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Quantitative insights into outcome-based education: a bibliometric exploration

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ABSTRACT

Outcome-based education (OBE) is a method of educational approach that focuses on defining specific learning outcomes or objectives that students should achieve by the end of a course, program, or educational experience Instead of merely following a predetermined curriculum, OBE places focus on what learners should be able to accomplish or display as a result of their learning. A thorough bibliometric analysis utilizing biblioshiny and VOSviewer is used in this work to dive into the world of outcome-based education. This investigation attempts to offer quantitative insights into the development, trends, and significant contributors in the area of OBE by carefully examining a wide range of academic articles. The study encompasses a broad temporal range, capturing developments in the field from its inception in 1978 to 2023, thereby offering a comprehensive overview of its evolution over time. Patterns in research production, significant works, prolific authors, and collaboration networks appear via the prism of bibliometric approaches, illuminating the complex OBE landscape. This study not only contributes to the understanding of OBE's scholarly landscape but also underscores the significance of bibliometric approaches in illuminating trends and shaping future research directions.

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1. INTRODUCTION

Performance criteria of students and identification of results are highly relevant to quality management in educational systems [1]. The quality of an educational system can be judged normally through three perspectives: the inputs to the system, what happens within the system, and the outputs from the system. Those who are interested in the first perspective make their judgment based on economic rationalism by giving preference to finance, resources, and infrastructure. Those interested in the second perspective may focus their attention on various processes such as organization, control, and delivery of education. About the last perspective, the most important factors that affect judgment are the products or results of education. The last perspective is the key to the outcome-based education (OBE) system. However, in recent years, western society has been paying greater attention to the outcomes of education for the evaluation of an education system [2]. Thus, it is directly applicable to outcome-based education. In the

modern era, a transition from textbook-based learning is essential. Transformational education is the twilight zone between traditional curriculum and OBE [3].

Outcome-based education is more student-centric. OBE is an educational system that focuses on enabling all students to apply what they have learned in the classrooms to their lives. In this system, teachers act as facilitators. They are helping the students to realize and understand why and how the students can learn content. Moreover, teachers help the students to understand how much they have been able to extract and understand all these facts [4]. Conventional methods are totally teacher-centric and textbook-bound. There, the students are passive learners not active. Teachers are rushed to finish their syllabus because in this system they have more responsibility for their students' failure and success. The new educational system enhances the student's critical thinking and reasoning as it provides freedom to the learners to learn and practice in a flexible time. Here, the assessment of students will be done daily, using more discussions and other methods than tests. Students are also evaluated through quiz competitions, projects, internships, seminar group and discussions [5].

A curriculum focused on student learning outcomes constitutes a paradigm shift in educational philosophy and practice [6]. The curriculum of OBE has been developed in such a way that the ability and excellence of the students can be measured. After measuring the ability of each student through various methods, the curriculum should be revised again to include more subjects in the syllabus as needed to increase their skill. Unfortunately, many countries including India have started their initial implementation of the OBE system only after the syllabus revision.

Students in this digital age must survive in a rapidly changing society driven by technology and the economy. Educational institutions are beginning to understand the fact that the production of professionals is much more important than just an educational qualification. Employers require university graduates to have not only the knowledge but also the appropriate skills to be effective and productive in the workplace. To meet these challenges, universities around the world are considering how to redesign their academic models [7]. Although many universities have attempted to implement quality assurance systems for their students, the underlying principles of these systems vary significantly [8]. Various types of quality assurance learning methods have been tried to be included in the higher education field from time to time all over the world, it is necessary to reconsider how effectively they bring sustainable quality improvement [9]. Thus, in the present situation, the modification of curriculum based on OBE in colleges is very difficult. In the case of colleges, this can be easily implemented only if they get autonomous status. Most of the accreditation councils such as such as NBA and ABET. focus more on OBE [10]. The learning outcomes are used at all stages of the student's academic life.

The limitation of an OBE system is that the current system is unable to evaluate student's social commitment. There is no system in this new education policy to measure many of the non-educational factors such as attitude skills and humanism. The Traditional curriculum is revised in the national education policy with outcome based educational system. Educational institutions are conducting many programs on this topic to raise awareness among teachers and educationalists. Most of the students have very limited knowledge about this. Before the implementation of the national education policy, every student must be aware of its advantages and disadvantages. The higher education department and the government should take the necessary steps to educate the students about this OBE.

Bibliometric analysis is a quantitative research method that looks for connections, patterns, and trends in a body of academic literature [11]–[15]. It necessitates looking at bibliographic information, including citations, publication dates, author affiliations, and keywords, in order to comprehend the make-up and importance of study fields [16]–[21]. Bibliometric analysis is commonly used to determine the influence of certain researchers, journals, or organizations, track the evolution of research fields through time, and identify emerging trends [17], [22]–[24]. With this method, readers may also acquire comprehensive details on the intellectual, conceptual, and social structures of a particular field as well as information about how those structures have changed over time [25], [26]. Even if the number of academic publications keeps increasing, bibliometrics is still an essential tool for understanding the scientific environment and enhancing the efficacy of information dissemination.

For bibliometric analysis and visualizing bibliographic data, a well-known piece of software called VOSviewer is utilized [24], [27]. The term "Visualization of Similarities" viewer, or VOSviewer, emphasizes its capacity to reveal connections and patterns within massive data sets [28]–[31]. To learn more about research networks, partnerships, and trends, researchers frequently utilize it in cooperation with bibliometricians and information specialists [28], [32], [33]. The Integrated Development Environment (IDE) for the prevalent R programming language is called the "RStudio" which provides a simple graphical user interface for writing, executing, and updating R code [34]–[36]. Researchers frequently use RStudio for data analysis, data visualization, statistical modeling, and analysis of literature [32], [35]. Interactive web apps may be created in R directly by using the Shiny package [37]. Employing R code, it enables the development of interactive and dynamic web-based dashboards, visualizations, and applications [37], [38]. In order to

create a web application that allows users to dynamically explore the data, discover visualizations, and even customize analyses, the Shiny program utilizes bibliometric data [15], [39]–[41].

The research objectives of this bibliometric analysis on OBE includes:

- Identifying key contributors: Identify the most prominent authors, organizations, and nations in the OBE domain.
- Mapping research trends: Examine how OBE-related research topics and trends have changed over time.
- Assessing collaboration networks: Examining co-authorship and cooperation patterns may help you better understand how organizations and scholars collaborate in the subject of OBE.
- Evaluating impactful publications: Evaluate significant papers in the OBE field. Find the foundational works that have influenced the field.
- Geographical distribution: Analyze the distribution of OBE research geographically to ascertain where it is concentrated and whether there are regional differences.
- Emerging concepts and keywords: Examine new terminology and ideas in OBE research.

2. LITERATURE REVIEW

The outcome-based education (OBE) is recognized for its potential to bridge the gap between educational institutions and industry demands by focusing on specific learning outcomes and student performance. A range of research articles are analyzed, each demonstrating how OBE enhances curriculum design, faculty readiness, and student outcomes. By examining case studies across disciplines such as technical education, software engineering, healthcare, and computing studies, this review provides valuable insights into the multifaceted benefits and challenges of OBE.

The Washington accord's OBE aims to enhance technical education by setting clear student expectations and emphasizing specific learning outcomes for more accurate assessment of achievements. Bhatt *et al*. [42] conducts a meta-analysis of Indian engineering institutes' OBE implementation, highlighting a research gap in empirical validation of results and a lack of consistent comprehension regarding CO-PO mapping, underscoring the need for statistically validated pre- and post-implementation data to address these issues. Yang *et al*. [43] presented an OBE approach to enhance the foundation and application of microcontroller course for automation students. This approach, involving revised objectives, modular teaching, and practical projects, resulted in superior student performance in creating a temperature measurement system through software tools, ultimately advancing student-centered curriculum objectives and practical problem-solving skills.

Jie [44] proposes using OBE model to enhance software talent training, addressing the challenges of low-quality engineers and the gap between education and industry demands. The study demonstrates that implementing OBE improves satisfaction, team quality through research funding, and achieves high testing accuracy (94.23%) with the OBE talent training approach. Katawazai [45] investigated Afghan lecturers' attitudes towards outcome-based education, revealing their positive attitude and readiness to adopt the approach despite challenges. The findings offer insights to the Ministry of Higher Education for policy development and highlight the need to address key obstacles for effective implementation.

Tungpalan and Antalan [46] examine the implementation of OBE at Isabela State University-College of Computing Studies, focusing on the expertise and experience of faculty members during the second semester of the 2018-2019 academic year. Utilizing a mixed-method approach, the findings reveal that faculty members at the College of Computing and Information Communication Technology possess substantial proficiency and practical experience in OBE implementation, positioning them to effectively contribute to the advancement of OBE objectives. Wu *et al*. [47] address the challenges in teaching the data structure course and present an approach focused on student-centered education, integrating OBE and heuristic teaching methods. By emphasizing industry requirements and utilizing a blend of autonomous learning, teacher guidance, and practical programming, the study underscores the effectiveness of this approach, highlighting its implications and potential for the field.

Phuc *et al*. [48] investigate the factors influencing the implementation of OBE in the economic management master's program. The research reveals that professional knowledge, problem-solving ability, teamwork and communication skills, and work attitude directly impact students' perceived value, subsequently affecting their practical application ability in the field. Sasiprabha *et al*. [10] introduce a novel assessment method for evaluating capstone projects addressing complex engineering challenges, tailoring criteria to distinct project categories and their respective program outcomes. This approach utilizes rubrics to align problem definition, literature review, and other criteria with specific outcomes, enhancing precise evaluation, identifying shortcomings, and guiding improvements in student projects and overall quality. Esmail *et al*. [49] introduces an outcome-based educational intervention targeting general physicians in primary care (GPs)

to enhance rational prescribing practices in Iran. Results highlight that the intervention positively impacted GPs' knowledge, skills, and practices, leading to improved rational prescribing and suggesting the potential for broader implementation of outcome-based approaches in medical education.

3. METHOD

The methodology employed for this study involved a systematic search strategy executed within the Scopus database to procure scholarly literature concerning outcome-based education [50], [51]. Conducted on August 11th, 2023, the search utilized specific keywords such as 'outcome-based education' or 'outcome-based education' and was tailored to include articles solely from journals and conference papers spanning all languages. Inclusion criteria focused on articles directly addressing OBE within the timeframe of 1978 to 2023, encompassing diverse disciplines and geographical regions. Rigorous screening was implemented to eliminate any duplicate records, ensuring the integrity of the dataset. Following the extraction of relevant articles, bibliographic information including publication titles, authors, abstracts, keywords, and citation counts was compiled into a structured dataset saved in 'CSV' format for further analysis. The dataset underwent comprehensive bibliometric analysis utilizing VOSviewer version 1.6.19 and the Biblioshiny software, enabling the calculation of key bibliometric indicators and the visualization of collaboration networks and citation patterns. The visual representation of our methodology is presented in Figure 1, while Table 1 furnishes intricate details concerning the pivotal constituents and facets of our inquiry.

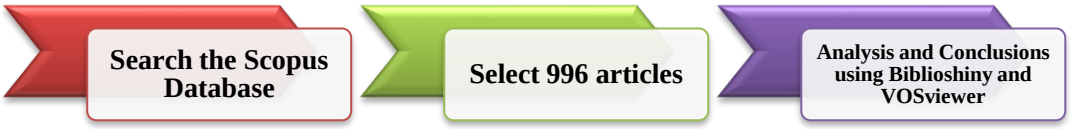

Figure 1. The methodology phases

Table 1. Key aspects of the investigation

Description	Results
Search Query	(TITLE-ABS-KEY ("outcome-based education") OR TITLE-ABS-KEY ("outcome-based education")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp"))
Timespan	1978:2023
Sources (Journals, books)	527
Documents	996
Annual growth rate %	9.27
Document average age	7.58
Average citations per doc	7.719
References	19374
Keywords plus (ID)	3034
Author's keywords (DE)	2216
Authors	2622
Authors of single-authored docs	185
Single-authored docs	202
Co-authors per doc	3.09
International co-authorships %	10.14
Article	620
conference paper	376

4. RESULTS

4.1. Annual scientific production

Between 1978 and 2023, the volume of publications concerning outcome-based education has displayed fluctuations, characterized by both increases and decreases. However, a significant upsurge in published materials was evident from 1998 to 1999, succeeded by a subsequent decline. Subsequently, a revival in growth was observed. This cyclic pattern of alternating upward and downward trends is discernible throughout the years. Commencing from 2006, there is a substantial rise in publication numbers, interspersed with periods of decline. The pinnacle was reached in the year 2020, recording a remarkable count of 109 documents. Figure 2 visually portrays this correlation between publication counts and their respective years using the Biblioshiny tool. Additionally, Figure 3 elucidates the distribution of the chosen 996 articles across various subject domains. The largest segment, constituting 33.1%, falls within the realm of social sciences. Engineering closely follows at 20.8%, with computer science representing 16.8% of the articles.

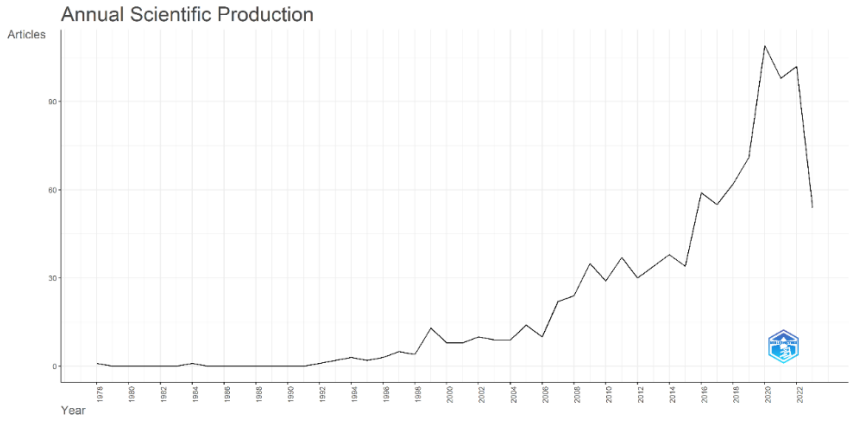

Figure 2. The annual scientific production from 1978 to 2023 visualized using Biblioshiny

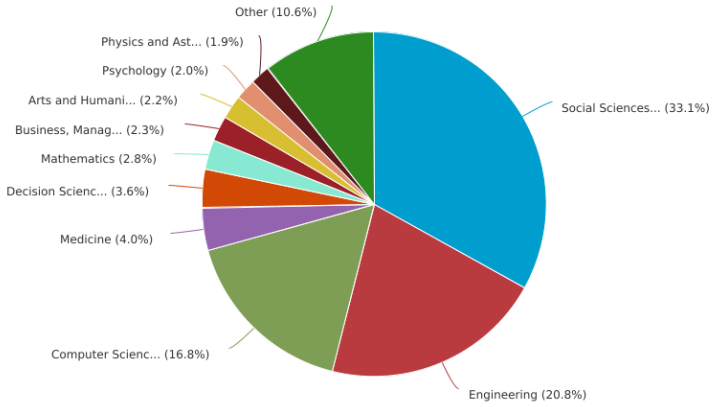

Figure 3. Documents by subject area

4.2. Most significant authors

In the realm of OBE, the collective efforts of 2,622 authors have been channeled through their written contributions. To gauge author significance, the count of published works was employed as a metric. Notably, Chandna and Harden shine as preeminent contributors, each credited with 7 published articles. In close pursuit, Hashim, Rajak, and Shrivastava each boast 6 articles. As illustrated in Figure 4, these distinguished authors exhibit consistent publication patterns over time, affirming their authoritative status in their respective domains. Their substantial expertise and extensive experience have firmly established their prominence.

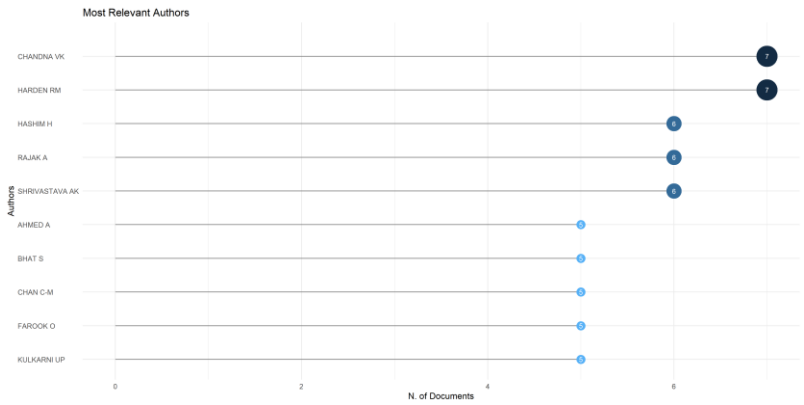

Figure 4. Most relevant authors

4.3. Most relevant sources

The analysis of 996 gathered publications sourced from 527 unique journals unveiled that the Journal of Engineering Education Transformations exhibited remarkable productivity, being responsible for 85 articles. The second position was claimed by the journal medical teacher, publishing 20 papers. Following closely was the ACM International Conference Proceeding Series and the ASEE Annual Conference and Exposition Conference, each contributing 16 articles. Figure 5 showcases the leading 10 sources that stood out in generating a significant quantity of research papers on outcome-based education.

4.4. Most relevant affiliations

Figure 6 illustrates the primary institutions engaged in generating research publications related to OBE using the Biblioshiny platform. Universiti Teknologi Mara leads the list with the highest volume of publications, reaching a peak of 59. Following closely is Universiti Kebangsaan Malaysia, contributing 40 publications. Significant research in this domain has also been conducted at Universiti Malaysia Sabah, University of Malaya, Thiagarajar College of Engineering, Universiti Teknologi Malaysia, Rajarambapu Institute of Technology, Taylor's University, and Multimedia University. The analysis of affiliations' output over time involves examining the frequency and number of affiliations associated with academic publications within specific periods.

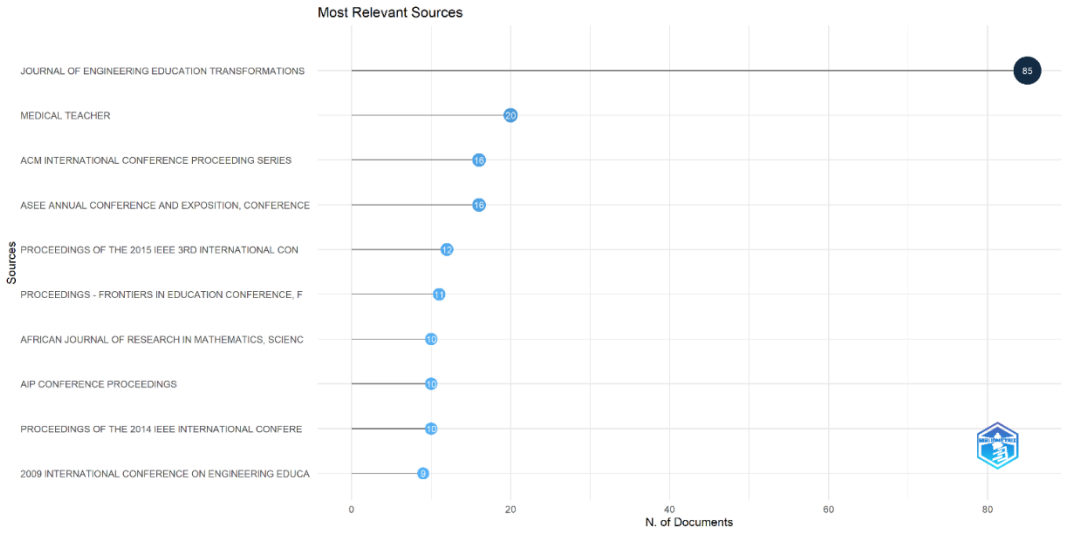

Figure 5. The top 10 relevant sources

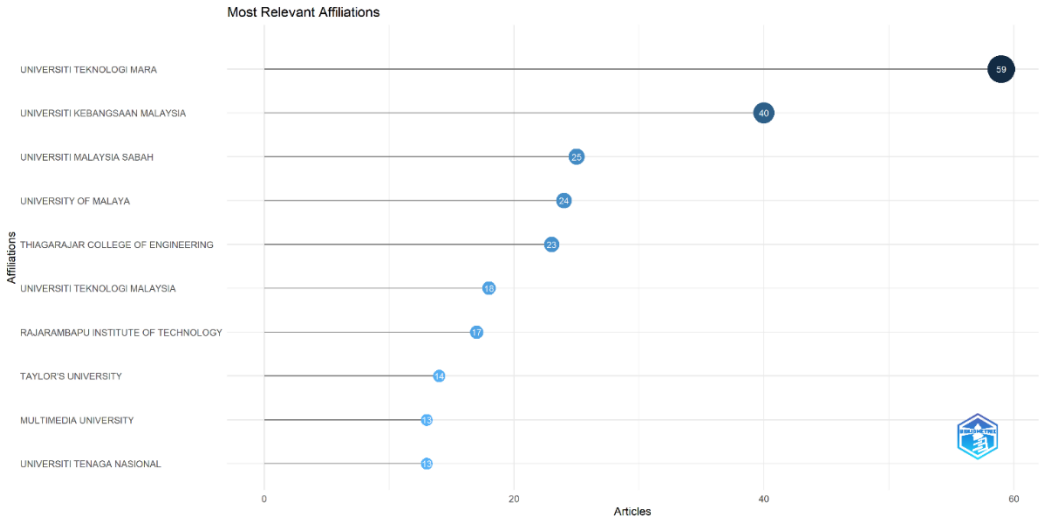

Figure 6. Most relevant affiliations

4.5. Trend topics

Furthermore, the study examined the subject that was gaining traction by scrutinizing the keywords chosen by the authors from the dataset. During this analysis, specific criteria were established: the study period ranged from 2010 to 2023, words had to appear at least five times, three words were selected per year, and a word label size of five was employed. Typically, the keywords provided by the authors are closely related to the content of their publications and offer sufficient information to identify the key aspects of a particular field. This examination provides additional insights into the prevalent themes associated with the occurrence of keywords in the literature on OBE over the years. Figure 7 visually represents the hierarchical organization of authors' keywords, showcasing annual discussions on various facets of OBE explored by scholars. These topics can be linked to OBE in various ways. For instance, in 2020, "outcome-based education" emerged as the most frequently discussed topic, while in 2021, the focus shifted to "attainment," and in 2022, "machine learning" and "experiential learning" took center stage within the context of OBE.

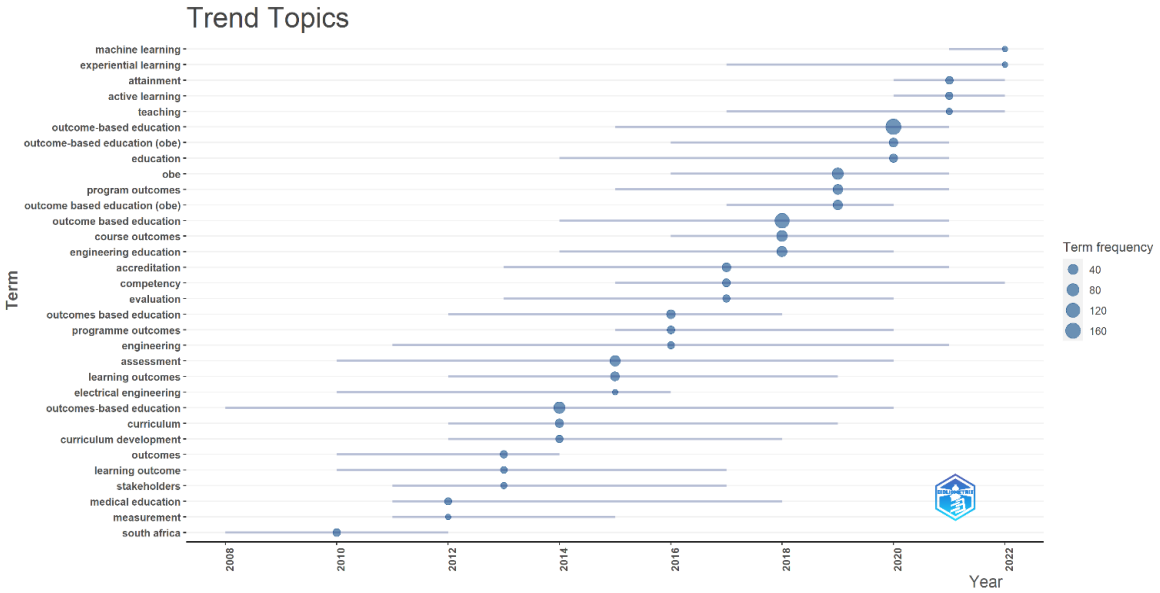

Figure 7. Trend topics identified using Biblioshiny from 2010 to 2023

4.6. Three field plot of keyword, author and source

A Sankey diagram, also referred to as a three-field plot, is a visualization method utilized to depict the movement of data or information. It represents different elements as rectangles or text, connected by arrows or arcs to signify relationships between them. The thickness of these arrows or arcs corresponds to the significance of the connection. In Figure 8, there is an illustration that explores the correlation among keywords (located on the left), authors (in the center), and sources (on the right) in the context of OBE literature. The purpose of this analysis was to identify commonly used keywords in the literature across various authors and published journals. Through the examination of the top keywords, authors, and sources, several notable phrases emerged, including "outcome-based education," "outcome based education," "OBE," “course outcomes,” and "program outcomes." It was noted that authors such as Rajak, Chandna, and Shrivastava frequently employed these keywords and published their work in outlets such as the ASEE Annual Conference and Exposition Conference proceedings, Journal of Engineering Education Transformations, and the Journal Medical Teacher.

4.7. Top 10 most cited papers

Table 2 presents a compilation of the ten most frequently cited papers in the field of outcome-based education. These articles, spanning from 1998 to 2017, have received significant attention in the academic community. Notably, the paper titled "The CanMEDS Initiative: Implementation of an Outcomes-Based Framework for Physician Competencies," authored by Frank, Jason, and Danoff in 2007, stands out as the most cited, boasting 619 citations. Following closely is "AMEE Guide No. 14: Outcome-Based Education: Part 1 - An Introduction to Outcome-Based Education," written by Harden, Crosby, and Davis in 1999, which has accumulated 481 citations.

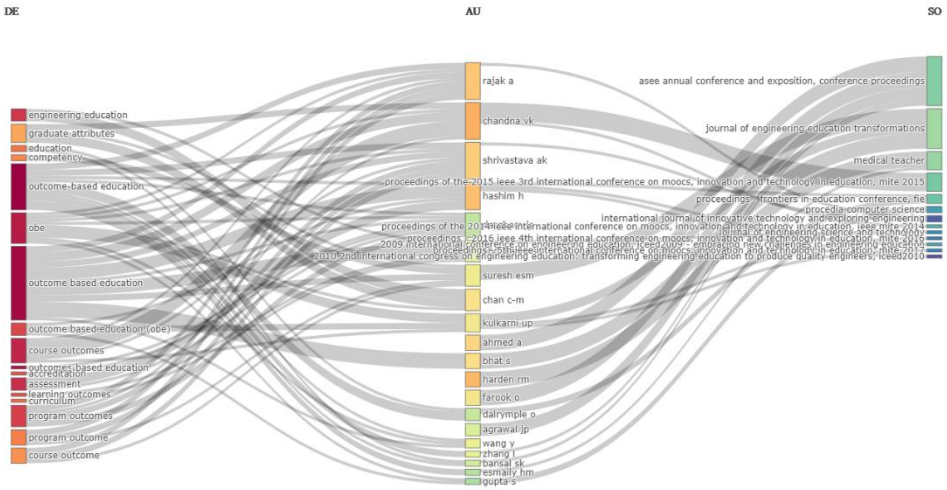

Figure 8. Three field plot representing the relationship between author keyword (DE), author (AU), and source (SO) using Biblioshiny

Table 2. The top 10 cited papers

Authors	Title	Year	Cited by
Frank and Danoff	The CanMEDS initiative: Implementing an outcomes-based framework of physician competencies	2007	619
Harden *et al.*	AMEE Guide No. 14: Outcome-based education: Part 1 - An introduction to outcome-based education	1999	481
Shumway and Harden	AMEE guide no. 25: The assessment of learning outcomes for the competent and reflective physician	2003	269
Harden	Learning outcomes and instructional objectives: Is there a difference?	2002	157
Elliott	Making evidence-based practice educational	2001	146
Morcke *et al.*	Outcome (competency) based education: An exploration of its origins, theoretical basis, and empirical evidence	2013	140
Cate	Competency-based postgraduate medical education: Past, present and future;	2017	138
Jansen	Curriculum reform in South Africa: A critical analysis of outcomes-based education	1998	131
Harden	International medical education and future directions: A global perspective	2006	116
Smith and Dollase	AMEE guide No. 14: Outcome-based education: Part 2 - Planning, implementing and evaluating a competency-based curriculum	1999	105

4.8. Co-citation analysis of cited references

A co-citation analysis was carried out to explore the associations among cited sources. We set a minimum requirement of 7 cited references, resulting in 14 references that met this criterion out of the 19,126 citation references generated. In Figure 9, the most robust connection (with a link strength of 12) was observed for the publication titled "Beyond Traditional Outcome-Based Education," authored by Spady, William, and Marshall, in 1991. This was followed by the publication titled "Outcome-Based Education: Critical Issues and Answers," written by Spady and William in 1994, which had a link strength of 11.

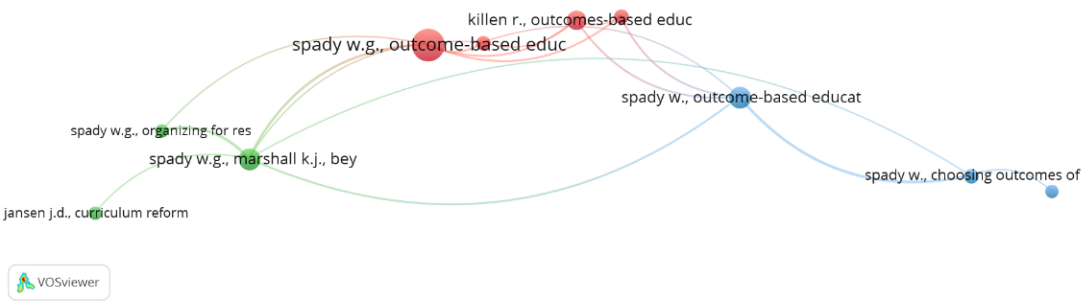

Figure 9. Network visualization of co-citation analysis of references produced using VOSviewer

4.9. Country co-authorship analysis

Analyzing country co-authorship entails examining how countries impact and interact within a specific field of study. In the context of OBE, Figure 10 provides a visual representation of a network that depicts country co-authorship. The size of the nodes signifies the countries with the most significant influence, while the connections represent collaborative partnerships between institutions across different countries. The thickness and distance between nodes convey the extent of cooperation between countries. The map also showcases the diversity of research areas through various colors. In terms of publication output, India (239), Malaysia (162), and China (125) have the highest number of publications. Additionally, when it comes to citations, the United Kingdom (1638), South Africa (1216), and the United States (1182) stand out, indicating their substantial impact. Furthermore, the United States (27) and Malaysia (25) possess the highest total link strength value, underscoring their prominent position within the co-authorship network.

4.10. Co-occurrence of keywords

The VOSviewer software was employed to generate a visual representation of clusters of keywords that co-occur in the context of Outcome-based education. To do this, we selected a subset of 300 keywords that appeared at least 5 times out of a total of 4549 keywords. The results of this analysis are depicted in Figure 11. In this figure, the size and font of each node are determined by the keyword's weight value, which indicates its frequency of appearance. Consequently, larger nodes and fonts represent keywords that occur more frequently. The connections between nodes in the figure denote common occurrences between keywords, with the thickness of these lines indicating the strength of their co-occurrence. A thicker line signifies a higher frequency of co-occurrence. The analysis presented in Figure 11 revealed the presence of five distinct clusters. The first cluster contains 126 items, the second cluster comprises 86 items, the third cluster includes 46 items, the fourth cluster consists of 41 items, and the fifth cluster contains just 1 item. The most prominent keyword in the network, appearing a total of 407 times, is identified as "outcome-based education".

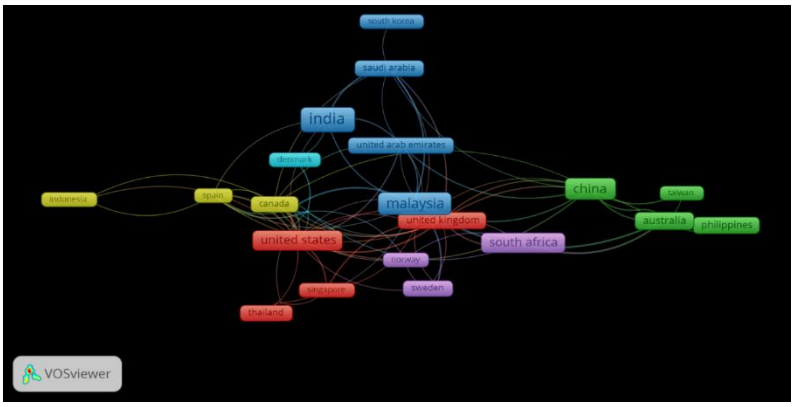

Figure 10. The network visualization of country co-authorship analysis generated using VOSviewer

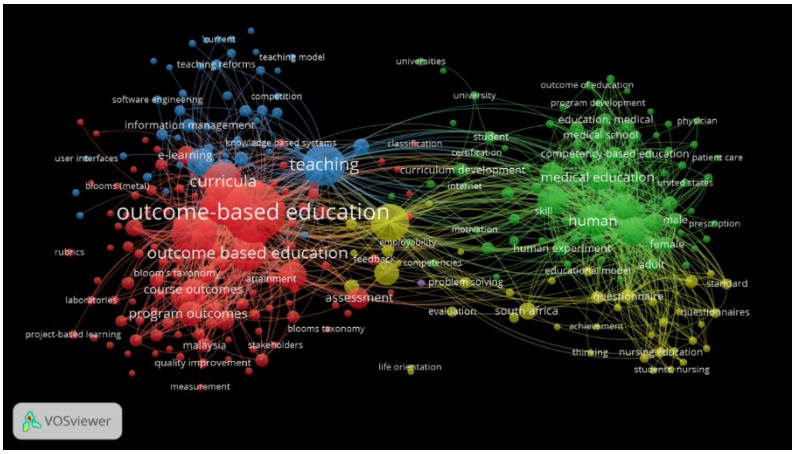

Figure 11. The network visualization of the co-occurrence of all keywords using VOSviewer

4.11. Countries' collaboration world map

Figure 12 illustrates the worldwide collaborative network within the realm of outcome-based education. The visualization uses the color blue to represent research partnerships between different countries, while the pink border indicates the degree of collaboration between individual authors. It is worth noting that the United States stands out as a leader in global collaborations, particularly with Canada, with a frequency of 5. Malaysia and South Africa also engage in substantial collaborations, having a frequency of 4 with Australia, and Spain maintains a strong collaborative link with Austria at a frequency of 4. Furthermore, India has noteworthy collaborative ties with Saudi Arabia, with a frequency of 3. In summary, the field of OBE exhibits extensive research collaboration among scientists across the globe.

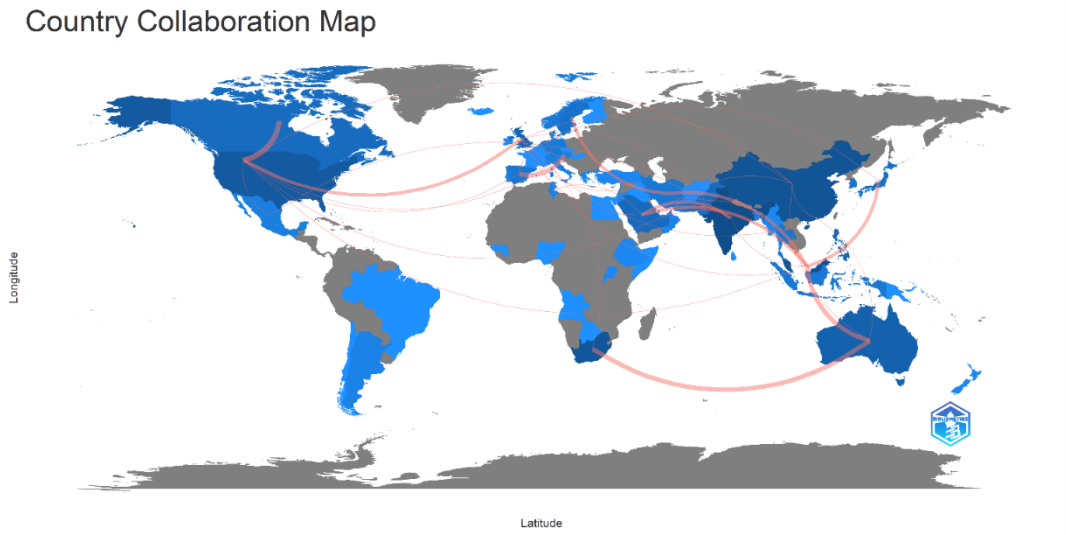

Figure 12. Countries' collaboration world map generated using Biblioshiny

5. DISCUSSION

A total of 996 articles were gathered from 527 different sources, covering the time frame from 1978 to 2023. These articles were collected by including the terms 'outcome-based education' or 'outcome-based education' in the query. The data indicates that there has been a cyclic pattern of fluctuation in publications related to outcome-based education, with a recent increase in research activity. Additionally, it highlights the multidisciplinary nature of this field, with a significant portion of research falling within social sciences, engineering, and computer science. There are well-known authors who have made substantial contributions to the field of outcome-based education. The quantity of works that have been published is the metric used to evaluate their relevance. With seven published articles apiece, Chandna and Harden stand out as the two most significant contributors. Hashim, Rajak, and Shrivastava are close behind with six each. According to the evidence, these writers have contributed to the field in significant and enduring ways, and their work has remained consistently worthwhile and pertinent throughout time.

The study has determined the top 10 sites that have made a substantial contribution to the creation of outcome-based education research articles. The most frequent source of research papers on OBE is the Journal of Engineering Education Transformations, which is followed by Medical Teacher, the ACM International Conference Proceeding Series, and the ASEE Annual Conference and Exposition Conference. Other sources also make significant contributions to the field. The top two universities producing research papers in the area of OBE are Universiti Teknologi MARA and Universiti Kebangsaan Malaysia, with 59 and 40 articles, respectively. This shows that they are very present and strongly focused on this field of study. A wide group of universities are engaged in research on outcome-based education, so it is not simply one or two institutions that are making a substantial contribution. Significant contributions to this subject have also been made by Taylor's University, Multimedia University, Universiti Malaysia Sabah, University of Malaya, Thiagarajar College of Engineering, Universiti Teknologi Malaysia, Rajarambapu Institute of Technology, and Universiti Teknologi Malaysia.

This research showed how the field of OBE has evolved over time, with distinct themes and areas of concentration emerging in different years, such as "outcome-based education," "attainment," "machine learning," and "experiential learning." This shows that the field has changed and broadened its emphasis

throughout the time under consideration. Authors like Rajak, Chandna, and Shrivastava frequently use keywords like "outcome-based education," "outcome-based education," "OBE," "course outcomes," and "program outcomes" in their writing. This is evident from the Sankey Diagram analysis of keywords, authors, and sources in the context of the literature on outcome-based education. Additionally, these academics frequently publish their work in specialized journals including Journal of Engineering Education Transformations, Medical Teacher, and the proceedings of the ASEE Annual Conference and Exposition. This demonstrates a close relationship between the authors, sources, and keywords in the literature on outcome-based education, pointing to recurring themes and areas of study.

We may infer from the data in Table 2 that the academic community is very interested in and focused on outcome-based education. This conclusion is backed by the fact that the 10 publications in the field with the highest number of citations, which cover the years 1998 to 2017, have attracted a lot of attention, with the top two studies alone amassing a sizable amount of citations (619 and 481, respectively). Furthermore, the fact that Frank and Danoff's 2007 paper, "The CanMEDS Initiative: Implementation of an Outcomes-Based Framework for Physician Competencies," is the most frequently cited paper in the field suggests that the approach to OBE they describe has had a particularly significant influence on the field. This suggests that OBE is a significant field of study and practice within education, in addition to being a topic of interest. The academic community has conducted much research on outcome-based education, and important publications and frameworks have had a significant impact on the discourse and practices in this area.

The analysis of country co-authorship reveals the influence and interaction of nations within the selected subject of study. This implies that an important component of international academic endeavors in this field is research collaboration. Some nations stand out for having a substantial impact in this area. In terms of publication production, China, Malaysia, and India stand out, demonstrating their active involvement in this field's research efforts. High citation counts for the United Kingdom, South Africa, and the United States are remarkable indicators of the significant effect of their research contributions in this area. The greatest overall link strength value is shared by Malaysia and the United States, highlighting their significant roles in the co-authorship network. This shows that these nations are crucial in promoting cooperation and the transfer of knowledge in the industry. In addition to highlighting the importance of the phrase "outcome-based education" within the network of related terms, the VOSviewer study of keywords linked to OBE indicated the presence of five different thematic clusters. The structure and important subjects in the area of OBE may be better understood with the help of this information.

There is a strong and wide-ranging global network of research collaborations in the area of OBE. Participating nations in this field of study include the United States, Canada, Malaysia, South Africa, Australia, Spain, Austria, India, and Saudi Arabia. With a frequency of 5, the United States is a notable leader in international partnerships, especially with Canada. This shows that these two nations often and intensively exchange ideas and research in the area of outcome-based education. With Australia, each of Malaysia and South Africa collaborates extensively, with a frequency of 4. This suggests that scholars from these nations commonly work together with their Australian colleagues. With Austria, Spain continues to collaborate with them four times each year, indicating a solid research collaboration between the two countries in the area of outcome-based education. With a frequency of 3, India and Saudi Arabia have notable cooperative connections. This shows that scholars from Saudi Arabia and India collaborate on projects, but sporadically compared to those from the other nations.

The comprehensive analysis of outcome-based education research presents a nuanced understanding of the field's evolution, contributors, and global dynamics. While the cyclic pattern of research activity indicates fluctuations in interest over time, the recent surge in publications suggests a renewed focus on outcome-based education, possibly driven by emerging educational paradigms or policy shifts. The multidisciplinary nature of the field underscores its relevance across diverse domains, reflecting the complex interplay between educational theory, technological advancements, and societal needs. However, while certain authors and institutions stand out for their prolific contributions, the emphasis on quantity as a metric for relevance may overlook the depth and impact of individual studies. Furthermore, the concentration of research outputs in specific journals and conferences may inadvertently limit the dissemination of alternative perspectives or marginalized voices within the field. Additionally, while international collaborations are celebrated for promoting knowledge exchange and diversity of viewpoints, the unequal distribution of research partnerships among nations raises questions about power dynamics and the accessibility of resources for scholarly engagement. Overall, while the findings provide valuable insights into the landscape of OBE research, critical analysis prompts reflection on underlying assumptions, biases, and opportunities for fostering inclusivity and innovation within the field.

There are numerous studies that justify the discussion of outcome-based education and its immense contributions, covering a wide range of impacts from different disciplines. Even at a very insignificant level, the practice of OBE has been promising in various fields of education, especially in medical training.

In 2010, Mukhopadhyay and Smith [52] applied OBE principles to the Labour Ward Advanced Training Skills Module of the Royal College of Obstetricians and Gynaecologists. This means that tenet for a balanced integration with knowledge, skills, and attitudes remained central in this application. Their study brought on board the application of OBE in effectively improving training and assessment for medical trainees if it had pragmatic benefits to create competent professionals. Harden *et al*. [53] also emphasized the potential for OBE to change medical education with their call for a performance-based approach to shift emphasis from traditional didactic methods to well-defined educational outcomes. Their proposal, therefore, brought out the need for relevance and accountability in the curriculum in medical education and furnished a robust framework for planning and evaluating a curriculum. In the University of Dundee, Davis [54] demonstrated in a practical case study in 2003 that the implementation of OBE in the medical school curriculum was successful. In this study, it was shown that there were many practical problems and advantages from adopting OBE, including increased relevance of the curriculum and student accountability. The result of this well-implemented framework for OBE reforms at this institution is an interesting experience brought to other institutions considering similar educational reforms. Anala *et al*. [55] supported the empirical approach for OBE by focusing on measuring students' performance to validate and adjust curricula. Their study proclaimed the flexibility of OBE that allows an institution to define outcomes and assessment methods on its own, thus enabling continuous improvement in quality of education.

Buddi *et al*. [56] worked on the detailed working of OBE by presenting a case study showing clearly the correlation of CO to PO. They evaluated student performance based on both direct and indirect assessments for pinpointing problems and facilitating continuous improvement in educational programs. Singh and Ramya [57], undertook a literature review on the benefits derived from OBE in nursing education. This paper focuses on the model that aligns curriculum content to achievement of expected outcomes in order to meet emerging health care needs. Their paper makes a clear case for having defined educational outcomes within the preparation of nurses to have effective new expectations regarding patients and the public. Study by Rao [58] contributed an all-comprehensive framework of defining and measuring outcomes in higher education, applying Bloom’s taxonomy so that the outcomes are observable and measurable. Much emphasis was given in this study to the aspect of alignment between the program outcomes and course outcomes in order to achieve effective educational programs as a whole. This structured approach shall certainly permit the achievement of goals one after another, which is very methodical in nature.

Japee and Oza [59] explained critical aspects of curriculum development and evaluation in the framework of OBE. They emphasized the need to balance a multidisciplinary approach with structured progress and accountability in education on the other. Kurukwar [60], presented an overview of OBE in engineering education, explaining how POs and graduate attributes can guide curriculum design. This paper identifies the role of OBE in making sure that engineering graduates have the skills and competencies required for professional success and merges educational outcomes with the requirements of industry. According to McNeir [61], a number of viewpoints regarding OBE were reviewed critically, putting forward its potential for reorganizing education around measurable outcomes. The author picked up on the general criticisms and limitations of OBE, thus giving a fair viewpoint about its implementation and also pointing out the requirement for flexibility in educational approaches. These studies provide collectively a firm base for understanding different dimensions of OBE, from theoretical principles to practical implementation challenges and benefits across different educational contexts.

Despite the valuable insights provided by existing literature on outcome-based education, notable gaps persist. The literature predominantly comprises qualitative analyses, case studies, and surveys, with limited quantitative bibliometric analysis conducted to comprehensively understand the landscape of OBE research. This absence of quantitative bibliometric analysis hinders the identification of key contributors, mapping of research trends, and assessment of collaboration networks within the OBE domain. Additionally, there is a lack of comprehensive studies that explore the evolution of OBE research over time and its impact on educational practices. Addressing these gaps through rigorous quantitative analysis and empirical research is essential for advancing the understanding of OBE and informing evidence-based educational practices.

In presenting the findings on outcome-based education research, it is essential to acknowledge certain limitations inherent in our methodology. Firstly, the reliance on the Scopus database for procuring scientific literature may have resulted in the exclusion of relevant articles not indexed within this database. Furthermore, the search was limited to articles from journals and conference papers, potentially excluding other valuable sources of information such as books, dissertations, and reports. Despite the efforts to ensure precision by screening for duplications in the Scopus records, there remains a possibility of some articles being inadvertently overlooked or excluded.

6. CONCLUSION

The bibliometric analysis of outcome-based education provides robust quantitative insights into its evolution and impact, offering a wealth of data to guide future research endeavors. This study illuminates the expanding interest in and influence of OBE within the educational landscape through a comprehensive examination of scholarly articles. The findings underscore the sustained interest in OBE over time, evident in the increasing volume of research publications, conference papers, and citations. Such trends highlight the enduring relevance and significance of OBE in shaping contemporary educational practices. Moreover, the analysis reveals the collaborative networks and key stakeholders driving advancements in OBE, offering valuable insights for educators, decision-makers, and researchers alike. By exploring shifting keyword trends, this study also identifies emerging areas of focus and research trajectories within OBE. Moving forward, researchers are encouraged to delve into various aspects of OBE implementation, including the efficacy of different strategies across diverse educational contexts and the long-term effects on student performance and engagement. Additionally, investigations into the integration of technology and innovative teaching methodologies within OBE settings hold promise for enhancing student learning experiences. Addressing issues of equity and inclusivity in education through OBE presents another compelling avenue for future research, particularly in marginalized student populations. Lastly, longitudinal studies tracking the evolution of OBE practices over time and across different regions will provide invaluable insights into its adaptability and sustainability in response to evolving educational landscapes. By embracing these research directions, stakeholders can continue to advance our understanding of OBE and its potential to improve educational practices and outcomes.

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