



A Bibliometric Analysis of Outcome-based Education Practices in the Education Domain

Ming Li¹, M. I. Rohayati^{2*}

ARTICLE INFO

Article History:

Received: 29 September 2023

Received in Revised Form: 24 October 2023

Accepted: 18 November 2023

DOI: 10.14689/ejer.2023.108.013

Keywords

Outcome-Based Education,
Bibliometric Analysis, Citespace, Vosviewer,
Research Hotspots, Development Trends.

ABSTRACT

Purpose: This study attempts to provide a comprehensive knowledge mapping and an in-depth analysis of Outcome-based education (OBE) practices to identify the research hotspots and development trends in this field which emerged between 1985 and 2023. **Method:** This study conducted a descriptive bibliometric analysis of 685 articles retrieved from the Web of Science Core Collection (WoSCC) databases relevant to Outcome-based education. Microsoft Excel and Vosviewer were used to characterize the contributions of countries, institutions, authors, and collaborative networks. The research hot spots and development trends were analyzed by Citespace and Vosviewer.

Findings: The results highlighted that the USA, England, and China were the three primary contributors to the largest number of publications in this field. But China needs to prioritize the quality of publications. The University of Dundee, the University of Toronto, and the University of California System were the three most productive institutions with the highest number of publications. Harden R. M. stood out as one of the most prolific authors in this field. Medical Teacher and Medical Education were the two most productive journals. The teaching process, framework, quality assurance, impact, and engineering education were the highly discussed issues in recent years. **Implications for Research and Practice:** The identification of prolific scholars and highly cited articles serves as references for scholars and educators new to OBE, assisting them in enhancing their reading efficiency and tracking authoritative scholars. This study also suggests that the research institutions and authors should strengthen cross-regional and international cooperation to enhance the implementation of OBE in education.

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¹ National Higher Education Research Institute, University of Science Malaysia, Gelugor, Penang, 11800, Malaysia.

School of International Education, Jiangsu Maritime Institute, Nanjing, 211170, China.
ORCID iD: <https://orcid.org/0009-0003-8420-8174>, Email: 330367400@qq.com

² National Higher Education Research Institute, University of Science Malaysia, Gelugor, Penang, 11800, Malaysia.

ORCID iD: <https://orcid.org/0000-0002-5288-5455>, Email: rohayati@usm.my

* Correspondence: rohayati@usm.my

Introduction

A global shift is discernible in tertiary education where there is a growing demand for graduates to acquire professional knowledge and competencies that align with the development of information technology and globalization. This shift is seen as an attempt to explore new approaches with the focus of higher education institutions worldwide now on student learning outcomes, curriculum customization, and assessment. This shift has also attracted increased attention from educators and universities since the early 1980s, with countries like the USA, UK, and Australia leading the way (De Guzman et al., 2017). The emergence of a new learning culture, known as outcome-based education (OBE), was a direct response to this shift in education. The OBE is a constructive alignment of intended learning outcomes with appropriate outcomes-based assessment methods and teaching and learning activities (Cruz, 2022). The OBE approach gained favor after it was widely adopted to reform and revitalize the global education system (Gurukkal, 2018), and when its implementation promised to produce numerous desirable results beyond one's imagination (Ortega & Cruz, 2016).

Simply put, the existing literature indicates a noticeable gap in understanding the comprehensive intellectual landscape of OBE practices, proper documentation, and other requirements that are needed to ensure better results before its implementation. This gap necessitates a systematic and comprehensive examination of the existing literature to identify the underlying reasons for the varied results of OBE implementation in education and explore opportunities to enhance its implementation (Glasser & Glasser, 2008). By employing bibliometric methods, this study intends to assist educators, policymakers, and researchers by providing a comprehensive overview of OBE's scholarly contributions, thereby facilitating informed decisions for the identification of learning outcomes, curriculum development, and educational reforms.

The present study aimed to address this vacuum by providing a comprehensive bibliometric analysis of OBE practices via CiteSpace and Vosviewer techniques. Quantitative methods in bibliometric analysis examine data such as publication years, publication count, citation numbers, authors, journals, countries, institutions, and keywords (Xue et al., 2021). This study intends to address the following research questions:

1. What are the publication trends for the implementation of OBE in education?
2. Which countries/regions, institutions, and authors have significantly contributed to and actively collaborated on the development of this field?
3. Which journals and references have made significant contributions to the development of this field?
4. What major themes have characterized the landscape of this field?
5. What are the hot research topics and development trends in this field?

The objectives of this study were threefold. This primary goal was to identify the countries/regions, organizations, authors, journals, and references that have significantly contributed to and collaborated on developing OBE implementation in education. Secondly, the study aimed to understand the knowledge structure and the thematic focuses within this field to bridge the knowledge gap in understanding the OBE practices and mandates in education. Thirdly, access to this information through keyword analysis enabled tracking the historical development and prospects of OBE in education, aiding scholars and educators in comprehending the potential future directions in this domain.

Literature Review

The evolution of the domain of education towards OBE has witnessed different stages of development, including competency-based education, criterion-reference learning, and mastery learning (Parker & Walters, 2008), which resulted in diverse definitions presented by different scholars. OBE experienced three distinct versions during its implementation, categorized by Biggs and Tang (2007). The earlier version, which Spady first introduced in 1994, focused on assisting underprivileged students who were having trouble adhering to established disciplines. The second version of OBE placed strong emphasis on quality compliance, market, and management orientation. This version, often called accreditation, involved institutional assessments (Miller & Ewell, 2005). The third version of OBE, known as outcome-based teaching and learning (OBTL), was sourced in the *The Dearing Report (1997)*, where the implementation of OBE was designed to enhance teaching and assessment, helping to inform what is intended for them to learn and how well students achieved success in examinations.

Despite its comprehensive implementation, OBE has encountered significant criticism from education administrators and academia. De Guzman et al. (2017) believed that OBE into higher education has resulted in a substantial shift in the teaching practices, forcing most teachers to drift away from traditional teaching methods to a more professional and result oriented approach. In certain universities or colleges, the adoption of OBE practices was constrained due to a lack of understanding among teachers to adapt to the new teaching practices based on course learning outcomes (CLOs) and their connection with program learning outcomes (Ling et al., 2023). Moreover, assessment was often focused on the course content and students' grades rather than on the intended learning outcomes established in the CLOs of the respective course (Sarikaya Erdem, 2019). Studies have observed that problems arose when teachers, as implementers, lacked a systematic understanding of the operational mechanism of OBE (De Guzman et al., 2017; Evardo, 2020; Rahate et al., 2020; Sarikaya Erdem, 2019).

Additionally, besides various distinct versions of OBE, there are also various opinions, critiques, and challenges surrounding its implementation, making it a subject of extensive study and debate in the academic field. Literature reports that educational institutions have encountered diverse challenges during the implementation of OBE in educational programs (Harmanani, 2017). According to Raihan and Azad (2021), various literature review techniques have been utilized, such as systematic review, structured review, review of developing models, framework-based review, meta-analysis, theory-based review, and bibliometric review. While there are several systematic reviews of the effect of implementation of OBE in the field of education (Amirtharaj et al., 2022; Charles & Sukumar, 2023; Tan et al., 2018) and a meta-analysis approach to investigate the impact of project-based assessment on the intended learning outcomes, there is a dearth of studies conducting bibliometric analysis to provide a comprehensive review of OBE implementation in this field (Raihan & Azad, 2021).

Therefore, it is imperative to conduct a comprehensive and systematic approach to conduct a bibliometric analysis to tackle the various issues that may hinder the successful implementation of OBE in an educational system. Bibliometric analysis is a commonly used method for statistically examining the knowledge structure, research hotspots, and new emerging trends from extensive datasets of articles or publications in specific fields (Donthu et al., 2021; Emich et al., 2020). Such an analysis is essential to systematically map

the scholarly publications, developing trends, and patterns in OBE research. As noted by [Guo et al. \(2021\)](#), a bibliometric analysis draws on scientific literature maps to supplement the limitations of traditional structured literature reviews. Last, but not least, traditional literature review methods are time-consuming and may miss critical documents, hence prompting the need for a structured and quantitative methods like bibliometric analysis. Therefore, employing bibliometric analysis is crucial to enhancing our understanding of the scholarly landscape and informing the implementation of OBE in education for educators and researchers.

Methodology

Research Design

This study conducted a descriptive bibliometric analysis of published works in relation to the implementation of outcome-based education in the domain of education. The research techniques like CiteSpace and VOSviewer were used in this study to conduct the bibliometric analysis. These two bibliometric softwares have features that show how a field has changed over time by offering a knowledge map of the reference network.

Sampling

The sampling of the research articles was made from the Web of Science (WoS) Core Collection as it contained high-quality articles and excluded irrelevant ones. The WoS database is acknowledged as the largest database of scientific publications globally, more distinct than all available databases ([Van Nunen et al., 2018](#)). It is widely recognized as an excellent resource for bibliometric analysis ([Fang et al., 2018](#)). The database has been extensively used in numerous social science studies for bibliometric analyses ([Fang et al., 2018](#); [Sarkar et al., 2022](#)). The data used for this study was retrieved from the WoS Core Collection on November 14, 2023.

Data Collection Methods

A systematic review tool, SALSA (Search, Appraisal, Synthesis, and Analysis), was used for data collection in this study, to ensure methodological accuracy, comprehensiveness, and extensiveness ([Grant & Booth, 2009](#)). First, during the search stage, the study employed double quotation marks to help identify queries as clauses. Using the searching formula in the topic domain, TS= ("outcome-based education" or "outcome based education") and TS= (education), the querying terms initially captured a total of 1054 records. A record was recognized as relevant if each of the querying terms appeared in the titles, abstracts, or keywords of the published articles. Second, during the appraisal stage, the dataset was refined to eliminate irrelevant subject areas that did not pertain to the implementation of OBE. Through the filters of "document types = articles or reviews" and "language = English," the study finally got a dataset of 685 publications (635 articles and 50 reviews) related to this field. Third, in the synthesis stage, the resulting digital database was stored in a plain text file encompassing various variables, including titles, authors, publication years, abstracts, keywords, citations, references, etc. Meanwhile, the digital database was imported into Citespace and Vosviewer as bibliometric analysis tools. Finally, the bibliometric parameters were analyzed to identify the research hotspots,

development trends, and potential future directions of OBE implementation in educational programs. Figure 1 presents the specific procedures of the SALSA method.

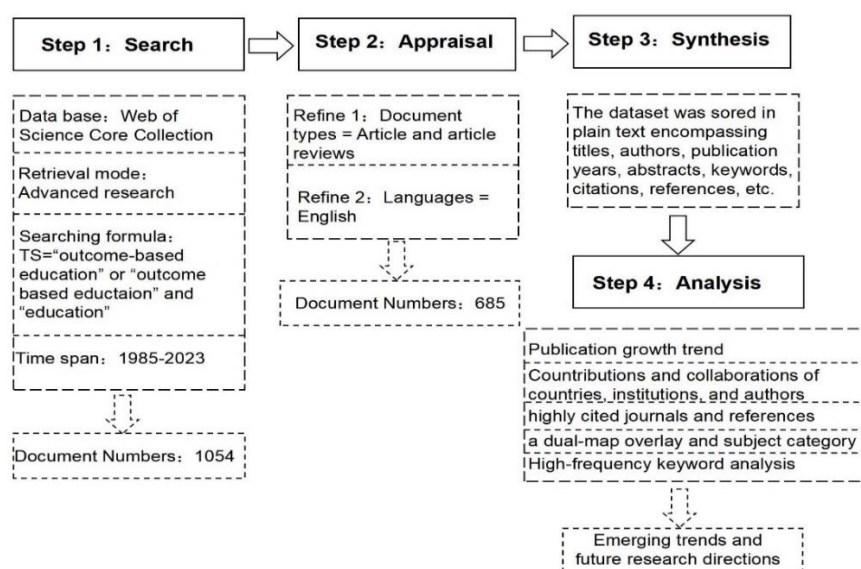


Figure 1: Steps of The SALSA Method for Data Collection and Analysis.

Data Analysis

Two software, VOSviewer and CiteSpace, were used to analyze the data and present a holistic and comprehensive knowledge map of the current research status of OBE implementation. A spatial layout was prepared that allowed for a wide range of time-based and dynamic analyses of citations, which gave a full picture of how the field had evolved (Guo et al., 2021). Many researchers have adopted these two softwares simultaneously in their studies (Guo et al., 2021; Zhang et al., 2022).

VOSviewer (Version 1.6.18) was developed by Leiden University in the Netherlands. It is employed to create visualized maps in terms of co-authorship countries/regions, co-authorship organizations, co-authorship authors, and co-citation of highly cited journals and references (van Eck & Waltman, 2010). It also helps in visualizing the network based on citation. CiteSpace (Version 6.1) was utilized to create a dual-map overlay, which visually depicted the evolution and expansion of the literature at the domain level (Chen & Leydesdorff, 2014). The subject category in CiteSpace is often used to identify the broader thematic concentration of the relevant articles. Similarly, CiteSpace enables researchers to identify research hotspots and future research directions by conducting keyword analysis in CiteSpace. In the graph of CiteSpace and VOSviewer, analytic objectives are depicted by nodes, and the importance is proportional to the node's size. The wider links between nodes indicate stronger cooperation strength (Zhang & Wang, 2018).

The H-index was also utilized in the data analysis, which is a metric used to assess the scientific impact of countries/regions, institutions, and authors. It measures the number of

journals, authors, and countries/regions that have produced H papers, each of which has been cited H times. Finally, the citation reports of articles were imported into Excel to examine the contributions of different countries, institutions, journals, and authors.

Results

Publication Growth Trend Analysis

The distribution of publications over time sheds some light on the growth trends in scientific research on a particular topic (Guo et al., 2021; Zhang, 2015). Figure 2 presents the chronological distribution of publications concerning the adoption of OBE in education.

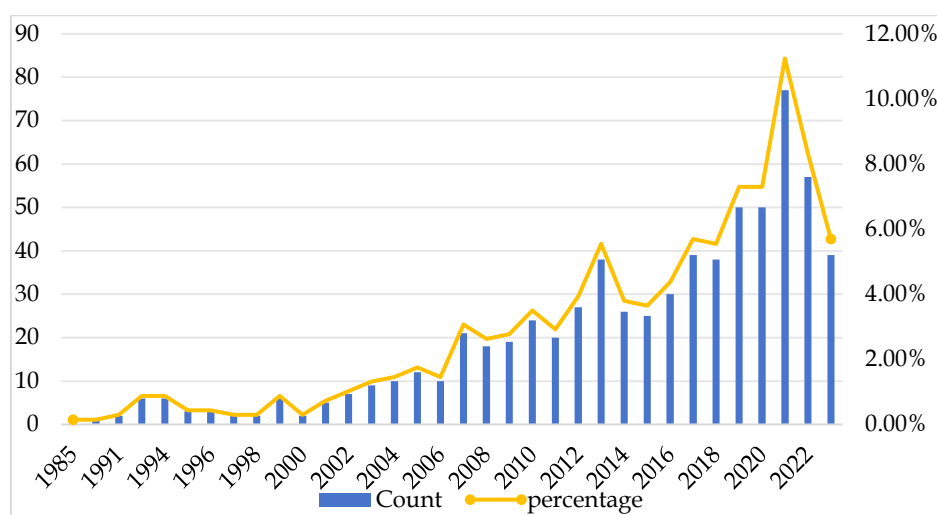


Figure 2: Distribution of Publications.

The literature can be divided into three stages based on their published dates. The initial stage was from 1985 to 2006, with an annual publishing count of less than ten articles. Notably, many years, including 1986, 1987, 1989, 1990, and 1992, had no publications at all. The scanty number of publications at this stage indicated that OBE implementation in education experienced an embryonic period. The subsequent phase, covering the years from 2007 to 2012, witnessed a gradual increase in annual publications, albeit with a minor fluctuation in some years, indicating the progression of the seedtime timeline. From 2013 to the present, the yearly publication output saw significant and steady growth, reaching a peak in 2021 with 77 publications. This rapid growth suggested a more sophisticated and developed stage of this field, representing blossoming in this period. Although there were only 39 articles in 2023, this count does not reflect the total number of publications throughout the year. Overall, the publication on implementing OBE in education during this timeframe displayed an upward trend; however, there were some slight variations in specific years.

Contribution and Cooperation Analysis by Country/Region

A total of 80 countries/regions have collectively contributed to the publication of 685 articles related to this field. The top 10 countries/regions in terms of highest publication

output, H-index, citing articles, average citations, and cited times are presented in Table 1. The United States led in the number of publications, accounting for 26.57% of the total, followed by England (9.34%), China (7.74%), Malaysia (7.01%), India (6.72%), Australia (6.57%), Canada (6.42%), the Netherlands (5.26%), Scotland (5.26%), and Saudi Arabia (4.38%). The prominence of the USA was primarily attributed to the American scholar William Spady, who first put forward the concept of OBE in 1981 as an approach to education to ensure quality in the American school system (Syeed et al., 2022). So far, OBE has attracted significant attention from many countries, such as the USA, Canada, Australia, New Zealand, China, and Malaysia.

Table 1

Ten Top-Most Productive Countries/Regions in OBE Publication

Rank	Countries/Regions	Articles	Percentage (%)	H index	Citing articles	Citations per article	Times cited
1	USA	182	26.57	32	4414	24.25	4,610
2	England	64	9.34	18	1352	21.13	1399
3	China	53	7.74	11	378	7.13	379
4	Malaysia	48	7.01	8	218	4.54	226
5	India	46	6.72	7	221	4.80	224
6	Australia	45	6.57	18	1442	32.40	1482
7	Canada	44	6.42	16	2436	55.36	2636
8	Netherlands	36	5.26	16	1360	37.78	1447
9	Scotland	36	5.26	24	2562	71.17	2982
10	Saudi Arabia	30	4.38	8	260	8.67	265

Besides, the United States had exceptional performance in terms of H-index and citations, which reflected its strong research capabilities and substantial research investment in this field. Contrastingly, despite ranking third in publication counts, China significantly fell far behind in aspects of H-index and citations. This underscores the significance of prioritizing the quality of the publications. Chinese academics should dedicate more to enhancing publication quality as a future goal. Conversely, despite fewer papers than China, Scotland, the Netherlands, Australia, and Canada exhibited higher H-index values and significantly higher average citations per paper, highlighting their significant academic influence and exceptional research standards in this field.

To identify the collaboration across countries/regions, the study employed VOSviewer to create a visualized network map of countries/regions. A minimum threshold of documents for each country was set at 5. Countries/regions sharing similar colors were considered to have closer collaborations and form clusters, with the width of the connections representing the strength of cooperation among them (Zhang et al., 2022). The wider the lines, the stronger the collaboration is.

As displayed in Figure 3, it is evident that the United States has the highest link strength, indicating its leading role in terms of collaborations among different countries/regions. The United States collaborated most frequently with England, Australia, Canada, the Netherlands, and Scotland when looking at the breadth and length of the links. This indicates substantial collaborations among the more influential countries/regions. These active collaborations demonstrate their concerted commitment to

advancing this field. Conversely, the countries/regions that collaborated most with China were Singapore, Malaysia, and New Zealand, but with relatively weaker cooperation with the USA, Australia, and England. Therefore, it was suggested that further collaboration between China and the United States, as well as other influential countries be pursued to promote the development of this field.

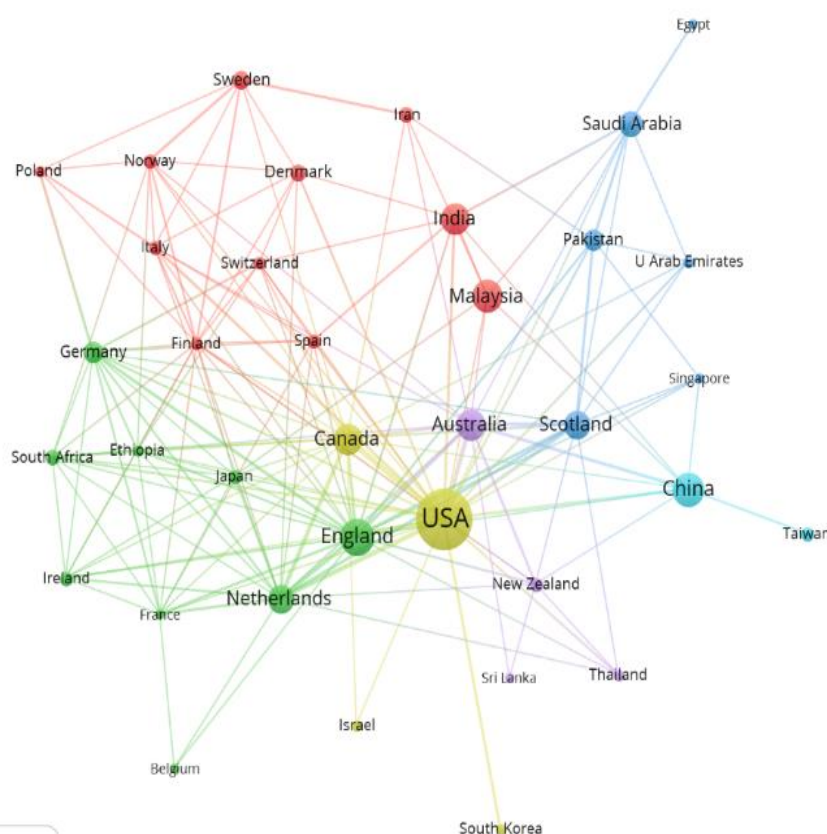


Figure 3: Co-Authorship Network Map of Countries/Regions.

Contribution and Collaboration Analysis by Organizations

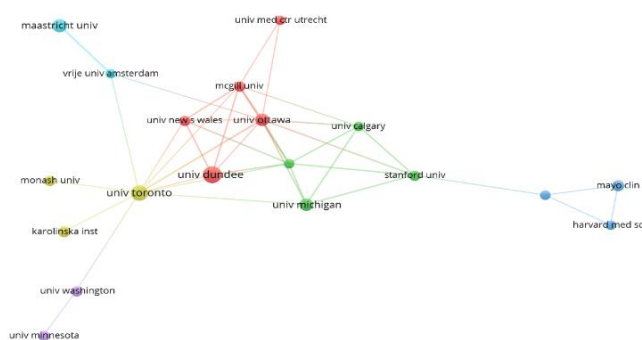
Regarding productive institutions, [Table 2](#) presents the top 10 institutions with the most publications. The [Table 2](#) indicates that five institutions are located in the USA, two in England and the Netherlands, respectively, and one in Canada. This finding corresponds to the above-mentioned results, explaining why the USA had the highest number of publications. The University of Dundee stood out as the most prolific institution with 27 publications, followed by the University of Toronto (13) and the University of California System (12). Although China ranked among the top three in the number of publications, none of its universities demonstrated substantial productivity in publishing articles related to OBE. This highlights the necessity for Chinese institutions to aggressively commit their efforts to promoting the implementation of OBE in education.

Table 2*Top 10 Most Productive Institutions*

Rank	Affiliations	Articles	Percentage (%)	Location
1	University of Dundee	27	3.942	England
2	University of Toronto	13	1.898	Canada
3	University of California System	12	1.752	USA
4	Maastricht University	11	1.606	Netherlands
5	University of London	11	1.606	England
6	Utrecht University	11	1.606	Netherlands
7	Mayo Clinic	10	1.46	USA
8	Pennsylvania Commonwealth System of Higher Education PCSHE	10	1.46	USA
9	University of Michigan	10	1.46	USA
10	University of Michigan System	10	1.46	USA

VoSviewer was employed to present the collaborative network relationship among institutions visually. Similarly, the examination set a minimum of five documents published by each institution. Out of 1011 institutions, 29 institutions met the required criteria. As depicted in [Figure 3](#), numerous institutions have significantly contributed to OBE implementation in education. The connections among the University of Dundee (England), the University of Toronto (Canada), the University of Ottawa (Canada), the University of New South Wales (Australia), and McGill University (Canada) demonstrated that the cross-organizational and international collaborations among institutions contributed to the advancement of research in this field.

The institutions with the highest level of total link strength and collaboration in the form of co-authorship are presented in [Figure 4](#). However, the collaboration among the high-yield research institutions was predominantly involved in renowned universities in Western countries. The research institutions in Asian countries, including China, have not yet exhibited significant regional collaborations with prominent institutions in this field. Therefore, these research institutes should strengthen regional and international cooperation, based on their unique characteristics, to establish a regional or international cooperation base to promote the development and implementation of OBE in education.

**Figure 4:** Co-Authorship Network Map of Organizations.

Contribution and Cooperation Analysis by Authors

The number of articles produced by authors within a specific domain is used as a metric for assessing their academic influence (Yue, 2018). Besides, citation per article and H-index are important indicators of measuring an author's contributions and impact. Table 3 presents the top 10 prolific authors with the most publications, ranked by their H-index, number of citing articles, and average citations. Harden R.M. was the primary author with the most publications (20), followed by Davis MH and Ten Cate, O (7 documents), Frank JR (6 documents), and Scheele F (5 documents). Meanwhile, Harden R.M., a highly accomplished author with the highest H-index and citations, has mainly concentrated on the introduction of OBE (1999, 2009), the developments and future of implementation of OBE in medical education (2002, 2006, 2007), a model for the identification of learning outcomes (2009), and guidelines for implementation of OBE in medical education (1999, 2001, 2005), etc. The work of Harden, R.M. developed solid and systematic approaches for implementing the OBE in medical education. However, it is noteworthy to acknowledge that the literature from earlier years has had a significant influence on the development of this field.

Table 3

Top 10 Most Prolific Authors

Rank	Author	Publications	Percentage (%)	Citations	Citations per Article	H-index
1	Harden RM	20	2.915	2301	115.05	17
2	Davis MH	7	1.02	755	107.86	7
3	Ten Cate O	7	1.02	839	119.86	7
4	Frank JR	6	0.875	1478	246.33	6
5	Scheele F	5	0.729	56	11.20	4
6	Abdullah SRS	4	0.583	69	17.25	4
7	Ben-David MF	4	0.583	200	50.00	4
8	Hsieh SI	4	0.583	69	17.25	4
9	Hsu LL	4	0.583	69	17.25	4
10	Schumacher DJ	4	0.583	37	9.25	3

To visualize the collaboration between authors, VoSviewer was used to detect a network of cooperation among the highly prolific authors. The threshold value was set at 3, which resulted in 33 authors satisfying the requirement. Figure 5 (a, b) depicts the network of author cooperation, where each node represents an author. The node's size reflected the number of articles published by that author. Figure 5 (a) illustrates the limited and dispersed cooperation among them, highlighting the necessity for prolific authors to strengthen cooperation to promote the development of this field jointly.

Figure 5 (b) depicts an author overlay visualization network with a color bar at the bottom ranging from blue to yellow, reflecting the varying publication dates of the documents by authors. The blue color signifies the previous studies conducted by prolific authors before 2010, as represented by the larger nodes of Harden RM. In 2014, the authors in dark green began to show interest in OBE research, such as Ten Cate O and Frank, JR. The light green color, as represented by Gruppen Larry, began to draw attention to the effect of the implementation of OBE in education. Recently, Schumacher DJ and Kinnear, Benjamin, have published relatively new works, which are colored yellow. In general, each of them facilitated collaborative efforts to enhance the development of this field.

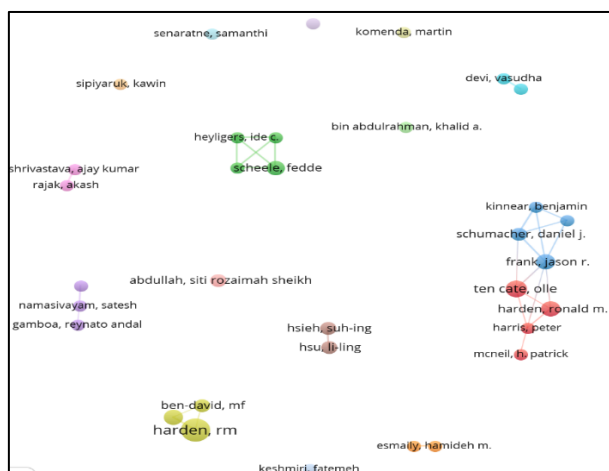


Figure 5: (A) Co-Authorship Network Map of Authors.

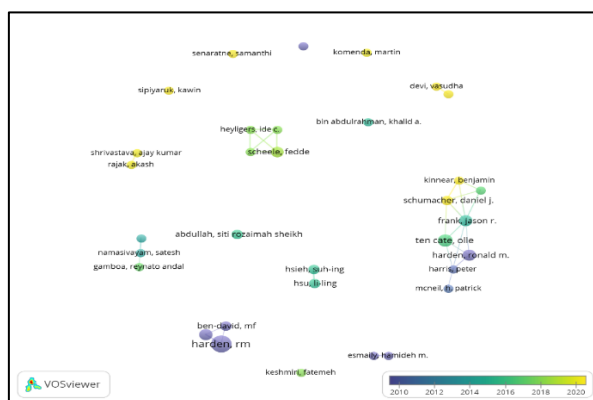


Figure 5: (B) Overlay Visualization Network Map of Authors.

Contribution Analysis by Journals

According to Dzikowski (2018), the impact of a journal increases with a growth in both the quantity of papers it contains and the number of citations it possesses. Besides, the co-citation analysis plays a vital role in determining which journals have had the most significant influence on the development of the field. The top ten citing and cited journals were identified by VOSviewer (Table 4). A total of 419 journals contributed to 685 publications in this field. The top ten prolific journals accounted for 149 publications, representing 21.8% of the total output. Medical Teacher came in the lead with 59 publications, followed by BMC Medical Education (19), International Journal of Engineering Education (16), Medical Education (11), and Journal of Engineering and Technology (10). This indicates that the five journals have a substantial interest in the subject and are increasingly focused on its application in medicine, engineering, and engineering science and technology. When examining the indicator of “average citation per publication,” Medical Teacher and Medical Education have contributed more to this field than other disciplines.

Regarding co-cited journals, the top five journals were Medical Teacher (1182 citations), Academic Medicine (672 citations), Medical Education (565 citations), JAMA Journal of the American Medical Education (146 citations), and BMC Medical Education (129 citations). Undoubtedly, Medical Teacher and Medical Education journals have had the most substantial impact on the development of OBE implementation in medical education.

Table 4

Top 10 Most Citing and Cited Journals

Rank	Citing Journal	Publications	Citations	Average Citation / Publication	Co-Cited Journal	Co-Citations
1	Medical Teacher	59	4412	200.55	Medical Medical	1182
2	BMC Medical Education	19	181	8.23	Academic Medicine	672
3	International Journal Engineering Education	16	83	3.77	Medial Education	565
4	Journal of Engineering Science and Technology	11	780	35.45	JAMA	164
5	Sustainability	10	14	64	BMC Medical Education	129
6	Computer Applications sin Engineering Education	8	35	1.59	Advances Health Science	120
7	Nurse Education Today	7	35	1.59	Eductaion Leadership	117
8	Educational Leadership	7	181	8.23	Journal of Dental Education	114
9	Journal Veterinary Medical Education	6	106	4.82	Lancet	104
10		6	38	1.73	Journal of Engineering Education	100

Co-citation Analysis on the Cited Reference

The co-citation analysis by cited references was employed to identify the most prominent publications and understand the structure of the references most frequently cited in this field. By establishing a minimum number of 15 citations for highly cited references, we obtained the top 17 most cited references out of 2201. [Table 4](#) lists the top 10 most frequently cited references in detail

As depicted in [Table 4](#), the top five most frequently cited references were as follows: [Harden et al. \(1999\)](#) (107 citations), [Spady \(1994\)](#) (58 citations), [Harden et al. \(1999\)](#) (52 citations), [Smith \(1999\)](#) (34 citations), and [Frenk et al. \(2010\)](#) (34 citations). These studies are considered reliable references for research in this domain. Meanwhile, [Figure 6](#) displays three distinguished clusters of the most prominent references, each represented in red, green, and blue.

The red cluster primarily addressed studies on the significance of transforming medical education and the evaluation of the paradigm shift from traditional teaching methods to outcome-based education. The studies covered various issues such as “a model for identifying the learning outcomes and planning” [Harden et al. \(1999\)](#), “implementing and evaluating a competency-based curriculum” ([Smith, 1999](#)), “shifting paradigms” ([Carraccio et al., 2002](#); [Frenk et al., 2010](#)). The green cluster mainly comprised studies that looked at creating a competence framework for medical graduates and resident doctors ([Frank & Danoff, 2007](#); [Simpson et al., 2002](#)) and writing about an OBE implementation inventory ([Harden, 2007a](#)). The OBE inventory said that learning outcomes should be clearly defined, and there should also

be a plan to ensure they are met. This plan should include creating standards for curriculum and assessment, teachers training, and access to educational resources. Furthermore, the OBE inventory introduced in these studies provided a vital tool to assist teachers, schools, or other stakeholders in being involved in assessing the extent to which they have successfully implemented OBE in practice.

Table 5

Top 10 Most Frequently Cited References

Label	Cluster	Links	Total Link Strength	Citations
Hardenrm, 1999 medteach, v21, p7, p7, doi10.1080/01421599979969	2	15	107	107
spady wg., 1994, outcome based ed cri.	2	13	53	58
frankjr, 2010, med teach, v32, p631, doi10.3109/0142159x.2010.500898	1	13	83	34
smithsr, 1999, med teach, v32, p631, doi10.3109/0142159x.2010.500898	1	15	81	34
harden rm, 2002, med teach, v24, p117, doi10.1080/01421590220120669	2	12	52	31
harden rm, 2007, med teach v29, p625, doi10.1080/01421590701729930	4	15	68	27
Simpson jg, 2002, med teach, v24, p136, doi10.1080/01421590220120713	3	13	72	25
frank jr, 2007, med teach, v29, p642, doi10.1080/01421590701746983	3	13	78	23
carraccio c, 2002, med teach, v77, p361, doi1097/000018882002050000-0003.	1	13	58	22
miller ge, 1990, acad med teach, v65 ps63, doi10.1097/00001888199009000-00045	1	11	32	19

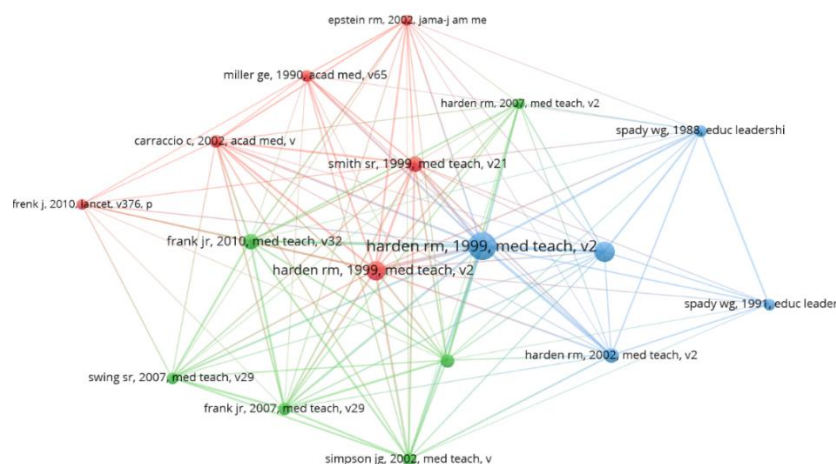


Figure 6: *The Network of Most Frequently Cited References.*

The blue cluster mainly comprised studies focused on the introduction of outcome-based education and the developmental processes in outcome-based education. According to Spady (1994), OBE was designed to ensure that all the students were equipped with the knowledge, skills, and qualities necessary for success upon completing their educational system. Furthermore, Spady (1994) emphasized that what has been lacking is a clear and thoughtful interpretation of what OBE is, why it is needed, and how it operates. In terms of the evolutionary process in outcome-based education, there have been several precursors to this shift to outcome-based education. These include competence-based education, criterion-referenced learning, and mastery learning, all of which focused on competencies or criterion levels of performance that were achieved by carefully sequenced teaching (Brady, 1994).

The highly cited references in Table 5 provide a comprehensive and systematic introduction to what OBE is, how learning outcomes should be covered, and how OBE should be implemented in education. However, it's worth noting that the knowledge structure in this field was mainly concentrated on implementing OBE in medical fields, which signified a partial monodisciplinary characteristic of the OBE implementation.

Thematic Evolution

Chen and Leydesdorff (2014) recommend employing a dual map overlay to visually present the evolution and expansion of literature at the domain level. This facilitates the discovery of more research themes that describe how OBE can be implemented in education. The essence of a dual-map overlay is to describe the relationships between citing and cited domains. It can reflect the knowledge flow between disciplines at the journal level.

Table 6 depicts the dual map, where the first column displays the primary clusters of journals in OBE, while the second column indicates clusters where they are cited. The regions were categorized based on common terms in the underlying journals, and the colors represented distinct citation relationships.

Table 6

Citation Trends at A Domain Level

Citing Region	Cited Region	Z-Score
medicine, medical, clinical	health, nursing, medicine	7.616
psychology, education, health	psychology, education, social	4.765
psychology, education, health	health, nursing, medicine	2.862

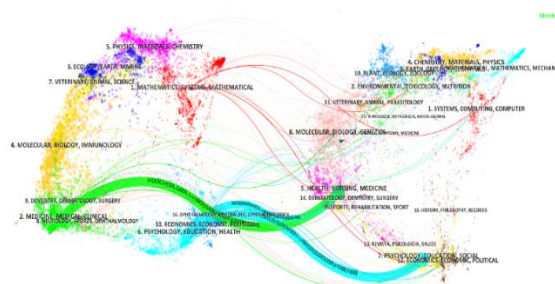


Figure 7: Domain-Level Citation Pattern.

As depicted in Figure 7, there are three main citation paths grouped by their width. Table 6 presents their main citation paths with citing and cited region names. The rows in Table 6 are arranged in descending order based on their z-scores. Each row is identified by the same color that matches its corresponding path. The domains that appear most frequently on both sides cover the records as follows: 2. medicine, medical, clinical, and 6. psychology, education, health. Then, the two domains are influenced mainly by: 5. health, nursing, education and 7. psychology, education, social. This aligns with the previous findings about the distributions by journals and cited references, where the studies on OBE implementation were mainly concentrated on the medical field.

In contrast, in terms of co-cited domains with high-frequency records covering 1. system, computing, computer, 8. molecular, biology, geniting, 14. dermatology, dentistry, surgery, 2. environmental, toxicology, nutrition, and 12. economics, economic, political contributed to the domain-level citation trends in the OBE implementation in mathematics, system, and mathematical, which partially indicated a multidisciplinary characteristic of the OBE implementation in scientific disciplines. According to Zhu et al. (2017), the subject category of an article can also be taken as evidence of a higher level of thematic focus in the article. To validate the findings above, we conducted a category analysis on the records using CiteSpace. Table 7 provides detailed information on the top 20 high-frequency subject categories based on their highest frequency and centrality. Centrality refers to an indicator acting as an intermediary within the entire network of relationships. It is generally believed that nodes with a centrality score higher than 0.1 indicate the nodes' significance among the networks of relationships.

Table 7

Top 20 Most Frequently Subject Categories

Frequency	Centrality	First Occurrence	Category
202	0.45	1993	Education, Scientific Disciplines
169	0.34	1985	Education & Educational Research
100	0.05	1993	Health Care Sciences & Services
48	0.1	1996	Engineering, Multidisciplinary
41	0.04	2003	Medicine, General & Internal
29	0.1	2002	Nursing
26	0.2	1993	Public, Environmental & Occupational Health
13	0.04	2003	Veterinary Sciences
13	0.04	2003	Engineering, Electrical & Electronic
13	0.12	1996	Surgery
12	0.01	2013	Computer Science, Information Systems
12	0.02	2011	Environmental Studies
11	0	2003	Telecommunications
11	0.03	2008	Medicine, Research & Experimental
10	0	2004	Dentistry, Oral Surgery & Medicine
10	0.01	2019	Environmental Sciences
10	0.02	2003	Pharmacology & Pharmacy
10	0.02	2016	Green & Sustainable Science & Technology
9	0.01	2012	Social Sciences, Interdisciplinary
9	0.06	2004	Management

Table 7 highlights education, scientific disciplines, educational research, public, environmental and occupational health, surgery, and engineering multidisciplinary as leading subject categories in the dataset. Among them, education and scientific disciplines have the largest centrality of 0.45. It indicates that scientific disciplines have significantly impacted on the appearance, progression, and integration of the implementation of OBE in education. More specifically, categories like environmental and occupational health, surgery, and nursing have played vital roles in connecting domains involved in the OBE research (centrality > 0.1).

Furthermore, the category of interdisciplinary (centrality = 0.1) has a significant influence on the development of OBE. Additionally, it is worth noting that OBE has gained growing attention from management, computer science, information technology, and social issues. Both observations indicate that the OBE has extended its application outside the medical field, suggesting its dynamic and interdisciplinary application in education. With the adoption of OBE, many subjects have been addressed, leading to many research themes and focuses. In the subsequent sections, we tried to understand these findings and identify hot spots and emerging trends at the keyword level.

Keywords As Indicators of Emerging Trends and New Developments

Table 8

Top 20 Most Frequently Keyword Occurrence

Keywords	Occurrences	Cluster	Links	Total Link Strength	Average Publication Year
outcome-based education	148	2	39	264	2014
education	127	1	45	193	2015
curriculum	62	3	40	172	2013
competence	53	2	34	148	2012
students	52	2	40	152	2016
medical education	47	2	36	98	2015
guide no. 14	44	2	28	134	2010
performance	33	3	35	77	2016
learning outcomes	33	3	32	87	2013
outcomes	30	1	31	72	2015
model	30	1	29	67	2014
impact	28	1	32	52	2018
skills	27	1	32	76	2017
outcome based education	24	1	16	27	2015
medical education	23	5	27	62	2016
assessment	23	1	26	69	2014
framework	21	3	29	73	2016
quality	21	4	27	58	2015
undergraduate	21	3	28	69	2013
engineering education	20	1	18	30	2018

Keywords are essential indicators of information measurement research, as they can provide an accurate summary of the entire text (Guo et al., 2021). Meanwhile, high-

frequency keywords can reflect the focus in a topic and can be used to determine emerging trends and new developments in a specific research field (Lu et al., 2021). Firstly, a co-occurrence keyword analysis in VoSviewer was conducted to specify hot spots and development trends on this field. With the minimum threshold of keyword occurrence set at 5, 47 items appeared in the visualization map. Table 8 lists 20 keywords most frequently given by authors and indexers to the records.

As we adopted “OBE” and “education” as the querying terms for this study, we did not include any discussions regarding them here. The core keywords, ranked by frequency, are curriculum (62), competence (53), students (52), medical education (47), guide no. 14 (44), learning outcomes (33), performance (33), model (30), outcomes (30), and impact (28). These terms represent substantial interconnections and intermediation within the entire network of relationships of this field, as shown in Figure 8 (a). They represent crucial operational processes, the stages of OBE implementation, a model or a framework for aligning with mandate of the OBE and the guidelines, and the influence of OBE in developing graduate competencies, making them the hot research spots in the research domain.

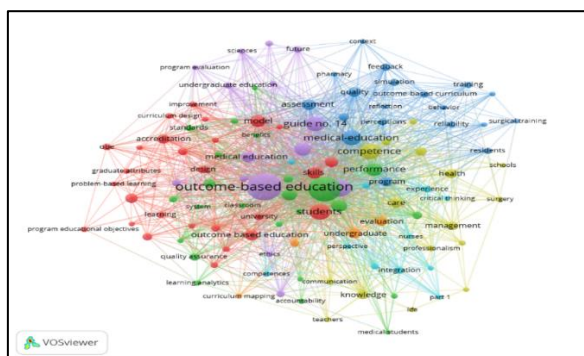


Figure 8: (a) Co-Citation Network Map of Keywords.

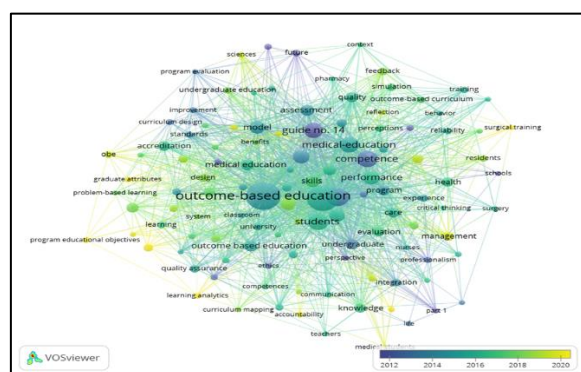


Figure 8: (b) Overlay Visualization Network Map of Keywords.

Figure 8 (b) displays different colors to represent the keyword occurrences over time from 2014 (purple) to 2020 (yellow). The overlay visualization of keywords showed that there were numerous emerging trends in this field in recent years (colored by yellow), such as “learning analytics (2021), strategies (2020), surgical training (2020), program educational objectives

(2020), and graduate attributes (2020)". The observations suggest that there has been growing interest in designing teaching and learning strategies and learning analytics to attain educational objectives or graduate attributes upon program completion.

Secondly, using the keyword burst technique was crucial to understand the emerging trends and shifts of specific topics in a particular field (Dong et al., 2020). CiteSpace was used to detect burst keywords using the following parameters: years per piece (1 year), node type (keyword), top N (50), and duration (2 years). Consequently, five keywords with the strongest citation bursts were identified and displayed in Figure 9. Guide No. 14 has the most substantial burst strength (n=10.04), which held significant importance in earlier years, offering vital information, recommendations, and best practices for educators and institutions involved in the implementation of OBE in medical education. In contrast, the focus of study in recent years has changed towards the topics of "impact," "higher education," and "engineering education," reflecting the emerging trends and research frontiers in this field.

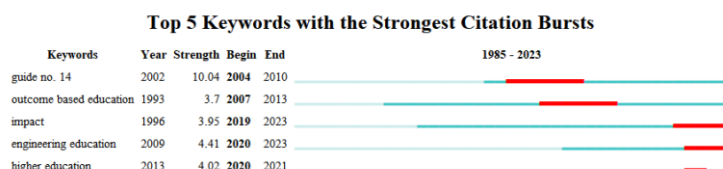


Figure 9: Top 5 Keywords with The Strong Citation Bursts.

However, the hot spots alone were insufficient to reflect the development trends in an academic area. According to Gong (2019), a keyword clustering map can reveal the focus of research frontiers more intensively in a specific field by summarizing the similarity between the keyword nodes and gathering nodes with co-occurrences through data processing. Thus, CiteSpace was again used to conduct a cluster analysis of the keywords to keep track of the emerging trends and cutting-edge keywords in OBE research. Similarly, the CiteSpace cluster parameters were set as above. Besides, the Log Likelihood Ratio (LLR) function was utilized to identify clusters. Then, a keyword cluster network map was displayed in Figure 10, where modularity $Q = 0.8215 > 0.3$ and the weighted mean silhouette $S = 0.9309 > 0.5$. Both values indicate that the cluster is significant, and the lines are clear.

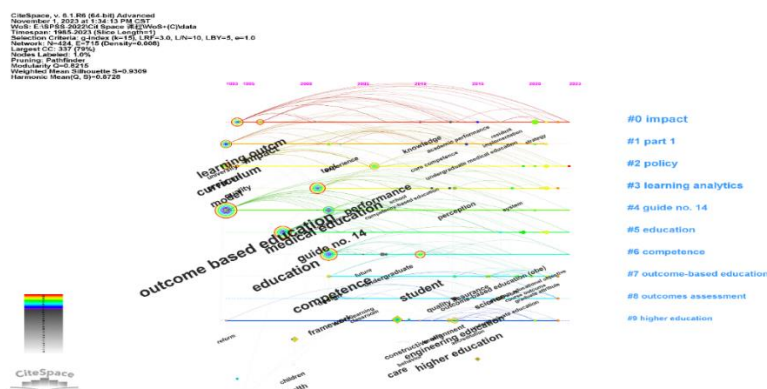


Figure 10: Timeline Visualization of Keyword Clusters (Labelled By LLR).

As shown in Figure 10, the research on the OBE implementation in education included ten key clusters: #0 impact, #1 part 1, #2 policy, #3 learning analytics, #4 guide No. 4, #5 performance indicators, #6 competence, 7# program educational objectives, #8 outcomes assessment, and #9 higher education. Among these clusters, cluster # 0, which focuses on the impact of OBE, ranked the highest with the most significant number of articles and silhouettes. As an emerging educational concept in the last century, the impact of OBE has been attracting the attention of many academics who have dedicated their efforts to assessing the effect of the implementation of OBE in various fields on attaining educational objectives.

Clusters # 1 part 1, # 2 policy, and # 4 guide no. 14 held the top positions in the table, indicating that the Commission on Higher Education (CHED) pursues strengthening the quality assurance of the implementation of OBE. Furthermore, examining the recent research trends in OBE from 2020 to 2023 reveals that #0 impact, #2 policy, #4 guide no. 14, #5 performance indicators, and #6 competence remained the prevailing research hot spots from their first years of occurrence to the present, which indicated the future work for the educators to investigate these aspects when implementing the OBE in education in the future. It aligns with the results derived from the analysis of keyword frequency.

Finally, to gain a deeper insight into the developmental trends in this field, we conducted an analysis of the time-zone visualization of keywords in CiteSpace. Due to the scarcity of publications before the 2000s and the subsequent increase in publications after that, our study focused exclusively on literature published from 2000 to 2023. Figure 11 presents a time-zone map for the OBE implementation, with publication years on the horizontal axis. A higher density of keywords within a specific period indicates more research themes related to the fields. The connections between nodes across different periods signified a continuity of research themes, with the number of links reflecting the level of closeness between those periods.

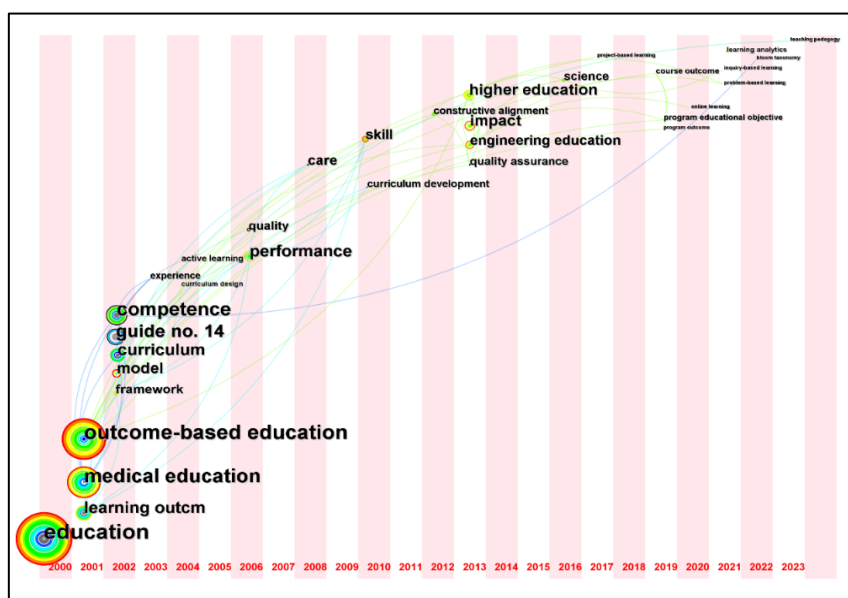


Figure 11: Time Zone Visualization of The Keyword (Labelled By LLR).

Figure 11 illustrates that researchers primarily focused on OBE in medical education in 2001, suggesting that this topic has been a significant concern since the inception of the concept of OBE. This finding aligns with the results of the contribution analysis by journals and references. From 2010 to 2013, the research exhibited a deepening and extension pattern, with keywords being denser and a more comprehensive range of themes being covered, indicating consistent expansion time. The keywords during this period included assessment, quality, care, impact, curriculum, skill, model, framework, etc., which indicated that more attention was paid to the quality of implementing the OBE approach in education. This was achieved by adhering to the OBE model, framework, or policy to develop competencies, skills, and performance upon completion of their programs of study.

As noted by Yusof et al. (2017), the development of these skills required a featured OBE-related supporting system to ensure the students get the best learning experience in their academic years through whatever a university can offer them, such as good teaching, assessment, a curriculum, and a featured focused model. The goals of tertiary education in implementing the OBE in earlier years were to develop competitive professionals with all-around attributes to meet the diversified yet global demand of 21st century society. Following 2013, the node density began to decline a little bit but still received increasing attention, indicating a stable and more in-depth phase. During this period, the researchers not only concentrated on the reform of the OBE to enhance the development of competencies but also introduced various theories to optimize the OBE implementation.

For example, Bloom's taxonomy was used to define different levels of intended learning outcomes, including institutional outcomes, program outcomes, course outcomes, etc. The taxonomy used to describe learning outcomes is divided into six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Rao, 2020). The classification of different levels of outcomes under OBE was analyzed to obtain a better understanding of the underlying concept and intentions of OBE. Additionally, from the perspective of continuity of connections between the nodes, the research on OBE adoption in education remained the research hotspot across the duration. However, while there were already links extending to the present, the number of links became sparse, which indicated that these topics were underexplored.

Although the existing researchers have devoted intensive attention to teaching and learning activities by integrating online learning (Sistermans, 2020), project-based learning (Goyal et al., 2022), inquiry-based learning (Bjørkvold & Ryen, 2021), etc., the selection of the effective TLAs to achieve the intended learning continues to be a challenge. Therefore, in the future, the researchers should dedicate their efforts to creating a comprehensive teaching pedagogy framework to ensure the successful implementation of OBE in education, as the effectiveness of the OBE implementation depends mainly on the quality of TLAs.

Discussion

The first research question underlies the publication trend of OBE witnessed three distinct development stages. Initially (1985-2006), there was a quiet phase with fewer than ten articles per year. Subsequently (2007-2012), despite fluctuations, interest in this field gradually increased. From 2013 onward, the publication output grew significantly, signifying a more advanced and mature stage in OBE research. The observed development trends align with the findings of Zain et al. (2016) that OBE has been implemented in various countries since the

1990s. However, success varied across different countries. Although OBE met with criticism and failure in Western Australia and South Africa (Lui & Shum, 2012), most countries have benefited from OBE. In recent years, many countries and institutions have increasingly embraced the OBE approach and practices. Therefore, the overall publication output of OBE presents an upturn trend, albeit with slight variations.

The second research question analyzes publication distribution and co-authorship using VOSviewer revealed the USA's leading roles in publications, citations, and research capabilities. Collaborations between the USA and other countries, such as England, Australia, Canada, the Netherlands, and Scotland, highlighted influential partnerships to enhance OBE implementation. Notably, collaborations with China mainly involved Singapore, Malaysia, and India, indicating limited ties with the USA. Cooperation with influential nations, including the USA, England, and Australia, is crucial for China's progress in this field. Institutionally, the University of Ottawa, the University of Toronto, and the University of Dundee stood out as major contributors, mainly through case studies at the University of Dundee, aiding curriculum planners and medical educators (Davis, 2003). While prolific American institutions engaged in substantial collaborations, less prolific institutions had fewer connections, suggesting the necessity for enhancing cross-organizational and international collaborations to ensure better results of OBE implementation. Prolific authors like Harden RM, Davis MH, Ten Cate O., Frank JR, and Scheele F. have made significant contributions with notable citations, particularly Harden's impactful work in medical education. However, collaborations among authors appeared scattered, calling for increased collaboration to enhance this field.

The third research question is exemplified in the co-citation analysis revealed that journals like *Medical Teacher*, *Academic Medicine*, and *Medical Education* played a significant role in shaping OBE implementation. Productive journals largely focus on medical and health disciplines, indicating a predominantly monodisciplinary focus in medical education's OBE implementation. The finding agrees with those of Harden (2007b) and Ammar and Rais (2021) that OBE adoption has gradually spread in the field of Medical Education. Highly co-cited references were categorized into three clusters, with a primary emphasis on the introduction and development of OBE, the identification of learning outcomes, and the evaluation of the level of attainment of these learning outcomes. These insights guide lecturers who are new to the field. However, the knowledge of how OBE should be implemented was mainly concentrated in medical fields, limiting exploration in other educational aspects.

The fourth research question is answered in the dual map overlay demonstrating the coexistence of both the monodisciplinary and interdisciplinary nature of OBE implementation in scientific disciplines, including medicine, psychology, computing, and environmental sciences. Moreover, the subject categorization of articles revealed a greater appearance of multidisciplinary characteristic of OBE implementation in the disciplines of management, economics, business studies, and social issues. The findings are similar to the results of Eng et al. (2012) that OBE was introduced to other disciplines, such as arts, humanities, technology, social sciences, and related disciplines. The statements confirmed the dynamic and interdisciplinary characteristics inherent in the various fields. These findings enhanced our understanding of the broader structure and scope of literature about OBE.

The fifth research question was examined with keyword occurrence analysis that revealed

significant terms like “competence,” “performance,” “curriculum,” “model”, and “learning outcomes” as research hotspots due to their centrality in OBE studies. The keyword burst revealed the shift in research focus in this field towards “engineering education.” Essential keyword clusters guided future research areas, emphasizing policy, impact, performance indicators, and competence. Future directions in OBE implementation should prioritize developing an empathetic teaching pedagogy to enhance effectiveness.

Conclusions, Limitations, and Implications

The bibliometric analysis used in this study has successfully identified vital contributors in terms of countries/regions, institutions, authors, journals, and references that have significantly influenced the development of OBE implementation in education. Furthermore, the study identified the thematic focuses in this field through dual map overlay and category analysis. The results showed that OBE implementation was seen in various subjects like management, economics, business studies, and social issues, indicating its multidisciplinary nature. Additionally, the study examined keywords in different aspects to determine the emerging hot spots and development trends for future research in this field. Notably, the research hot spots are gradually shifting from medical education to engineering education, management, economics, business, and social science, indicating the dynamic and multidisciplinary nature of the field. Future directions for educators and researchers include (1) optimizing the quality of publications for China, (2) strengthening collaborations between influential countries/regions, prolific institutions, and productive authors, and (3) developing a unified teaching pedagogy design or a model for aligning assessment with learning outcomes and learning activities to help graduate students attain the desired different levels of competencies.

A few limitations were felt during the course of this study. Firstly, the data collection was restricted to the WoSCC. Integrating non-WoS-indexed journals; however, utilizing other databases might have led to different results. Thus, additional sources, such as PubMed and Scopus, are recommended for future refinement of this type of analysis. Secondly, this study only focused on highly cited publications and cited references for generating intellectual landscapes. However, the larger number of publications was not the only indicator of influence for the journal, as other indicators (e.g., impact factor, SNIP, CiteScore, SJR) are widely used. Conducting a specific study to explore the theoretical implications of employing diverse conceivable selection criteria could yield more valuable insights. Third, this study only included English-language articles, excluding several papers with non-English languages, such as Japanese (n = 8), Spanish (n = 4), Chinese (n = 3), and German (n = 1). This may result in discrepancies in the results, necessitating more in-depth analysis or comparative studies of different manuscript versions in future research.

The practical implications derived from this study can be understood as follows: Firstly, through the bibliometric analysis, the study identified the most influential countries, institutions, authors, and highly cited references within the field of OBE while also illuminating collaboration networks among them that contributed to its development. The identification of the most influential authors and most cited articles serves as valuable guidance for academics and educators to improve their reading efficiency and locate authoritative scholars to track their studies. The most contributing journal in this field, for example, *Medical Teacher* and *Medical Education*, can serve as the most relevant and

related source of literature and a suitable publication platform for scholars. Besides, the identification of collaboration networks offers guidance for scholars and institutions seeking collaborative opportunities with other researchers or institutions. This is particularly significant for universities in developing countries, as it highlights the importance of forging alliances with influential institutions, such as those in the United States, Canada, and other influential nations, to promote the advancement of this field. Moreover, the bibliometric analysis has highlighted emerging trends through keyword analysis that suggest future research directions. These trends suggest that researchers interested in OBE should integrate available empirical evidence to investigate how OBE practices impact the development of various levels of competencies in engineering graduates in their future studies.

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