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Analyzing Research Trends and Collaborations in the Community of Practice in Engineering Education

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ABSTRACT

BACKGROUND & CONTEXT

As institutions improve learning, teacher training, and outcomes, engineering education research progressed over time. Communities of Practice (CoP) fostered collaboration and innovation, yet frameworks and knowledge transfer remain understudied. Empirical research on outputs and impact especially in global and regional networks is limited.

PURPOSE OR GOAL

From a Philippine perspective, this study examined research trends, collaborations, and influence in the engineering education CoP. It examined notable authors, works, subjects, and transdisciplinary and international partnerships. Bibliometric and patent analyses provided a broad view of knowledge development and its impact on the field.

APPROACH OR METHODOLOGY

A data-driven approach used SciVal and Scopus analytics to obtain metrics on publication, citation, collaboration, views, and patents relevant to engineering education. Critical publishing sources and impact metrics were analyzed to determine knowledge diffusion within the CoP.

OUTCOMES

Global and regional engineering education research productivity peaked in 2018. Philippine production and citation volume were modest, but its citation-per-publication and view percentile were competitive. STEM integration, e-learning, and student-centered instruction were engineering education research priorities. Most collaboration was institutional, with limited international and academe-industry.

CONCLUSIONS

The evidence indicated that while the global community is advancing engineering education research rapidly, the Philippines remained underrepresented. Despite this, its engagement per publication was promising, suggesting untapped potential. This study reinforced the need for strategic international and industry partnerships to enhance knowledge diffusion in the field.

KEYWORDS

Engineering Education, Community of Practice, Research Collaboration Networks, Bibliometric Analysis, Knowledge Dissemination.

Introduction

Engineering education has experienced significant transformation over the past decades, driven by the evolving demands of industry, rapid technological advancements, and the increasing emphasis on outcome-based education. Central to this transformation is the global Community of Practice (CoP) that has emerged among researchers, educators, and institutions committed to enhancing teaching, learning, and curriculum development in engineering. This community thrives on collaboration and shared expertise, enabling the continuous refinement of pedagogical strategies and the alignment of educational outcomes with professional competencies.

Despite the vibrancy of this community, there is limited empirical research that systematically maps its collaborative structures, research productivity, and knowledge dissemination practices. Existing literature often focuses on individual case studies, program evaluations, or pedagogical innovations, while broader patterns of influence, interconnectivity, and intellectual leadership within the community remain underexplored. Furthermore, the extent to which multidisciplinary and international partnerships shape the direction and impact of engineering education research is not yet fully understood.

This study addresses these gaps by employing bibliometric and patent analytics to analyze research trends, identify key contributors, and describe the collaborative networks that define the Community of Practice in engineering education. Specifically, the study seeks to answer the following research questions:

1. What are the dominant themes and topics emerging in engineering education research globally and in the Philippines?
2. Who are the most influential contributors and institutions in this research community, and what is their level of collaboration?
3. To what extent does research in engineering education exhibit international, national, institutional, or industry-academe collaboration?
4. How do knowledge production, impact, and diffusion in the Philippines compare to global and regional benchmarks?

Through a comprehensive exploration of publication data, citation patterns, and cooperation indicators using Scopus and SciVal, this paper uncovered how knowledge is produced, disseminated, and amplified within this field. By shedding light on the structure and dynamics of this research ecosystem, the study contributed valuable insights that may inform policy, funding priorities, and strategic academic partnerships in engineering education, particularly within developing contexts like the Philippines.

Literature Review

In engineering education, academic focus on research trends and collaborative methods is still limited, despite its growing importance in quality assurance and accreditation. Recto and Timajo (2022) emphasized the necessity of aligning educational management frameworks with international agreements, such as the Washington Accord, notably via models like the Balanced Scorecard. Their work illustrated that quality assurance methods now regard collaborative and research-oriented activities as essential markers of institutional effectiveness.

In the Philippine context, three key factors contribute to the limited growth of engineering education research. First, many institutions lack dedicated funding and infrastructure to support this emerging field. Second, faculty are often burdened with heavy teaching loads, leaving minimal time for research. Third, engineering programs tend to prioritize technical outcomes and industry alignment over pedagogical inquiry, resulting in low institutional emphasis on education-focused research.

While limited studies explicitly examined research trends and collaborations in engineering education, other publications contributed indirectly to this discourse. Nxumalo and Mnkandla (2019) emphasized the advantages of knowledge sharing within software development communities, underscoring personal benefits and improved organizational performance as results of robust communities of practice. Kuo and Lin (2015) examined interaction patterns in virtual learning communities within a K–12 framework and identify notable country disparities in collaborative behavior and knowledge exchange.

The significance of communities of practice (CoPs) in facilitating collaboration was also apparent in non-engineering domains. Kanjo et al. (2022) illustrated how coordinated Communities of Practice (CoPs) improved the integration of community health information systems. Despite the health setting, the implications for collaborative infrastructure are applicable elsewhere. Zhang et al. (2008) highlighted the trust mechanisms inherent in Communities of Practice (CoPs) that facilitated successful knowledge management. However, their research did not explicitly investigate trends in the field as well.

Aron and Niemann (2014) examined how decision-makers and scientists would utilize data science, especially Big Data, from a technological and scientific viewpoint. Although their study addressed data publication and semantic technologies, it failed to explore research patterns explicitly. Conversely, Fayyaz and Jesiek (2012) performed a mesoscopic examination of engineering education scholarship in electrical and computer engineering, encompassing the years 2002 to 2011. This work, although foundational, is now obsolete and restricted in scope.

Smith et al. (2015) highlighted that initiatives to establish and maintain engineering education research networks are increasingly apparent, as teachers and graduate students engaged in this field frequently experience isolation. Their program aimed to cultivate relationships and enhance a robust academic network. Capobianco et al. (2006) proposed for the establishment of a professional Community of Practice in engineering education, providing a conceptual and structural framework, shared methodology, and strategies for talent cultivation. Although fundamental, these initiatives prioritize community development over trend analysis.

Brunhaver et al. (2018) contended that the engineering practice landscape is swiftly transforming due to globalization, technical advancements, and emerging organizational requirements. They emphasized the necessity for additional study connecting academic preparation to professional reality. Nonetheless, the focus stayed on practical application rather than scholarly research methodologies.

Although current literature recognized the importance of collaboration, community, and knowledge sharing, a distinct gap existed in the analysis of the evolution of research trends in engineering education and the impact of collaborative networks on these trends. This study sought to fill that gap by offering a comprehensive analysis of research networks and collaborations in the field.

Methodology

This study employed a data-driven approach to investigate research trends and collaboration in engineering education, specifically emphasizing information dissemination and community

development within the discipline of Engineering Education. The methodology combined bibliometric and scientometric analysis of data from Scopus and SciVal, alongside a qualitative thematic examination of pertinent literature.

Data Sources and Tools

The data for this study were predominantly sourced from Scopus, a major abstract and citation database of peer-reviewed literature. SciVal, an analytics instrument created by Elsevier, was utilized to collect and assess research performance data. These instruments facilitated the measurement and examination of publication volume, citation impact, international collaboration, patent production, and other pertinent indicators related to engineering education research.

Search Strategy

Search phrases were constructed utilizing Boolean operators and keyword combinations including “engineering education research,” “collaboration,” “communities of practice,” “research trends,” and “knowledge sharing.” Filters were implemented to restrict the search to peer-reviewed papers in English. A temporal filter was employed to highlight works published from 2014 to 2023, along with the expansion of worldwide certification frameworks and heightened focus on global engineering education outcomes.

Inclusion and Exclusion Criteria

Studies were included if they concentrated on engineering education research at the tertiary level, included metrics or analyses pertaining to collaboration, publishing, or impact, and addressed issues such as knowledge dissemination, innovation, or quality assurance frameworks. Conversely, studies were excluded if they were not indexed in Scopus, concentrated solely on K–12 education, or comprised editorials, letters, or other non-peer-reviewed materials.

Data Analysis and Reporting

Quantitative metrics were collected utilizing SciVal’s Research Areas and Collaboration modules, concentrating on five principal indicators: publications, citations, worldwide collaboration, views and engagement, and patents. The overall number of publications, their growth over time, and concentration by subject area were also analyzed. The citation data comprised total citations and citations per publication. International collaboration was evaluated via co-authored papers by country and institution. Engagement indicators encompassed document views, especially from leading publications and institutions. Ultimately, patent data were examined to pinpoint occurrences of citations of academic research in engineering education. These variables were employed to assess the progression of research activities, collaboration patterns, and the dissemination of knowledge inside and outside academic groups. Prominent publication sources, such as high-impact journals and conference proceedings, were examined to assess their significance in influencing discourse in engineering education research.

For ethical transparency, AI assistance was used solely to enhance the coherence of the final manuscript. The ideas, interpretations, and conclusions presented remain the authors’ own. Full responsibility for the content rests with the authors.

Results and Discussion

The foremost 50 keyphrases by relevance, depicted in Figure 1, predominantly focus on “engineering education,” accompanied by associated themes such as “e-learning,” “STEM,” and “engineering student.” This illustrates an evolving dialogue in the domain, grounded in educational innovation, computational integration, and STEM-oriented methodologies. The use of phrases such as “computer-aided instruction” and “educational computing” indicates a continued interest in technological facilitators of learning.

although output is limited, the quality of Filipino research is comparable. This may suggest recent yet inadequately funded involvement in international academic discussions.



Figure 3: Citation Metrics for Engineering Education

Philippine articles achieved an audience reach of merely 12,635 views, far lower than the Asia Pacific's 751,280 and the global total over 2.2 million, as illustrated in Figure 5. Table 2 reveals a significant observation: 5.6% of Philippine publications were classified in the top 1% of most viewed, while 33.3% were inside the top 10%, exceeding both regional and global averages. This indicates that although general visibility is constrained, certain Filipino-authored works garner significant attention, highlighting an underappreciated potential for enhanced worldwide influence and academic leadership. Furthermore, as illustrated in Figure 4, the Philippines maintains its position regarding citations per publication, closely aligning with Asia Pacific and global standards.

Table 2: Top View Percentile

Styles	Share of Publications in Top 1% Most Viewed	Share of Publications in Top 10% Most Viewed
Worldwide	4%	25%
Asia Pacific	4%	25.1%
Philippines	5.6%	33.3%

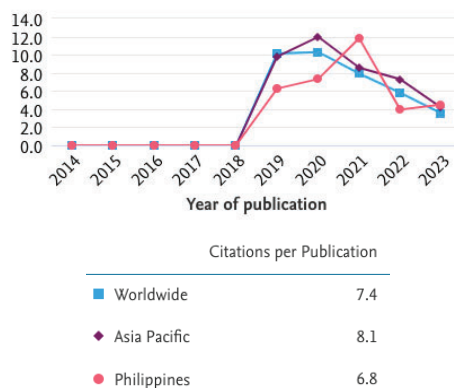


Figure 4: Citations Per Publication for Engineering Education

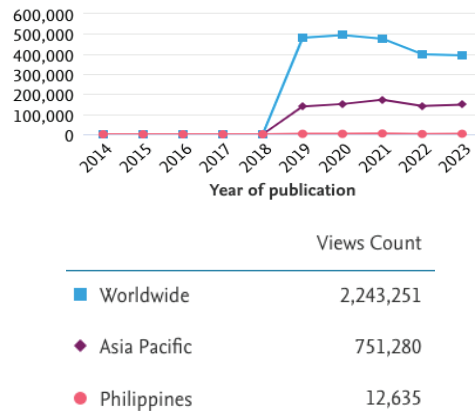


Figure 5: View Metrics

Table 3 indicates that Q1 and Q4 journals predominate among the publication locations. The field has stringent peer review standards and superior dissemination quality, with 32.3% of work published in Q1 journals. The robust Q4 share (27.6%) may also signify accessibility and inclusivity for early-career researchers or resource-limited institutions.

Table 3: Journal Quartiles

Quartiles	Publications	Publications Share
Q1	11,707	32.3%
Q2	7,441	20.5%
Q3	7,075	19.5%
Q4	9,990	27.6%

The Philippines ranks 46th worldwide in academic production, with 324 articles and 2,190 citations. Table 4 indicates that the United States, China, and India collectively dominate, contributing about 30,000 papers and exceeding 247,000 citations. This highlights an urgent necessity for regional capacity enhancement and investment in engineering education research in the Philippines and Southeast Asia at large.

Table 4: Top 10 Countries

Styles	Scholarly Output	Citation Count
United States	16,963	148,393
China	9,028	68,143
India	3,226	30,990
United Kingdom	2,787	44,207
Russian Federation	2,630	8,710
Indonesia	2,484	10,538
Germany	2,412	23,814
Spain	2,409	28,333
Australia	1,726	26,605
Canada	1,555	18,826

Table 5 reveals that prominent sources encompass significant conferences like ASEE and IEEE EDUCON, underscoring the critical role of professional assemblies in knowledge dissemination. This also illustrates the vitality of engineering education as an applied and collaborative field, where swift information dissemination frequently occurs through proceedings rather than solely through journal publications.

Table 5: Top 10 Scopus Sources

Styles	Scholarly Output	Citation Count
ASEE Annual Conference and Exposition, Conference Proceedings	6,244	9,442
Journal of Physics: Conference Series	2,353	7,300
ACM International Conference Proceeding Series	1,387	4,275
Advances in Intelligent Systems and Computing	1,342	4,680
Proceedings - Frontiers in Education Conference, FIE	1,142	3,421
IEEE Global Engineering Education Conference, EDUCON	1,033	6,003
Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	957	2,951
Lecture Notes in Networks and Systems	750	1,066
CEUR Workshop Proceedings	677	2,639
Communications in Computer and Information Science	602	1,514

Figure 6 illustrates that engineering education constitutes around fifty percent of all publications, with computer science (41.6%) and social science (36.3%) as prevalent secondary categories. This overlap indicates the multidisciplinary character of the discipline, affirming its identity as a community of practice that integrates insights from teaching, computer, and human behavior.

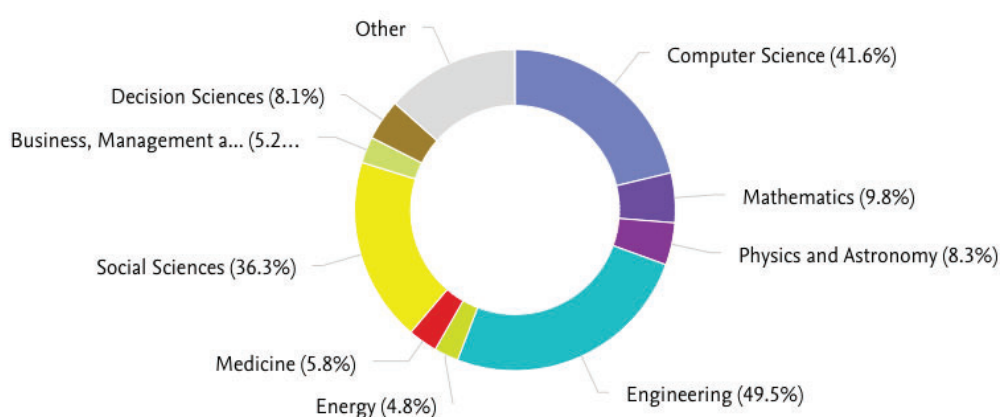


Figure 6: Subject Areas

Table 6 indicates that American universities lead the list of top contributors, with Purdue University and Virginia Tech in the forefront. Only one non-US institution, the Instituto Tecnológico de Estudios Superiores de Monterrey in Mexico, is represented in the top five,

indicating a lack of global diversity in leadership within the discipline. This affects equity in knowledge production and necessitates measures to facilitate research involvement from the Global South.

Table 6: Top Contributors

Keyphrase	Scholarly Output from 2014-2023
Purdue University, USA	619
Instituto Tecnológico de Estudios Superiores de Monterrey, Mexico	414
Virginia Polytechnic Institute and State University, USA	376
Pennsylvania State University, USA	327
Texas A&M University, USA	281

Figure 7 highlights issues regarding collaboration levels. Merely 14.5% of papers entail international collaboration, and collaboration between academia and industry is exceedingly minimal at 1.1%. A thriving community of practice relies on extensive, cross-sector involvement; however, present trends indicate a disjointed ecology. This constrains innovation, application, and reciprocal learning between academia and industry.

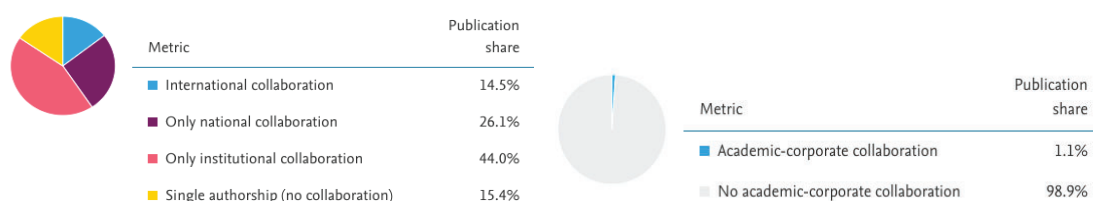


Figure 7: Geographical and Academic-Industry Collaboration

Figure 8 illustrates a decrease in patents referencing academic contributions in engineering education following a peak in 2019. This indicates a potential stall in the conversion of research into concrete innovation. Due to the practical character of engineering, it is essential to promote more robust knowledge transfer paths, especially between educational research and technological development sectors.

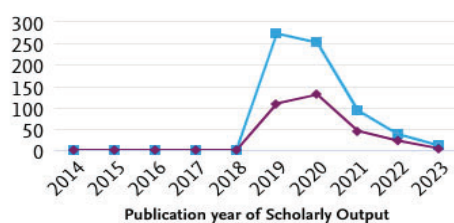


Figure 8: Patents

Data reveal that engineering education research is expanding; however its distribution is inconsistent. The pre-eminence of select nations and organizations exposes disparities in academic influence and constrains the range of viewpoints in creating the discipline. The Philippines and analogous nations, notwithstanding their limited volume, exhibit encouraging effect indicators that warrant strategic assistance. This encompasses financing for joint initiatives, faculty exchange programs, and open-access distribution.

The development of the area as a community of practice is hindered by inadequate collaboration, particularly on an international scale and with industry partners. Establishing more organized consortia, regional networks, and collaborations may enhance reciprocal participation and expand the field's influence. The substantial concentration of work in conferences necessitates improved integration of proceedings into global citation systems to augment visibility.

To chart a practical path forward, engineering education research in the Philippines can focus on accessible innovation and strategic policy alignment. Accessible innovation can democratize research by leveraging open-source platforms, free simulation software, and low-cost prototyping tools. These technologies can empower students and faculty even in resource-constrained environments (Masa, Rafael, & Recto, 2024). Industry-academe partnerships may also co-develop educational pathways, as seen in Imagineering-based curricula that promote creativity and research (Recto, Consignado, & Neyra, 2022). The evolution of programming languages—from machine code to natural language interfaces—has similarly reduced barriers to participation while raising ethical and pedagogical concerns, particularly in AI-driven instruction (Rafael & Recto, 2024). These concerns, however, may be addressed by adopting a national framework on Ethical AI integration. One such framework has already been proposed, ensuring that learners acquire not just technical competency, but also ethical responsibility (Recto, Neyra, & Teologo, 2025).

Finally, while not all faculty members are directly involved in national research councils or fully aware of long-term policy directions, integrating relevant national priorities can enhance relevance and funding alignment. For instance, members of the National Research Council of the Philippines are encouraged to align their work with national research agendas. However, participation remains uneven. The goal is not forced uniformity but fostering greater awareness and convergence.

Conclusion

The results confirm that engineering education research is gaining substantial global traction, particularly in North America and the Asia-Pacific regions. The Philippines' limited contribution underscores the necessity for enhanced structural support, international cooperation, and partnerships between industry and academia. The comparatively high citation-per-publication and view percentile indicate that current Filipino outputs are influential when they participate in intellectual discourse. These findings correspond with prior studies highlighting the significance of cross-border and cross-sector collaboration and indicate a definitive strategy for nations seeking to enhance their research visibility and impact in engineering education.

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