Generative Artificial Intelligence in Engineering and Construction Management Education: A Bibliometric Literature Review (2015–2025)

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Abstract

Generative artificial intelligence (GenAI) has rapidly emerged as a transformative technology in engineering and construction management education, influencing instructional practices, assessment, and student learning. This study presents a bibliometric review of GenAI research in engineering and construction management education published between 2015 and 2025. A total of 111 peer-reviewed articles were identified, screened against inclusion and exclusion criteria, and selected through manual abstract and full paper review. Bibliometric analysis of the papers examined publication trends, leading publication outlets, citation patterns, and keyword co-occurrence. Our findings show no research activity before 2023, followed by rapid growth after the public release of ChatGPT. The American Society for Engineering Education (ASEE) emerged as the dominant publication platform. Citation and keyword analyses indicate that current research primarily focuses on AI-enhanced learning, assessment support, and ethical considerations, while construction management for specific applications remain underrepresented. Our findings also show that although GenAI adoption in engineering education is accelerating, its integration into construction management education remains nascent. By synthesizing publication trends and thematic patterns, this study provides a foundation for advancing the ethical and effective integration of GenAI in engineering and construction management education.

Keywords: GenAI, Engineering Education, Construction Management Education, Large Language Models, Bibliometric Literature Review

Introduction

The rapid development of Generative Artificial Intelligence (GenAI) has transformed how knowledge is created and utilized in higher education, especially in technical fields like engineering and construction management. Studies have examined the impacts of GenAI on professional preparation, teaching methods, and student learning, the findings remain uneven and lack clear convergence, a pattern reflected in the varied perspectives [1]. Emerging trends in Artificial Intelligence (AI) adoption are documented in engineering education studies, including shifts in student attitudes, classroom experiments, and early challenges in integration [2], [3]. Despite these advances, gaps persist in educators' understanding of the benefits and limitations of integrating GenAI, as the broader landscape of its application in engineering and construction management education has not been comprehensively documented [4].

Recent research indicates that GenAI can enhance technical communication, boost engagement, and deepen conceptual understanding. For instance, GenAI has helped students better explain engineering ideas and evaluate design options in project-based scenarios [5], [6]. However,

issues related to accuracy, reliability, and academic integrity remain significant challenges, requiring careful integration strategies, transparent evaluation frameworks, and ongoing ethical oversight to ensure responsible use in educational contexts [2], [4]. Concerns about the quality of AI-generated content, potential misuse, and the need for clearer instructional guidance are discussed in engineering education studies [7], [8]. Despite the significance of these findings, a review is needed to synthesize the structure of GenAI scholarship in engineering and construction management education. Without this synthesis, the field risks fragmented progress that may not align with industry changes or emerging professional skills. Recent works emphasize this need, highlighting the importance of well-designed curricula, evidence-based teaching strategies, and ongoing faculty development [8], [9], [10], [11].

To address this gap, this bibliometric literature review examines publications from 2015 to 2025 across engineering and construction education platforms, such as American Society of Engineering Education (ASEE) proceedings, American Society of Civil Engineers (ASCE) publications, Institute of Electrical and Electronics Engineers (IEEE), the International Journal of Construction Education and Research (IJCER), Web of Science, and the Education Resources Information Center (ERIC via EBSCO).

This review conducts a bibliometric analysis to achieve the following objectives:

1. Examine publication trends from 2015 to 2025.
2. Identify the journals and conference proceedings that have published the highest number of articles.
3. Identify the most frequently cited publications.
4. Characterize the current state of the art in generative AI applications within engineering and construction management education.
5. Outline key gaps and opportunities for future research.

Literature Review

Generative artificial intelligence (GenAI) has begun to reshape engineering and construction management education by transforming teaching methods, professional development, and student learning. Research shows growing interest in how AI-enabled tools can improve learning outcomes, streamline design processes, automate complex tasks, and enhance student engagement [11], [12]. Despite this momentum, the literature remains dispersed, with major concerns centering on workforce preparedness, pedagogical integration, and the development of technological competencies [4], [7].

Educators recognize the potential of GenAI to enhance instructional efficiency, yet significant uncertainty persists regarding its reliability, appropriate use cases, and long-term implications for academic integrity [1]. Although GenAI promises benefits such as improved design workflows and support for professional upskilling, its integration within engineering and construction management curricula is inconsistent, highlighting the need for coordinated strategies, faculty development, and clearer frameworks for responsible use [4].

AI-Enabled Teaching and Learning in Engineering Education

A broader shift toward data-driven, interactive, and computationally supported pedagogies is evident across engineering education research. Studies in the United States show that AI-powered platforms can strengthen students' abilities to evaluate design alternatives, troubleshoot technical issues, and manage complex engineering systems [13]. When meaningfully integrated, AI-supported instructional tools have demonstrated the potential to improve learning outcomes [11]. Research increasingly explores how GenAI supports student-centered, technologically advanced learning environments. Studies evaluating tools such as ChatGPT, AI-generated instructional media, and automated feedback systems report growing experimentation with generative applications to support writing, conceptual understanding, and iterative learning [5], [6], [10]. At the same time, students' evolving perceptions particularly related to trust, ethics, and academic integrity demonstrate the need for structured AI literacy within engineering programs [3], [7], [8]. Network analyses further reveal increasingly collaborative and interdisciplinary scholarship, with emerging themes centered on digital transformation, intelligent systems, and data-informed pedagogy [14], [15].

AI and Generative Technologies in Construction Management Education

Artificial intelligence research within construction management education increasingly emphasizes practical applications that improve project outcomes through risk prediction, process automation, safety monitoring, and data-driven decision making. Studies show that AI technologies are reshaping construction workflows by optimizing resource allocation, enabling real-time progress tracking, and providing intelligent decision-support systems [16]. Parallel developments in engineering education highlight the potential of generative AI to support personalized and adaptive learning. Research demonstrates that tailored instructional content, iterative design feedback, and support for self-regulated learning can enhance student achievement and engagement [11]. Evidence also indicates that students are rapidly adopting GenAI tools, perceiving benefits in efficiency, understanding, and problem-solving autonomy [17].

Within construction curricula, studies report that AI-enhanced instruction particularly modules focused on AI literacy, computer vision, and project-management computing improves student engagement and AI competence. Simulation-based and project-based learning strategies further help learners grasp complex, real-world project dynamics [18], [19]. The use of large language models such as ChatGPT has intensified pedagogical interest due to their ability to provide customized feedback, scaffold problem solving, and generate instructional content aligned with individual learning trajectories [20].

AI applications in scheduling, predictive analytics, and supply-chain optimization are becoming central to modern construction programs, prompting calls for dedicated instructional modules and hands-on access to AI tools [16]. These instructional approaches reflect active, student-centered pedagogies that complement the experiential and simulation-based learning foundational to engineering and construction education [4]. Despite promising results, research continues to identify gaps in preparing graduates for the rapid integration of AI tools in professional practice. Challenges include limited curricular breadth, insufficient instructor readiness, and incomplete alignment between academic training and emerging industry AI competencies [4], [19].

Student Use and Perceptions of Generative AI

Students across engineering disciplines widely use and trust GenAI tools such as ChatGPT, although ethical perspectives vary. Frequent users tend to express more positive attitudes, underscoring the urgent need for AI literacy instruction particularly in first-year programs [7]. In introductory engineering course where students were granted full access to generative AI, many used tools like ChatGPT to meaningfully support their learning, especially for coding, while still recognizing the limitations and avoiding over-reliance [5].

Students generally value AI-generated feedback for its clarity and usefulness, although some find it less nuanced than peer feedback, indicating that AI can supplement but not replace feedback literacy development in project-based courses [6]. Faculty also find AI-driven analytics tools valuable for real-time instructional insights, though concerns remain regarding data privacy and the accuracy of AI-generated outputs [21].

Challenges, Gaps, and the Need for Synthesis

Despite the promise of GenAI, concerns persist related to accuracy, over-reliance, ethics, and academic integrity. Uncertainty about dependability and appropriate classroom use continues to challenge educators [3], [8]. These concerns highlight the importance of clearer instructional guidelines, robust faculty training, and comprehensive AI literacy frameworks.

Given the rapid but fragmented development of GenAI applications across engineering education and construction management education, a bibliometric synthesis is necessary to consolidate trends, identify leading contributors, and clarify emerging concepts. Without such synthesis, educational programs risk responding to AI advancements in a fragmented manner that neither aligns with industry innovation nor prepares students for AI-driven careers. A consistent theme across the literature is that GenAI holds significant potential to enhance learning, improve professional readiness, and modernize engineering and construction management curricula. While students value GenAI for assistance with learning tasks, design exploration, and feedback [22], concerns about digital literacy, ethics, and faculty preparation remain [3], [7]. Concurrently, global pressures for advanced STEM education continue to push instructional models toward AI-enhanced simulations, project-based learning, and problem-solving approaches [23].

This bibliometric literature review provides insight into how GenAI is transforming engineering and construction management education. By synthesizing emerging patterns, it offers guidance for educators, program designers, and accreditation bodies aiming to develop coherent, ethical, and future-ready strategies for integrating GenAI into their curricula.

Research Methodology

Research Design

This study employed a bibliometric literature review methodology to systematically examine scholarly research on the use of Generative Artificial Intelligence (GenAI) in engineering and construction management education published between 2015 and 2025. The review followed a structured 7 stages approach encompassing define the scope, data source and search strategy, data collection, data organization, quality evaluation, data analysis, and interpretation of results as shown in Figure 1. The review followed a transparent process involving structured database

searches, iterative screening, data cleaning, and collaborative validation by multiple researchers to enhance rigor and reproducibility.

Data Sources and Search Strategy

Six primary databases and publication sources were systematically searched to ensure comprehensive coverage of both peer-reviewed journal articles and conference proceedings: American Society of Engineering Education (ASEE) conference proceedings, American Society of Civil Engineers (ASCE) publications, Institute of Electrical and Electronics Engineers (IEEE), International Journal of Construction Education and Research (IJCER), Web of Science (WOS), and Education Resources Information Center (ERIC via EBSCO). The search encompassed publications from 2015 to 2025, with geographical focus limited to North America. Publications that did not align with the educational focus, lacked relevance to GenAI, or addressed AI solely from a technical or industry-only perspective were excluded.

A comprehensive search strategy was developed using Boolean operators to identify relevant literature at the intersection of generative artificial intelligence and engineering/construction education. The search string employed was: ("GenAI" OR "Generative Artificial Intelligence" OR "Generative AI" OR "ChatGPT" OR "Large language models" OR "LLM") AND ("Construction Education" OR "Engineering Education") AND ("Teaching") AND ("Student Learning" OR "Student Performance").

Data Collection and Management

A shared Microsoft OneDrive folder was created as the central repository for all retrieved documents, facilitating collaborative access and version control throughout the research process. The data collection process was executed by two independent researchers (Agha and Oluniyi) to ensure systematic coverage and reduce individual bias. The literature retrieval process was organized into distinct phases. Initially, database-specific folders were created within the shared OneDrive environment to organize documents by source.

Screening and Selection Process

A rigorous two-round screening protocol was implemented to enhance reliability and minimize selection bias. The screening process incorporated both independent assessment and cross-validation mechanisms.

In the first screening round, each researcher independently reviewed abstracts from their assigned databases while simultaneously downloading potentially relevant articles. This simultaneous screening-and-retrieval approach allowed for preliminary filtering based on alignment with the research objectives, specifically examining whether the articles addressed generative AI applications in engineering or construction education contexts. To ensure efficiency, responsibilities were divided by database. Researcher 1 (Agha) conducted searches in ASEE, ASCE, and IJCER databases, while Researcher 2 (Oluniyi), searched on WOS, ERIC, and IEEE databases. During the initial retrieval phase, researchers performed relevance screening by reviewing abstracts concurrently with document downloads, retaining only articles deemed potentially relevant. Abstracts were assessed for consistency with the study's scope, and studies that did not meet the criteria were excluded.

To reduce individual bias and enhance reliability, a second round of abstract screening was conducted using a reverse-assignment protocol. Each researcher independently screened the documents that had been initially reviewed and downloaded by their colleague. Specifically, Researcher 2 (Oluniyi) reviewed documents from ASEE, ASCE, and IJCER databases, while Researcher 1 (Agha) reviewed documents from WOS, ERIC, and IEEE databases. This cross-validation approach provided an independent verification of inclusion decisions and helped identify any articles that may have been inappropriately included or excluded during the initial screening. At the end of the screening and selection process a total of 392 articles were retrieved across all databases.

Duplicate Removal and Data Organization

Following the two-round screening process, all retrieved articles were imported into Zotero reference management software [24], which served as the primary platform for bibliographic data organization and duplicate detection. A two-stage duplicate removal process was implemented. First, Zotero's built-in duplicate detection functionality was utilized to identify and remove duplicate documents from the initial collection. Subsequently, SR Accelerator [25] was utilized to conduct a secondary verification of document identification and remove duplicate documents, ensuring comprehensive elimination of redundant entries across the six data sources. A total of 392 articles were initially retrieved across all databases prior to duplication removal. Following the automated duplicate detection and removal process using both Zotero and SR Accelerator the collection was reduced to 369 articles.

Throughout the screening and selection process, the research team maintained regular communication through structured meetings. During the active academic semester, weekly research meetings were held to discuss progress, resolve ambiguities in inclusion criteria, and make consensus decisions regarding borderline cases. During the academic break, meeting frequency was increased to twice weekly to accelerate the review process and maintain research momentum. These collaborative sessions served multiple purposes: resolving disagreements regarding article inclusion or exclusion, refining inclusion and exclusion criteria based on encountered edge cases, identifying articles that did not align with the research purpose and objectives despite meeting initial screening criteria, and ensuring consistency in application of selection criteria across both researchers.

After removing duplicates, the research team conducted a detailed review of the remaining 369 articles, examining both abstracts and full papers. During this stage, each abstract was carefully assessed against the refined inclusion and exclusion criteria developed through the collaborative review process. For articles that met these criteria, the full text was thoroughly read and evaluated by the research team. Articles were excluded if they: did not specifically address generative AI technologies, lacked focus on engineering or construction education contexts, did not examine teaching or learning applications, or fell outside the defined geographical scope. Through this abstract review process, the final corpus was refined to 111 articles that met all inclusion criteria and were deemed relevant to the research objectives. These 111 articles formed the basis for subsequent bibliometric analysis and synthesis. The full list of the 111 articles included in the bibliometric analysis is provided in the Appendix.

Quality Assurance Measures

Several quality assurance mechanisms were embedded throughout the methodology to enhance the reliability and validity of the review. The dual-researcher approach with reverse-assignment cross-validation provided systematic verification of screening decisions. Regular collaborative meetings enabled identification and resolution of inconsistencies in criteria application. The use of established reference management software (Zotero) ensured accurate bibliographic data management and facilitated systematic organization of the literature corpus. The multi-stage duplicates removal process, employing two different tools (Zotero and SR Accelerator), provided redundant verification to ensure complete elimination of duplicate entries. This comprehensive methodological approach ensured systematic identification, screening, and selection of relevant literature while maintaining transparency and reproducibility of the review process.

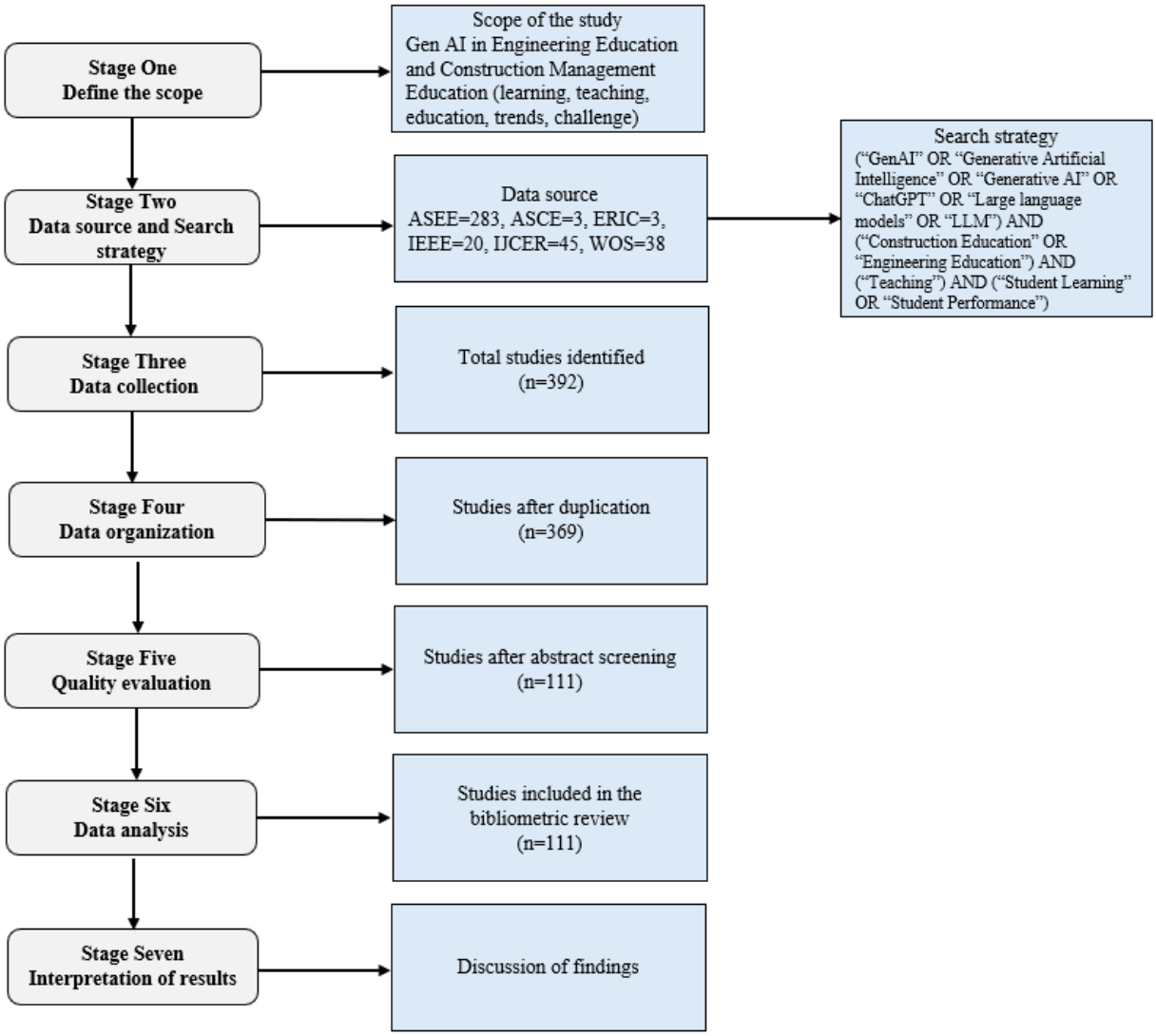

Figure 1. The 7 Stages of the bibliometric review

Findings

This section presents the findings from the analysis of 111 papers included in the bibliometric study. The review examined publication trends from 2015 to 2025, identified the journals and conference proceedings that published the highest number of articles, and highlighted the 10 most frequently cited works. Also, a keyword co-occurrence analysis was conducted to reveal the dominant thematic patterns within the selected literature.

Publication Trends From 2015 to 2025

The publication trends from 2015 to 2025 show that generative artificial intelligence (GenAI) is a very recent research focus within engineering and construction management education. Across major scholarly outlets including ASEE, ASCE, ERIC via EBSCO, IEEE, IJCER and Web of Science no publications on this topic appeared prior to 2023. From 2015 through 2022, GenAI simply had not yet emerged as an area of inquiry in these fields.

A dramatic shift occurred following the release of ChatGPT in late 2022, which catalyzed a rapid expansion of research interest. Our analysis identified 6 publications in 2023, signaling the first notable wave of scholarly engagement. This momentum accelerated sharply, with 41 publications in 2024 and 64 in 2025, illustrating an exponential rise in academic activity. Similar trends have been documented across the broader Architecture, Engineering, and Construction domain, where recent reviews emphasize GenAI's growing relevance for design automation, workforce upskilling, and AI-supported learning environments [4].

Although early work has begun to explore the educational implications of tools such as ChatGPT, research in this area remains relatively limited and still developing [26]. Nevertheless, the swift uptick in publications reflects how quickly scholars have mobilized to examine the pedagogical opportunities, integration challenges, and disciplines specific impacts of GenAI technologies within engineering and construction management programs [27], [28], [29], [30]. The trajectory from 2023 to 2025 as shown in Figure 2 demonstrates that generative AI has rapidly evolved from an emerging concept into a central topic of inquiry in engineering and construction education.

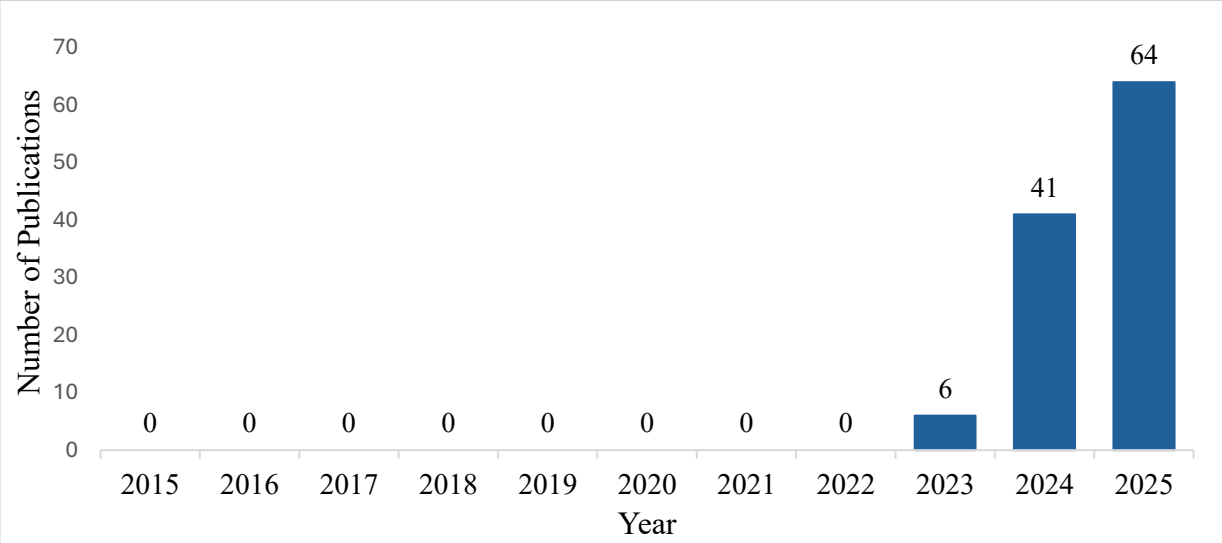

Figure 2. Number of publications per year

Journals and Conference Proceedings that have Published the Highest Number of Articles

The analysis of publication venues from 2015 to 2025 as shown in Table 1, reveals that research on generative artificial intelligence within engineering and construction management education in North America has been highly concentrated within a small number of journals and conference proceedings. The American Society for Engineering Education (ASEE) overwhelmingly dominates the field, accounting for 97 publications (87%), making it the primary outlet for scholarly work related to generative AI applications in engineering and construction management education. The Institute of Electrical and Electronics Engineers (IEEE) represent the second most active publisher, contributing 6 publications (5%). Although smaller in volume relative to ASEE.

The remaining publication venues each contributed 1 article (1%), including Architecture, CIB Conferences, Computer Applications in Engineering Education, European Journal of Engineering Education, International Journal of Technology in Education, Journal of Civil Engineering Education, Journal of Engineering Education, and Journal of Engineering Education Transformations. Although individually limited in output, this diverse set of outlets demonstrates the growing cross-disciplinary interest in generative AI as a transformative pedagogical tool within engineering and construction management domains.

Overall, the distribution of publications indicates that while generative AI is emerging across several disciplinary platforms, ASEE remains the central hub for disseminating educational innovations in engineering and construction management, with IEEE serving as a secondary but important contributor.

Table 1. Top 10 Journals and Conferences Publishing Generative AI Research in Engineering and Construction Management Education

Rank	Journals and Conference Proceedings	Number	Percentage (%)
1	American Society for Engineering Education	97	87%
2	Institute of Electrical and Electronics Engineers	6	5%
3	Architecture	1	1%
4	CIB Conferences	1	1%
5	Computer Applications in Engineering Education	1	1%
6	European Journal of Engineering Education	1	1%
7	International Journal of Technology in Education	1	1%
8	Journal of Civil Engineering Education	1	1%
9	Journal of Engineering Education	1	1%
10	Journal of Engineering Education Transformations	1	1%

The Most Frequently Cited Publications

An analysis of citation patterns within the literature on generative artificial intelligence (AI) in engineering and construction management education reveals several influential works that have shaped the discourse between 2015 and 2025. Table 2 shows the top ten most frequently cited publications in this domain.

The most cited publication is Johri et al. (2023) [12], titled *Generative Artificial Intelligence and Engineering Education*, which has accumulated 118 citations. This paper is a guest editorial that explores the transformative impact of generative artificial intelligence, such as ChatGPT, on engineering education, focusing on its potential to reshape research and teaching practices. It

explores pedagogical implications, discusses opportunities, limitations, ethical concerns, and the need for community-based approaches to integrate generative artificial intelligence responsibly into educational contexts.

Following closely is Onatayo et al. (2024) [4] with *Generative AI Applications in Architecture, Engineering, and Construction: Trends, Implications for Practice, Education & Imperatives for Upskilling—A Review*, garnering 89 citations. This paper reviews the applications of generative AI and large language models (LLMs) in architecture, engineering, and construction, analyzing trends, practical implications, educational strategies, and required skills for effective integration. It highlights opportunities for innovation and efficiency, challenges such as data privacy and ethical concerns, and emphasizes the need for upskilling through formal education, training, and collaborative learning approaches.

Other notable contributions include Yelamarthi et al. (2024) [31], which investigates opportunities and challenges in leveraging generative AI for engineering education (37 citations), and Tanay et al. (2024) [32], an exploratory study on the use of large language models in upper-level computing projects (30 citations). These studies collectively underscore the growing interest in practical applications and student engagement with AI tools. Publications such as Kim et al. (2024) [33], focusing on ChatGPT's impact on lab report writing (23 citations), and Harris & Kittur (2024) [15], presenting a systematic review of generative AI in undergraduate engineering (17 citations), further illustrate the breadth of research addressing both instructional strategies and ethical considerations. Camacho-Zuñiga et al. (2024) [34]with 17 citations, explores the ethical and responsible integration of Generative AI (GenAI) in higher education by presenting a set of usage guidelines proposed by engineering undergraduates, comparing them with institutional recommendations, and highlighting their implications for teaching, learning, and policy development.

Recent works, including Wang et al. (2025) [35] and Simelane & Kittur (2025) [36] with 14 citations respectively, reflect a shift toward examining student perceptions and instructor perspectives, signaling an evolution from theoretical frameworks to empirical investigations of AI adoption in STEM education. He et al. (2024) [37] with 14 citations, analyzes the pedagogical potential of ChatGPT in computer science and engineering education by evaluating its performance across diverse subjects and task types using a five-factor reliability framework, highlighting strengths, limitations, and implications for curriculum design and policy adaptation.

Overall, these highly cited publications form the intellectual backbone of current scholarship, offering insights into pedagogical innovation, technological integration, and the future trajectory of generative AI in engineering and construction management education.

Table 2. Top 10 Most Frequently Cited Publications

Rank	Title	Author(s)	Year	Total Citations
1	Generative Artificial Intelligence and Engineering Education	Johri et al. [12]	2023	118
2	Generative AI Applications in Architecture, Engineering, and Construction: Trends, Implications for Practice, Education & Imperatives for Upskilling—A Review	Onatayo et al. [4]	2024	89

3	Exploring the Potential of Generative AI in Shaping Engineering Education: Opportunities and Challenges	Yelamarthi et al. [31]	2024	37
4	An Exploratory Study on Upper-Level Computing Students' Use of Large Language Models as Tools in a Semester-Long Project	Tanay et al. [32]	2024	30
5	A Pilot Study Inquiring into the Impact of ChatGPT on Lab Report Writing in Introductory Engineering Labs	Kim et al. [33]	2024	23
6	Generative Artificial Intelligence in Undergraduate Engineering: A Systematic Literature Review	Harris & Kittur [15]	2024	17
7	Generative AI Guidelines by/for Engineering Undergraduates	Camacho-Zuñiga et al. [34]	2024	17
8	Scaffold or Crutch? Examining College Students' Use and Views of Generative AI Tools for STEM Education	Wang et al. [35]	2025	14
9	Use of Generative Artificial Intelligence in Teaching and Learning: Engineering Instructors' Perspectives	Simelane & Kittur [36]	2025	14
10	The AI Companion in Education: Analyzing the Pedagogical Potential of ChatGPT in Computer Science and Engineering	He et al. [37]	2024	14

Analysis of Keyword Co-Occurrence

The VOSviewer tool version 1.6.20 [38] was used to analyze the co-occurrence of keywords in the 111 selected papers to identify prior research focus areas and suggest future research directions for the application of generative AI in engineering and construction management education. One term was used in place of several synonyms. After setting the minimum number of keyword occurrences at three, 28 keywords were selected for the keyword co-occurrence analysis (see Figure. 3). Each keyword's circle size indicates how often it appears in the sample; larger circles indicate more instances. Generative AI (65 occurrences), engineering education (37 occurrences), artificial intelligence (35 occurrences), ChatGPT (33 occurrences), and large language model (23 occurrences) were the top five terms by circle size, indicating high frequency of occurrence. The highest occurrence frequency for the generative AI keyword indicates that researchers are paying more attention to technology-enhanced learning through the use of generative AI, as well as to the application of generative AI specifically in engineering education.

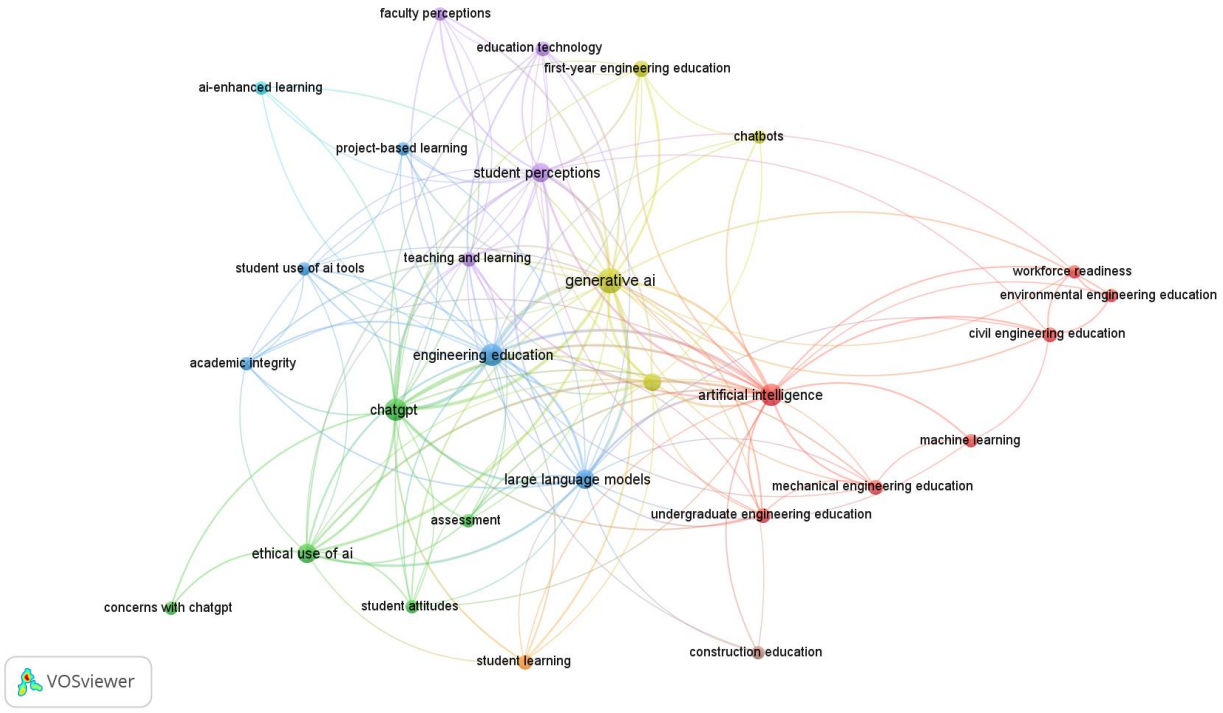

Figure 3. Keyword analysis in VOSviewer.

The keyword co-occurrence network identifies five theme clusters. Each cluster keyword reflects closely linked fields of study. The yellow cluster represents research on generative AI in higher education, with a focus on first-year engineering education. Chatbots are closely related to generative AI terminology, suggesting frequent use in introductory engineering contexts. Applications of AI in undergraduate engineering education, especially in mechanical, civil, and environmental engineering, are represented by the red cluster. Workforce preparedness and machine learning are related topics. Although AI adoption is prevalent, it has not yet achieved widespread integration within construction education, as evidenced by the weak connection between the two. The green cluster, focused on ChatGPT, highlights studies on ethical issues, student attitudes, evaluation procedures, and concerns about the use of ChatGPT. The blue cluster includes research on engineering education and large language models, with an emphasis on AI-enhanced learning, project-based learning, AI tools, and academic integrity. The purple cluster encompasses research on teaching and learning, educational technology, and student and faculty perspectives, with student perceptions emerging as the most significant theme. Overall, generative AI emerges as a dominant and well-connected theme within engineering education research, while construction education remains comparatively peripheral, indicating an opportunity for further exploration and integration.

Current State of the Art

The scholarly domain of generative artificial intelligence (GenAI) in engineering and construction management education represents an emerging field characterized by rapid expansion and concentrated disciplinary focus. This section synthesizes key findings from the

bibliometric analysis of 111 publications from 2015 to 2025, examining publication trajectories, influential outlets that define the current state of research.

Research on GenAI in engineering and construction management education demonstrates an accelerated evolution beginning in 2023. No publications on this topic appeared in major scholarly databases (ASEE, ASCE, ERIC via EBSCO, IEEE, IJCER, Web of Science) prior to this year. The release of ChatGPT in late 2022 catalyzed exponential growth: 6 publications in 2023, 41 in 2024, and 64 in 2025. This trajectory parallels broader trends within the Engineering and Construction domain, where GenAI has gained prominence for design automation, workforce development, and AI-supported learning [39].

Publication distribution reveals significant concentration within specific outlets. The American Society for Engineering Education (ASEE) dominates the field with 97 publications, establishing itself as the primary dissemination platform. The Institute of Electrical and Electronics Engineers (IEEE) contribute 6 publications, while eight additional venues each published one article. This pattern indicates that while cross-disciplinary interest is expanding, ASEE remains the central hub for educational innovation discourse.

Citation analysis identifies key works establishing the field's intellectual foundation. Johri et al. (2023) (118 citations), leads with an examination of GenAI's transformative impact on teaching practices, pedagogical implications, and ethical integration. Onatayo et al. (2024) [39] (89 citations) provides a comprehensive review on Architecture, Engineering, and Construction sector, analyzing trends, educational strategies, and upskilling needs while addressing challenges. Other influential works include Yelamarthi et al. (2024) [31](37 citations) on opportunities and challenges, Tanay et al. (2024) [32](30 citations) on large language model use in computing projects, and Kim et al. (2024) [33] on ChatGPT's impact on lab reports (23 citations). publications including Wang et al. (2025) [35] and Simelane & Kittur (2025) [36] (14 citations each), reflects evolution toward empirical investigations of student and instructor perspectives. Researchers also address ethical integration (Camacho-Zuñiga et al., 2024) [34] (17 citations), systematic reviews (Harris & Kittur, 2024) [15] (17 citations), and pedagogical assessment (He et al., 2024) [37] (14 citations).

Keyword co-occurrence analysis identified 28 keywords appearing at least three times, revealing five thematic clusters. The most frequent keywords, generative AI (65 occurrences), engineering education (37 occurrences), artificial intelligence (35 occurrences), ChatGPT (33 occurrences), and large language model (23 occurrences), indicate concentrated attention on technology-enhanced learning. Notably, generative AI emerges as a dominant theme within engineering education research, while construction education remains peripheral with weak thematic connections, indicating significant opportunity for expanded integration and investigation.

Future Research Directions

This bibliometric review indicates that research on GenAI in engineering and construction management education is emerging rapidly but remains unevenly distributed across disciplines. While engineering education dominates the literature, construction management specific applications are weakly represented, highlighting a critical gap. Future studies should focus on construction management relevant instructional applications of GenAI, including estimating, scheduling, safety planning, and materials and methods. Empirical research is needed to evaluate

how GenAI supports hands-on learning, problem-solving, and professional skill development, as well as its impact on student performance, knowledge retention, and workforce readiness.

Research should also examine pedagogical models for effective and ethical GenAI integration, addressing academic integrity, student trust, and AI literacy. Issues of equity and accessibility require further attention to ensure inclusive adoption across diverse student populations. Finally, stronger academia–industry collaboration is needed to align GenAI-enabled instruction with authentic engineering and construction management practices and evolving workforce expectations.

Conclusion

The findings of this bibliometric study show that research on generative artificial intelligence (GenAI) in engineering and construction management education is expanding rapidly but remains in an early developmental stage. Publication trends demonstrate that meaningful scholarly engagement only began in 2023, with an exponential rise in output through 2025. The dominance of ASEE as the primary publication venue and the concentration of citations around a small number of foundational papers illustrate that the field is currently driven by a narrow set of disciplinary communities and thought leaders. Keyword co-occurrence patterns further reveal well-established themes in engineering education such as ethics, student perceptions, and AI-enhanced learning while construction management education remains comparatively underrepresented. Together, these patterns reflect a field that is growing quickly but still unevenly across domains and research themes.

The study finds that the majority of existing publications are conceptual, exploratory, or descriptive, offering valuable early insights but limited methodological rigor. Highly cited works often provide frameworks, pedagogical reflections, ethical guidelines, or initial investigations of student and instructor attitudes, which are useful for shaping foundational understanding but insufficient for generating strong evidence-based practices. Empirical studies, especially those employing robust designs, large samples, or longitudinal data are relatively scarce. As a result, while the current body of work is instrumental in defining the landscape of GenAI in engineering and construction education, its practical utility is constrained by a lack of rigorous, discipline-specific, and construction-focused research. Strengthening methodological depth and expanding inquiry into construction management contexts will be essential for advancing the field and developing a more reliable foundation for educational policy and practice.

Limitations of this study include database selection, variations in search strategies, and the rapidly evolving nature of GenAI research, particularly the use of ChatGPT in engineering and construction management education. Nevertheless, this review provides a timely synthesis of publication trends, influential works, and thematic gaps. Addressing these gaps through targeted, construction management specific, and empirically grounded studies will be essential to fully leverage GenAI’s potential in engineering and construction management education.

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Appendix: Corpus of Documents Included in the Bibliometric Analysis

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