2.5%), Materials Science (2.1%), and Medicine (2.0%), illustrating the broad applicability of engineering education across disciplines. This distribution emphasizes that engineering education is not confined to technical domains alone but intersects meaningfully with the social sciences, business, and emerging interdisciplinary areas, reflecting a growing need for holistic and integrative approaches to engineer training in the 21st century.

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The bibliometric analysis reveals a dynamic and rapidly evolving research landscape in engineering education. As presented in **Figure 1**, the number of publications related to engineering and education has grown exponentially since the early 2000s, reaching a peak in 2023 with over 12,000 publications. This growth trend illustrates the increasing global attention toward educational innovation within engineering disciplines. The surge may be attributed to multiple converging factors such as global STEM education policies, digital transformation in education delivery, and the pressing need for industry-ready engineering graduates. The sharp increase in output, particularly after 2015, suggests a shift from traditional engineering instruction to more interdisciplinary and pedagogy-centered approaches. This aligns with global efforts to reform engineering curricula to include problem-solving, sustainability, entrepreneurship, and digital literacy—skills required for the Fourth Industrial Revolution. Moreover, the COVID-19 pandemic and the shift to online learning environments likely accelerated scholarly interest in engineering education, prompting further innovation and research dissemination.

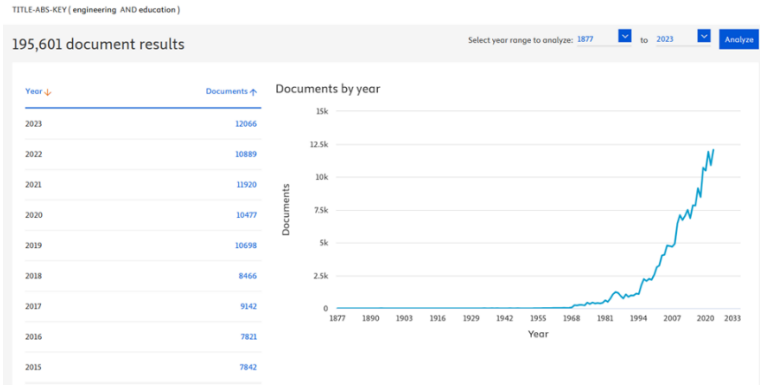

Figure 1. Annual distribution of publications on engineering and education from 1877 to 2023 retrieved from Scopus using the search query TITLE-ABS-KEY (engineering AND education).

Complementing this temporal analysis, **Figure 2** presents the disciplinary diversity of engineering education research. As expected, the field of engineering constitutes the largest share (32.3%) of the total publications. However, significant contributions also emerge from computer science (20.8%) and social sciences (19.7%). This triangulation of technical, digital, and social dimensions underscores the inherently interdisciplinary nature of engineering education. The strong representation of computer science suggests a growing focus on educational technologies, simulations, AI-driven learning platforms, and virtual laboratories. Concurrently, the involvement of social sciences reflects increased attention to educational psychology, curriculum development, learning assessment, and diversity and inclusion in engineering learning environments. Additionally, the presence of fields such as mathematics, business, decision sciences, and materials science points to the integrative efforts of researchers to connect technical learning with strategic thinking, applied problem-solving, and data-driven decision-making in engineering contexts. These trends mirror the broader educational shift from knowledge transmission to competence development, learner-centered instruction, and contextualized learning. The combined insights from the figures demonstrate that engineering education research is not only expanding in quantity but also maturing in scope and complexity. It reflects a paradigm shift from isolated engineering instruction to a transdisciplinary educational ecosystem that responds to societal, technological, and industrial demands.

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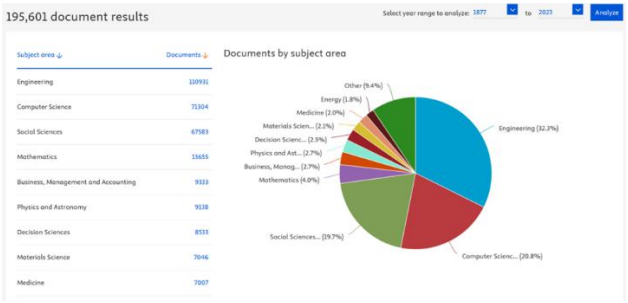

Figure 2. Distribution of documents by subject area related to engineering and education based on Scopus data from 1877 to 2023. The dominant fields are Engineering (32.3%), Computer Science (20.8%), and Social Sciences (19.7%).

4. CONCLUSION

This bibliometric analysis reveals a significant increase in global research output on engineering education over the past two decades. The data shows that the field has evolved into a multidisciplinary space that intersects engineering, computer science, and social sciences. The dominance of engineering-related research is complemented by growing attention to digital pedagogy, curriculum innovation, and educational theory, reflecting the global push for education systems that are both technically robust and socially responsive. Notably, the surge in publications after 2015 aligns with increased demand for STEM professionals and broader educational reforms emphasizing competencies for Industry 4.0. The subject area analysis confirms that engineering education is no longer a domain confined to technical training, but rather a convergent field that engages with social inclusion, sustainability, and digital transformation. This study provides researchers, educators, and policymakers with a foundational understanding of the intellectual and thematic landscape of engineering education. Future research should delve deeper into underexplored areas such as equitable access, localized pedagogical strategies, and the integration of AI and automation in engineering curricula. A periodic update of this bibliometric review is also recommended to track emerging trends and guide impactful research.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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