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Review Article

Bibliometric Analysis of Learning Styles Research in Higher Education: Trends and Insights from 1973 to 2024

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Abstract
Identifying students' learning styles is essential for enhancing the quality of education. This study aims to comprehensively understand the publication trends and conceptual, intellectual, and social structures within the topic of learning styles in higher education. The literature data were sourced from the Scopus database, covering the period from 1973 to 2024, and analyzed using bibliometric methods. This process began with an initial identification of 3,779 articles, which were then filtered according to specific criteria, resulting in 2,190 selected articles for in-depth analysis. The findings of this study reveal critical themes within the topic of learning styles and provide statistical insights through tables, graphs, and maps. This research also examines keywords and citations based on scientific publications. The results indicate that learning styles are closely linked with learning outcomes, learning objects, and students' psychological aspects. A notable increase in publications began around 2001, reaching a peak in 2022 with 131 articles. Analysis reveals the three authors with the greatest publication output in this domain are Brown T., Van Petegem P., and Vermunt JD. The analysis identifies BMC Medical Education as the leading journal publishing research on learning styles in higher education, followed by Medical Teacher and Nurse Education Today. Based on bibliometric analysis, the most cited article was authored by Kolb A.Y. in 2005. The countries with the greatest publication output are the United States and the United Kingdom. The relevant keywords include "human," "learning," "female," "article," "male," "humans," "learning styles," "teaching," "adult," and "education." This information is expected to help researchers further develop, explore, and uncover additional dimensions, themes, ideas, and research trends related to the topic of learning styles in higher education.

Keywords: Bibliometric Analysis, Learning Styles, Higher Education, Scopus

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1. INTRODUCTION

Learning is a process of enhancing knowledge to acquire and retain facts or procedures that can be applied effectively. It can also be described as a process of abstracting meaning and an interpretative process aimed at understanding reality (Richardson, 2011). The evaluation of students' learning styles is fundamental for optimizing the effectiveness and quality of the teaching and learning process, thereby supporting both immediate and sustained academic achievement (Nguyen et al., 2024). Learning styles refer to the distinct methods individuals employ to absorb and process information efficiently. In science education, adapting instructional strategies to accommodate these diverse learning approaches can greatly improve students' engagement and comprehension of scientific concepts (Shaidullina et al., 2023). Additionally, the cultural and ethnic diversity within student populations requires universities to implement more inclusive and adaptable educational methods (O'Brien et al., 2019). To effectively equip students for modern challenges, it is essential to design and apply teaching strategies that reflect contemporary trends and address individual learning preferences (Magulod, 2019).

Felder and Silverman (1988) suggest that recognizing students' preferred learning modalities—such as kinesthetic, auditory, or visual—enables educators to adapt their teaching methods to align with learners'

needs, resulting in improved educational outcomes, engagement, and motivation. Additionally, understanding these learning preferences allows education professionals and curriculum developers to customize their approaches and resources to better suit students' unique requirements (Bernard et al., 2017). Recognizing individual learning styles is vital for optimizing learning efficiency, promoting motivation and engagement, and reducing the time required for study. Stone (2021) conducted research investigating the connection between high school students' performance in chemistry and their preferred learning styles. The findings indicated that aligning instructional strategies and resources with students' preferred learning modalities can improve academic outcomes in science education. As a result, further exploration of learning styles in higher education is warranted, particularly through bibliometric analysis.

The bibliometric method is a systematic approach to article analysis that delineates and maps cumulative scientific knowledge across various fields over time (Donthu et al., 2021). Bibliometric analysis enables researchers to discover the perspectives of other scholars relevant to their research topic, presented in the form of written contributions, citations, and citation collaborations within research articles. Through bibliometric techniques, researchers can objectively identify the most influential articles and emerging research ideas related to their topic without conducting an exhaustive literature review from multiple sources (Župič & Cater, 2015). Thus, the bibliometric method is highly effective for mapping research topics.

Previous researchers have reviewed articles on the topic of learning styles in higher education. For instance, Shaidullina et al. (2023) conducted a systematic review of the topic using 21 selected articles extracted from the Scopus database, covering the period from 2007 to 2023. Their findings reveal that learning styles have significant implications for science education at the tertiary or university level (Shaidullina et al., 2023). Similarly, Nguyen et al. (2024) undertook a comprehensive bibliometric analysis of 394 articles obtained from Scopus, covering publications from 1984 to 2022. They identified that research on learning styles in higher education primarily relates to three major themes: learning environments, educational technology, and subject behavior (Nguyen et al., 2024). Andrade-Arenas et al. (2023) also examined the literature on learning styles in general, employing both bibliometric and systematic review methods. Their research began with a literature search on Scopus, supplemented by the Dimensions database, resulting in 59 items. The collected data were analyzed using VOSviewer and RStudio, uncovering innovative models relevant to learning styles that can be adapted to various study programs and courses (Andrade-Arenas et al., 2023).

In this study, articles analyzed using bibliometric methods were sourced from Scopus, covering publications from 1973 to 2024. A total of 2,190 selected articles were subjected to in-depth analysis. This study aims to provide teachers, researchers, educators, academic institutions, and prospective teachers with a comprehensive understanding of publication trends, as well as the conceptual, intellectual, and social structures associated with learning styles in higher education. This information is expected to facilitate the development, exploration, and discovery of additional dimensions, themes, ideas, and research trends over time. Additionally, this study serves as a reference for identifying articles discussing learning styles in higher education. The research questions in this article include:

1. What are the primary themes and developmental trends in the body of research on learning styles within higher education?
2. Who are the key contributors, and what are the notable source titles associated with research on learning styles in higher education?
3. What insights can be derived from a review of the most frequently cited research articles on learning styles in higher education?
4. Which countries and institutional affiliations are the leading contributors to the publication of research on learning styles in higher education?
5. What are the emerging trends in keyword usage and their visual representations within research articles on learning styles in higher education?
6. What are the underlying knowledge structures in the literature surrounding learning styles in higher education?

2. METHODS

This research adopts a bibliometric method to map and analyze publication trends related to learning styles in higher education. The data utilized in the bibliometric method is extensive and objective, necessitating the use of a comprehensive database such as Scopus. Scopus, produced by Elsevier Co., is one of the largest databases with high citation and abstract accuracy (Burnham, 2006). Its extensive collection of published documents enables researchers to access relevant topics across various timeframes. Therefore, Scopus is utilized as the primary data source in this research.

2.1. Article Selection Process and Method

Figure 1 illustrates the selection process and methodology used in selecting research articles. This process involves three main stages: searching, filtering, and synthesis. The search phase began with data extraction from the Scopus database on September 12, 2024. Using the keywords "Learning Styles" AND "Higher Education" OR "University," a search was conducted on the Scopus website, resulting in 3,799 documents from the period 1973-2024. In the next stage, filtering, documents that were not research articles—such as conference proceedings, books, book chapters, reviews, errata, editorial reviews, notes, letters, and non-English documents—were excluded, narrowing the selection to 2,192 articles. The final synthesis stage involved conducting a bibliometric analysis to eliminate duplicate documents and evaluate topic relevance, resulting in a final selection of 2,190 articles. Articles were chosen as the primary document type for this study as they represent original research outputs, contain valid and essential information, and have not been previously published. Articles derived from observational, theoretical, or experimental processes relevant to current conditions are ideal for use as data sources (J. Piqué-Angordans & S. Posteguillo, 2006).

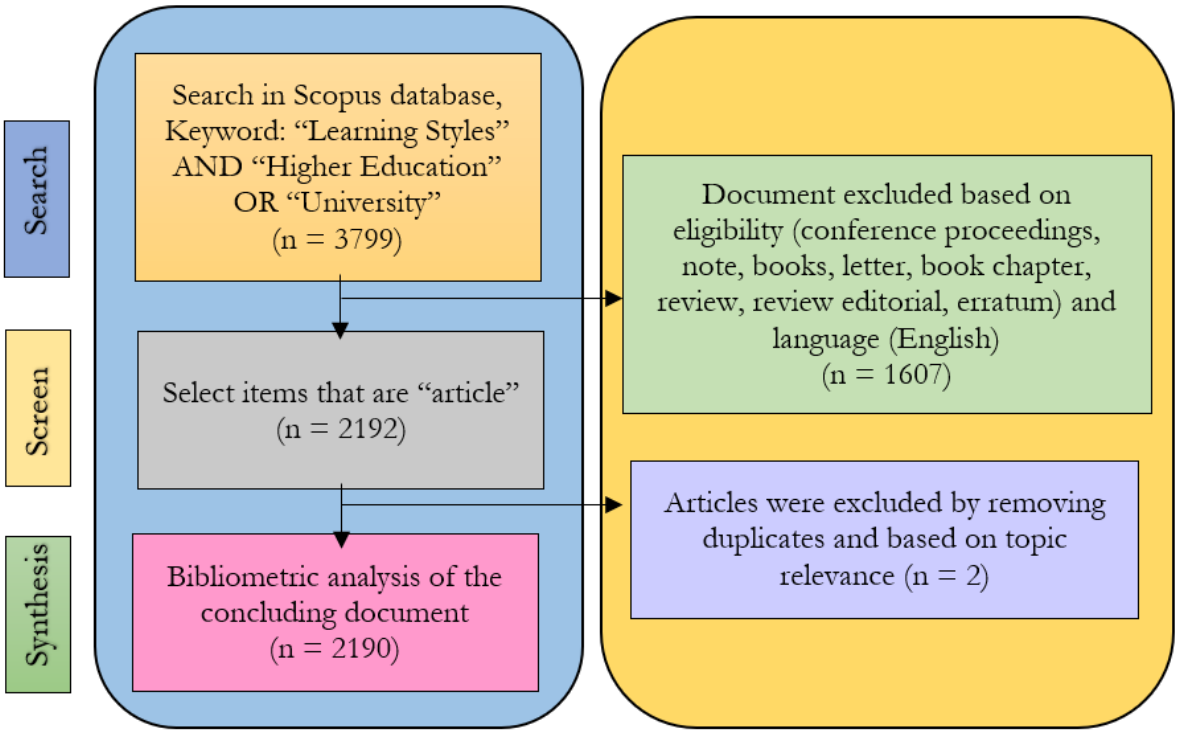

Figure 1. Article Selection Methodologies and Procedures

2.2. Data Analysis

This study analyzes data in (.csv) format containing publication information related to learning styles in higher education. The documents are then analyzed using bibliometric methods, which are visualized as statistical data and graphs. The bibliometric analysis offers a comprehensive understanding of the research landscape, including publication trends over time, research themes, sources, authors, and countries related

to the topic (Aria & Cuccurullo, 2017). The quantitative data generated from bibliometrics is then detailed in descriptions covering key information, publication trends, top authors, top sources, top countries, top journals, keywords, citations, citation collaborations, and country collaborations related to learning styles. Through bibliometric analysis, researchers can understand the scientific dynamics and structure related to the research topic and evaluate publications by authors, sources, and countries (Župič & Cater, 2015).

3. RESULTS

3.1. Main Information

Table 1 presents key information on the literature regarding learning styles from 1973 to 2024, extracted from the Scopus database. The data indicate that the topic has been a prominent research topic chosen by scholars over the past 51 years. The diversity of interdisciplinary themes and the wide range of keywords used suggest that learning styles in higher education remain a valuable area of exploration, continuing to contribute significantly to the field of education.

Table 1. Main Information of Bibliometric Data

Description	Results
Period	1973:2024
Sources	1059
Article	2190
Annual Growth Rate %	9.84
Average Document Age	11
Average citations per document	19.25
References	71437
Keywords Plus (ID)	3732
Authors	5892
Author's Keywords (DE)	4589
Authors of single-authored documents	510
Single-authored documents	535
Co-Authors per Documents	2.9
International co-authorships %	10.96

3.1.1. Trends in Published Research

Trends in published research on learning styles in higher education fluctuated between 1973 and 2024.

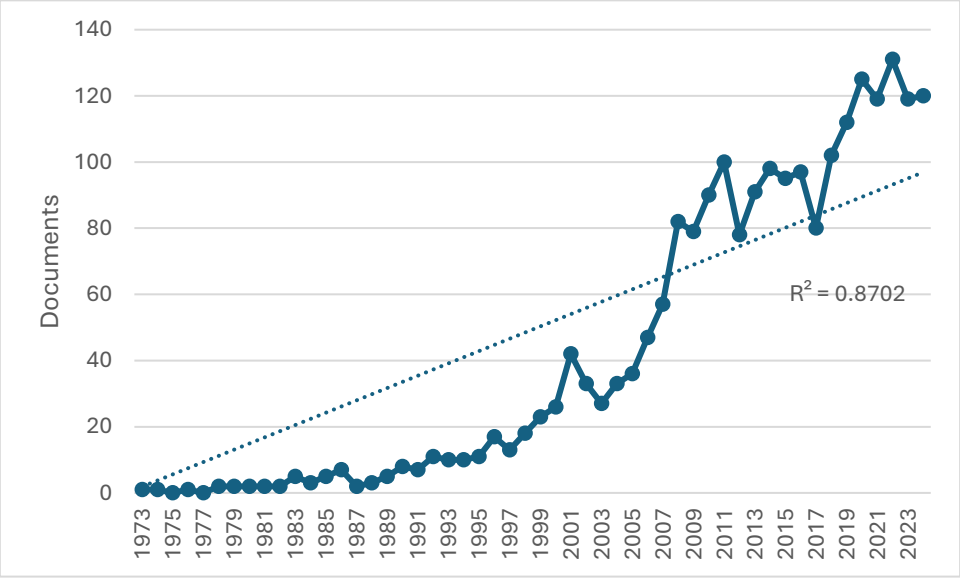

Figure 2. Annual Research Output of Learning Styles in Higher Education

Figure 2 shows that in 1975 and 1977, there were no publications on this topic, indicating that learning styles in higher education had not yet gained significant scholarly attention. However, a notable increase in publications began around 2001, reaching a peak in 2022 with 131 articles. Based on the data, the average document productivity rate is R = 0.8702 (approaching 1), indicating a robust annual growth in publications on this topic. This trend underscores that learning styles have become an important component of higher education research.

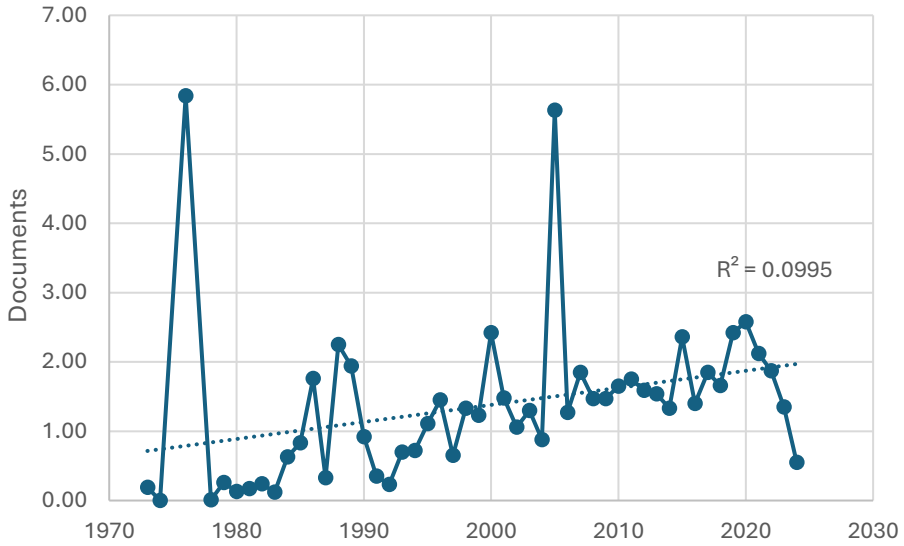

Figure 3. Annual Citation Per Year in Learning Styles Literature

Figure 3 illustrates the average citation rate per year for research on learning styles. The lowest average citation rate was in 1974 (0.00), while the highest occurred in 1976 (5.84) and 2005 (5.63). With an average citation rate of R = 0.0995 (approaching 0), the early years, such as 1974, indicate limited use of learning styles as a reference or research basis, resulting in fluctuating citation averages. However, by 1976 and 2005, learning styles had begun to serve as a supporting topic in educational research discussions, leading to an increase in citations, albeit not highly pronounced.

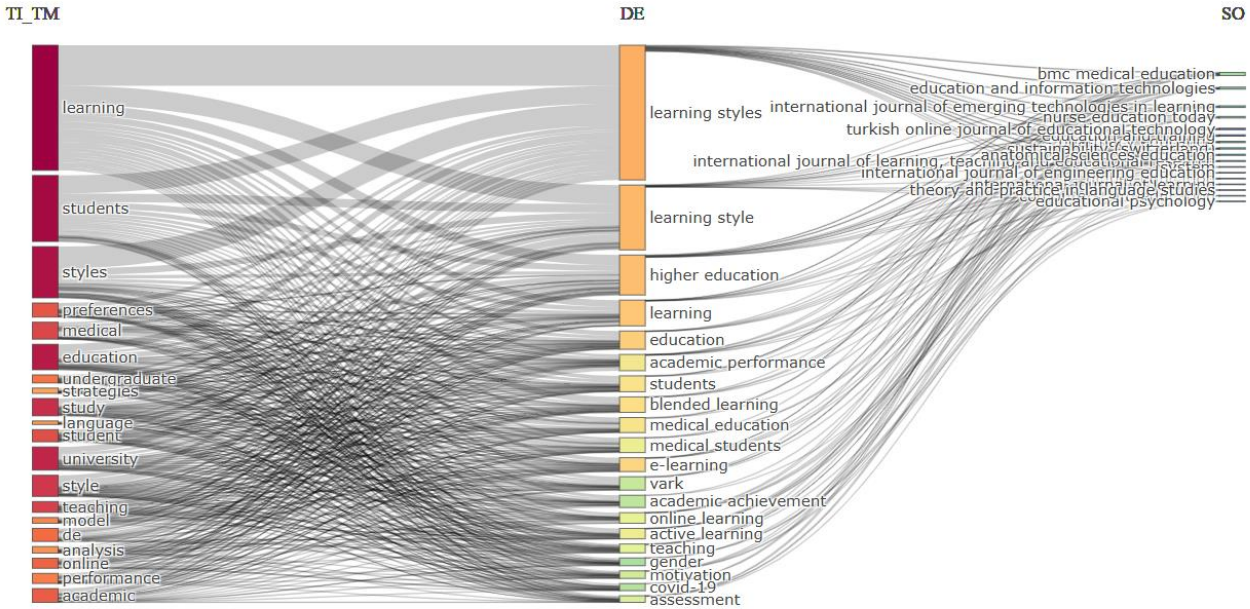

Figure 4. Thematic Development of Learning Styles

3.1.2. Thematic Development

Figure 4 illustrates thematic developments on the topic of learning styles, presented as a Sankey diagram.

This diagram, based on literature data from articles published between 1973 and 2024, reveals the thematic evolution within this field. Initially, article titles focused on terms such as "learning," "student," "styles," and "preference," which later evolved into "learning style" and "learning styles." These terms also connect with related keywords like "VARK," "academic performance," and "teaching." Titles that include "learning," "student," "styles," "education," and "university" link to "higher education," which is further associated with terms like "assessment," "student," and "academic performance." These keywords frequently appear in journals such as BMC Medical Education, Medical Teacher, and Nurse Education Today.

3.2. Profiles of Researchers and Source Publications

3.2.1. Top Author

The bibliometric data show that numerous scholars have conducted extensive research on learning styles from 1973 to 2024. Table 2 presents the top 10 authors with the highest publication output in this research area, led by Brown T, followed by Van Petegem P, Vermunt JD, among others. In addition to individual publications, several authors have collaborated on studies related to the topic.

Table 2. Top Authors and Their Impact on Learning Styles

Authors	Articles	Total Citation	h-index	Articles Fractionalised
Brown T	7	204	7	1.73
Van Petegem P	7	228	7	1.45
Vermunt JD	7	996	7	4.66
Wang Y	7	15	3	1.53
Coertjens L	6	201	6	1.33
Donche V	6	201	6	1.33
Nuankaew P	6	52	4	3.12
Yousef DA	6	48	4	6
Zhang H	6	84	3	1.62
Zhang Y	6	8	2	1.28

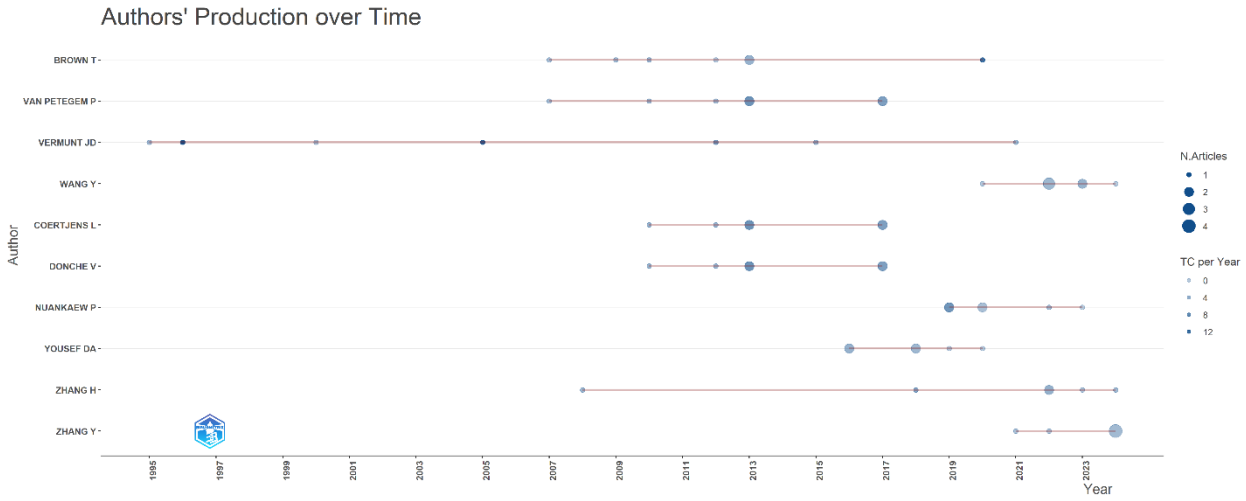

Figure 5. Top Author Production Over Time

The depiction of scientific publications by the authors regarding learning styles during this period is illustrated in Figure 5. Brown, T., and Van Petegem, P. initiated their publication efforts in 2007, with the highest number of articles produced in 2013. In contrast, Vermunt, J.D. has demonstrated a more consistent research trajectory on this topic from 1995 to 2021, although the volume of publications

generated is relatively lower. However, due to the earlier onset of his research, articles authored by Vermunt, J.D. are the most frequently cited in other research articles, accumulating a total citation count of 996. Other authors began to engage with this topic for research articles and have published from 2008 to the present.

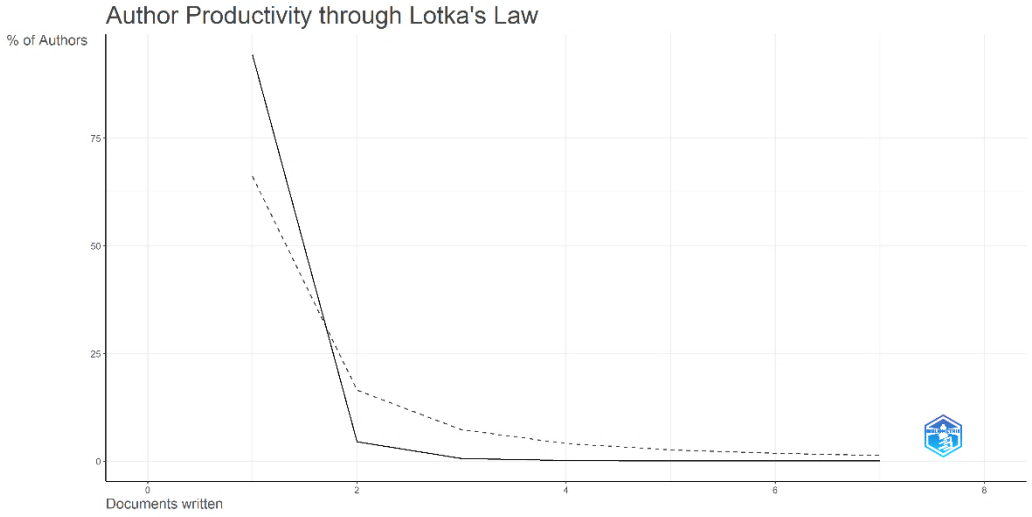

Figure 6. Author Productivity

Figure 6 presents a graph depicting the productivity of authors in scientific publications on the subject of learning styles, as analyzed using Lotka's Law. This law illustrates the number of authors producing articles within a specified time frame. 5,892 authors have researched this topic, resulting in 2,190 articles (Table 1). However, Lotka's Law graph reveals that more than 75% of authors have contributed a single publication, while the frequency of authors publishing between two and seven articles remains below 25%. This indicates that not all authors engage in repeated publications on the topic of learning styles in their research.

3.2.2. Top Source

Table 3 provides data on the top ten journal sources and their local impact within the field of research.

Table 3. Top Sources and Their Local Impact

Journal	N	TC	Cite Score (2024)	m_index	h_index	g_index	PY_start
BMC Medical Education	33	598	4.9	0.688	11	24	2009
Medical Teacher	27	824	7.8	0.410	16	27	1986
Nurse Education Today	27	907	6.9	0.457	16	27	1990
Education and Information Technologies	26	316	10.0	0.846	11	17	2012
International Journal of Emerging Technologies in Learning	19	377	N/A	0.818	9	19	2014
Pharmacy Education	16	81	0.8	0.300	6	8	2005
PLoS One	15	347	6.2	0.643	9	15	2011
Sustainability (Switzerland)	15	120	6.8	0.857	6	10	2018
International Journal of Learning, Teaching and Educational Research	14	34	2.1	0.500	3	5	2019
Anatomical Sciences Education	13	607	10.3	0.647	11	13	2008

The table reveals that the journal with the highest quantity of publications on learning styles is BMC Medical Education, with 33 articles, followed by Medical Teacher with 27 articles. BMC Medical Education commenced publication in 2009, whereas Medical Teacher began in 1986, suggesting that Medical Teacher

was the pioneer in research on this topic compared to BMC Medical Education. Due to this earlier research initiation, Medical Teacher has been frequently cited by other articles, achieving a total citation count of 824. However, the highest total citation is held by Nurse Education Today, with 907 citations from 27 articles published since 1990. This observation indicates that research published earlier tends to be cited more frequently than more recent studies.

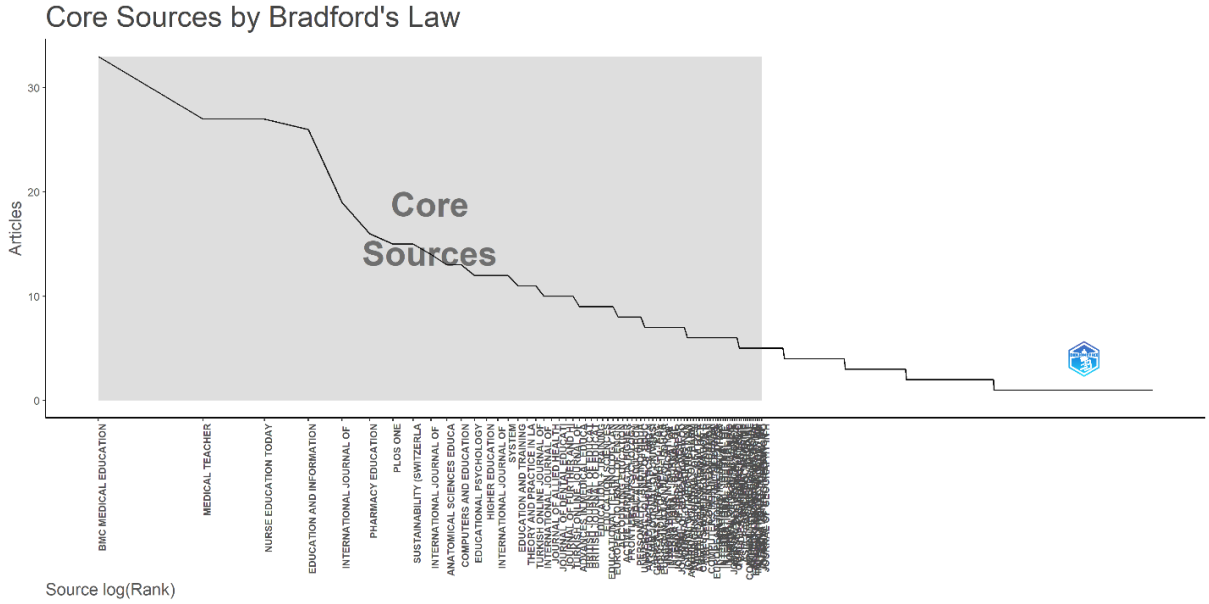

Figure 7. Core Sources by Bradford's Law

Figure 7 illustrates the journal sources that have been published on the topic of learning styles, as depicted in a Bradford's Law graph. The shaded area in the graph highlights the core sources that are most relevant and have published the most on this subject. The greater the number of publications, the more influential the journal discusses the research theme. The top five journal sources include BMC Medical Education, Medical Teacher, Nurse Education Today, Education and Information Technologies, and the International Journal of Emerging Technologies in Learning. These five journals significantly support the progression and integration of the topic with various other variables.

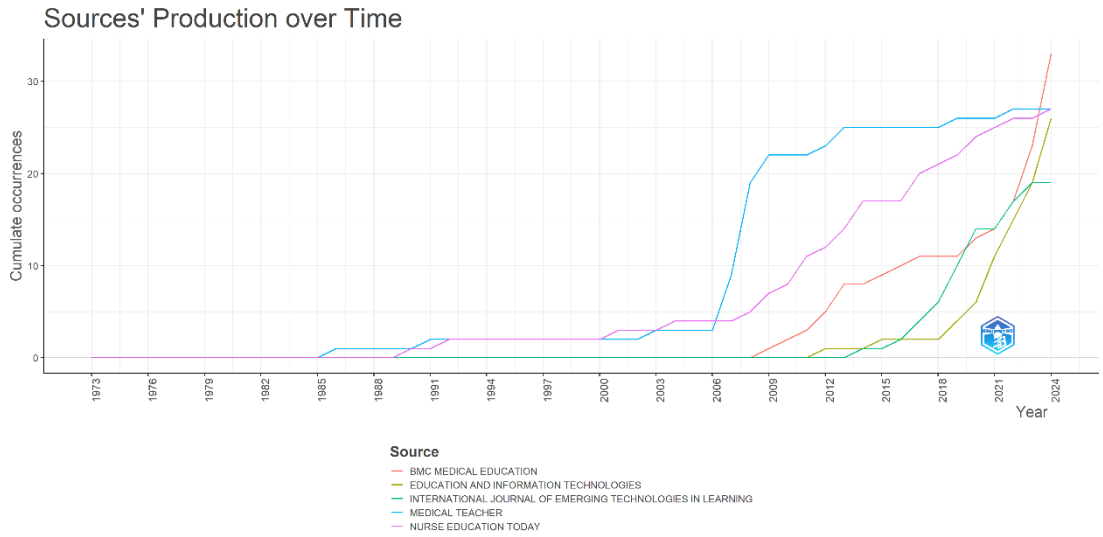

Figure 8. Top Sources Publication Growth

The growth of publications from these leading journals is further illustrated in Figure 8. The lines depicted in the graph represent the growth of publications by each journal over specific time periods. The journals demonstrating the most significant growth are BMC Medical Education, Medical Teacher, and Nurse Education Today, which corresponds with the substantial number of articles they have published.

3.3. Most Influential Literature

Table 4 provides a list of the ten most cited articles in research on learning styles. The article with the highest citation count was authored by Kolb, A. in 2005. Published in *Academy of Management Learning & Education*, it has garnered a total of 2,921 citations, with an average citation rate of 146.05 per year. Following this is an article by Margaryan, A. published in 2011 in *Computers & Education*, which has received 649 citations and an average of 46.36 citations per year. In third place is an article by Jensen, J.L., published in 2015 in *CBE—Life Sciences Education*, with a total of 506 citations and an average citation rate of 50.60 per year. Notably, these authors are not the leading contributors, and their respective journals do not rank among the top sources. However, their research articles are widely referenced by authors exploring similar topics.

Table 4. The Most Cited Article on Learning Styles from 1973 to 2024

Rank	Author(s)/year	Source	DOI	TC Per Year	Total Citation
1	(Kolb Ay, 2005)	Acad Manage Learn Educ	10.5465/AMLE.2005.17268566	146.05	2921
2	(Margaryan A, 2011)	Comput Educ	10.1016/j.compedu.2010.09.004	46.36	649
3	(Jensen Jl, 2015)	CBE Life Sci Educ	10.1187/cbe.14-08-0129	50.60	506
4	(Vermunt Jd, 1996)	High Educ	10.1007/BF00129106	15.90	461
5	(Busato Vv, 2000)	Pers Individ Differ	10.1016/S0191-8869(99)00253-6	16.44	411
6	(Newble Di, 1986)	Med Educ	10.1111/j.1365-2923.1986.tb01163.x	10.36	404
7	(Healey M, 2000)	J Geogr	10.1080/00221340008978967	12.64	316
8	(Dale Ps, 1989)	J Child Lang	10.1017/S0305000900010394	8.78	316
9	(Dimov D, 2007)	Entrep Theory Pract	10.1111/j.1540-6520.2007.00188.x	16.17	291
10	(Kolb Da, 1976)	Calif Manage Rev	10.2307/41164649	5.84	286

3.4. Leading Countries and Affiliations

Table 5 with the most publications focused on learning styles from 1973 to 2024. The United States ranks first, producing 1,138 documents with a total of 6,061 citations, resulting in an average citation rate of 22.90. The United Kingdom is next, with 519 documents and 5,362 citations, yielding an average citation rate of 34.80.

Table 5. Countries Leading in Document Production and Citation Frequency

Country	Frequency	Average Article Citations	Total Citations
USA	1138	22.90	6061
UK	519	34.80	5362
Australia	432	27.50	2529
China	396	10.10	1113
Malaysia	327	11.40	695
Iran	216	6.00	276
Spain	215	12.20	586
Saudi Arabia	191	12.30	700
Canada	175	15.40	386
Turkey	168	12.20	916

The graph in Figure 9 illustrates the growth of publications by several countries on the topic. It is evident that the most prominent trend is represented by the purple line, which corresponds to the United States, the blue line for the United Kingdom, and the orange line for Australia. Based on the data presented, these three countries have shown a steady increase in publication growth from the year 2000 to the present.

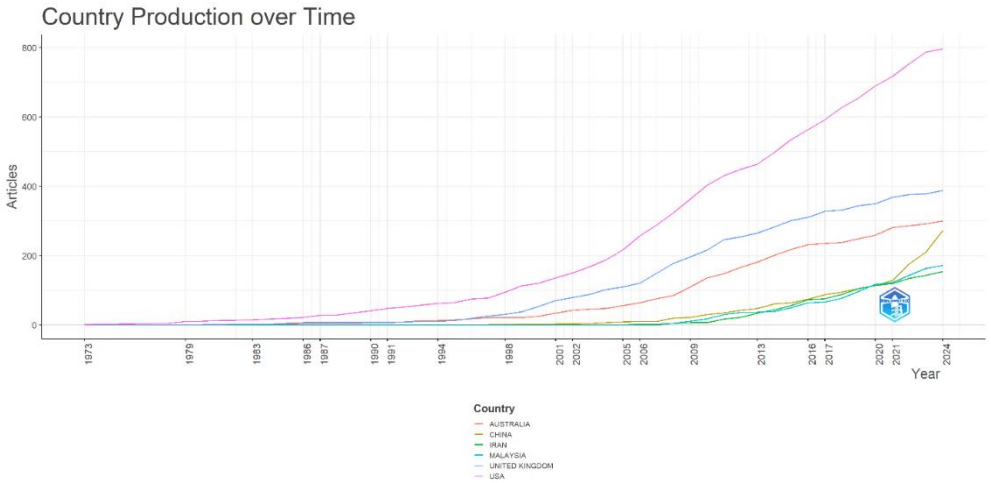

Figure 9. Document Growth of Learning Styles by Country

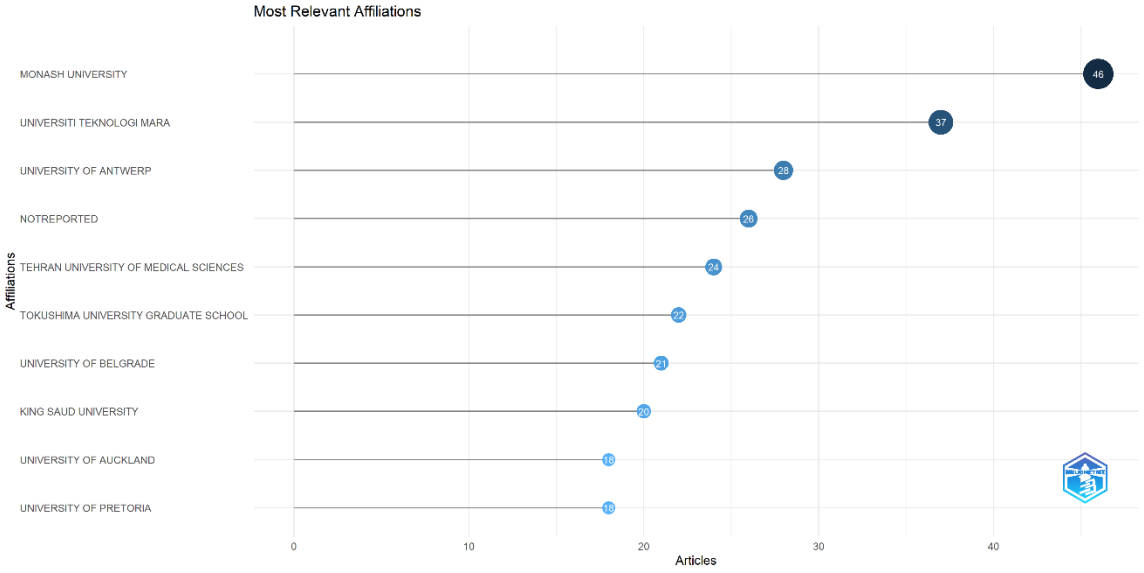

Figure 10. Top Affiliations

In addition to country-level analysis, contributions to scholarly publications on learning styles in higher education can also be observed across various affiliations or universities worldwide. Figure 10 displays the top 10 affiliations or universities with the highest number of publications from 1973 to 2024. Monash University ranks first with a total of 46 articles, followed by Universiti Teknologi Mara in second place with 37 publications.

3.5. Keywords Trend

Keywords are a crucial component of a research article, as they highlight the main points and principal focus areas within the study.

Figure 11 presents several keywords that are highly relevant to the topic. The most frequently occurring keywords include "human" with 559 occurrences, followed by "learning" with 482 occurrences, "female" with 472 occurrences, "article" with 468 occurrences, and "male" with 457 occurrences, along with several other keywords.

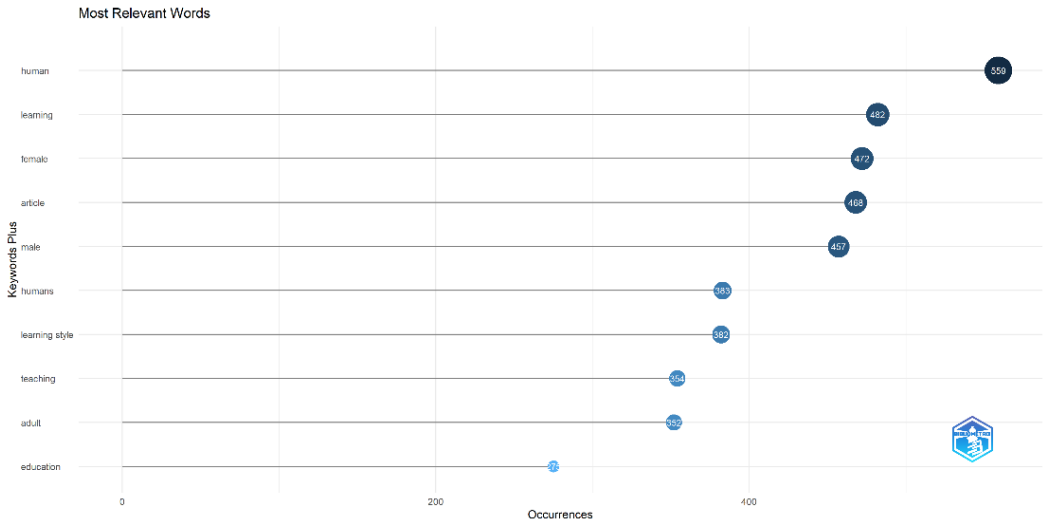

Figure 11. Most Frequent Words

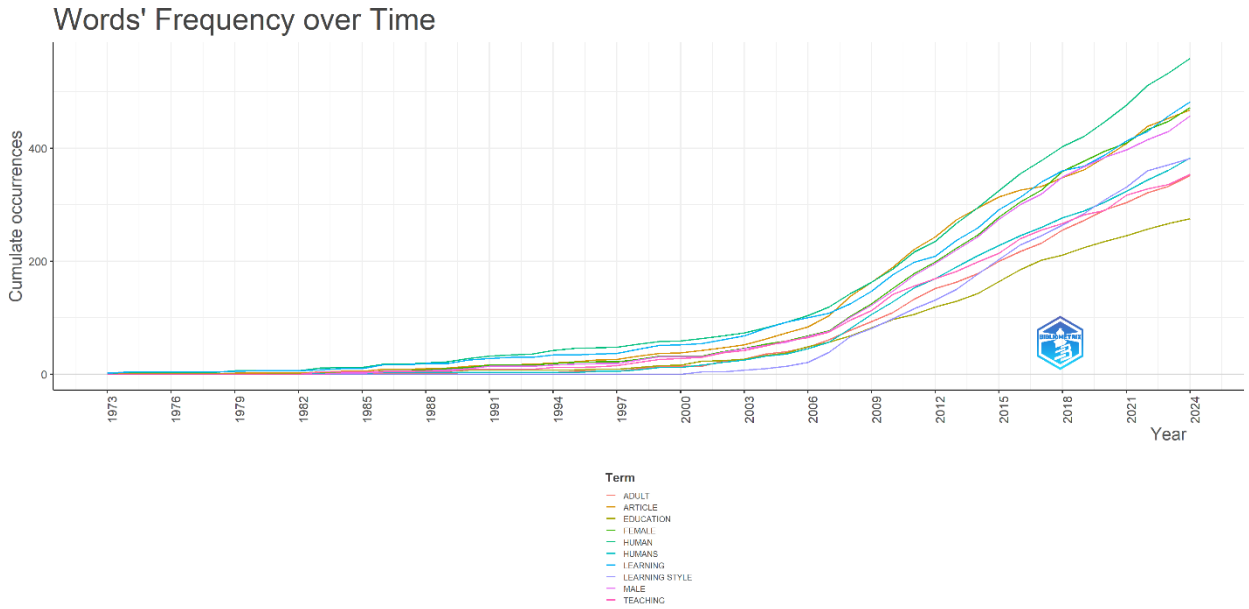

Figure 12. Words' Frequency Over Time

In Figure 12, a graph illustrates the growth of the most frequently used keywords in research on learning styles from 1973 to 2024. It is evident that the green line, representing the keyword "human," shows the most significant growth, followed by the blue line for the keyword "learning." Both keywords have exhibited notable growth since 2005. This trend suggests that research consistently incorporates the aspects of "human" and "learning," regardless of varying research themes and focuses.

3.6. Analysis of Knowledge Structures

The analysis of knowledge structures related to learning styles is divided into three components: conceptual structure, intellectual structure, and social structure.

3.6.1 Conceptual Structure

The conceptual structure provides an overarching view of the research theme. This can be observed through the network of keywords and thematic dimensions appearing from 1973 to 2024.

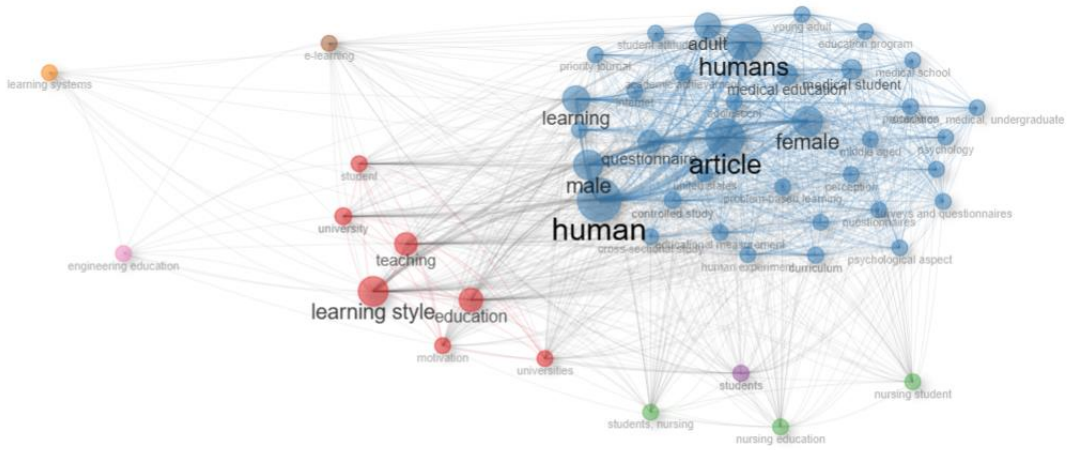

Figure 13. Co-occurrence Network

Figure 13 presents the relationships between keywords and publication articles related to the topic of learning styles. These relationships are analyzed and visualized as a network, divided into several color-coded clusters. The clusters are as follows:

1. Blue Cluster: The blue cluster represents the most prominent set of keywords in this research area. Key terms in this cluster include "human," "humans," "article," "female," "learning," and "male." These keywords indicate that this cluster reflects the connection between learning styles, learning processes, and human aspects, encompassing both male and female individuals.
2. Red Cluster: The red cluster includes key terms such as "learning style," "education," "teaching," "university," and "student." These keywords suggest that this cluster highlights the connection between learning styles and the broader domains of teaching and education.
3. Green Cluster: The green cluster contains keywords like "nursing education," "nursing student," and "students nursing." These terms indicate that this cluster represents the specific connection between learning styles and nursing education.

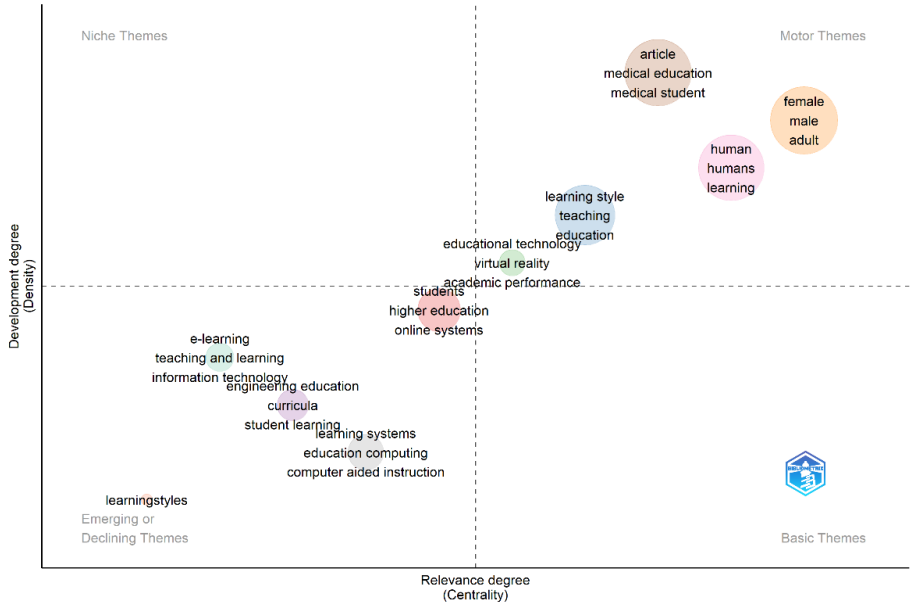

Figure 14. Thematic Map

Figure 14 presents a thematic map related to learning styles. This thematic map is categorized into several dimensions: emerging or declining themes, motor themes, basic themes, and niche themes. In the basic themes and niche themes categories, no keywords or research topics associated with the subject were identified.

However, in the motor themes category, five groups of relevant themes are evident. Group 1 includes the terms "female," "male," and "adult"; Group 2 includes "human," "humans," and "learning"; Group 3 consists of "article," "medical education," and "medical student"; Group 4 includes "learning style," "teaching," and "education"; and Group 5 consists of "educational technology," "virtual reality," and "academic performance."

In the emerging or declining themes category, four thematic groups are associated with the research topic. Group 1 includes "e-learning," "teaching and learning," and "information technology"; Group 2 includes "engineering education," "curricula," and "student learning"; Group 3 includes "students," "higher education," and "online system"; and Group 4 consists of "learning system," "education computing," and "computer-aided instruction."

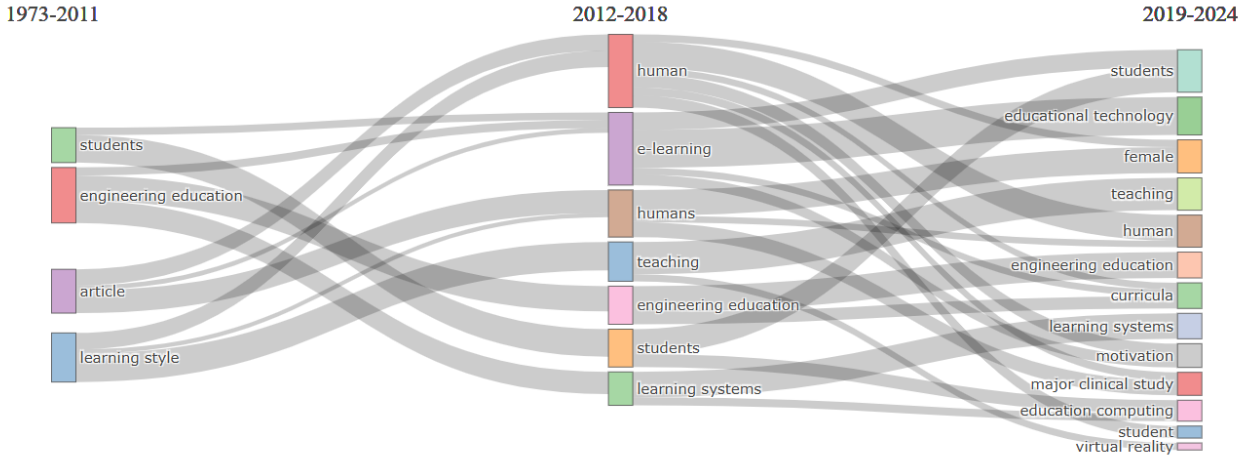

Figure 15. Thematic Evolution

Figure 15 illustrates the thematic evolution within the topic of learning styles from 1973 to 2011, the topic of learning styles was primarily associated with students, engineering education, and academic articles. In the period from 2012 to 2018, this focus evolved to include concepts related to "human" and "e-learning." Finally, from 2019 to 2024, the theme further expanded to encompass concepts such as learning systems, teaching, curriculum, and related topics.

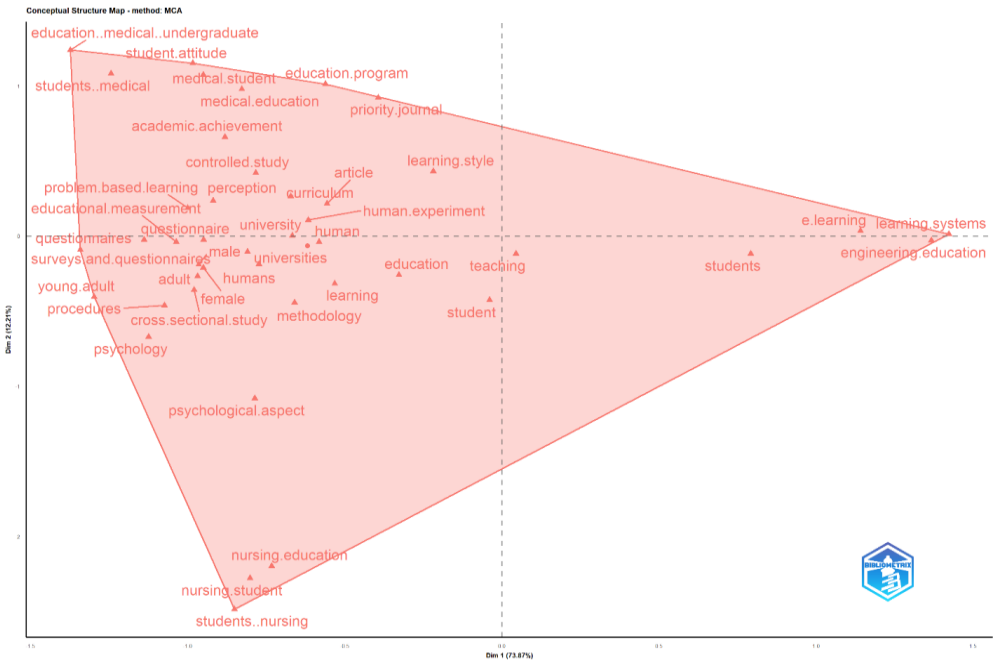

Figure 16. Factorial Analysis using MCA

Figure 16 presents the two primary dimensions of the topic "learning styles in higher education," analyzed using Multiple Correspondence Analysis (MCA). The MCA divides dimensions based on keywords associated with the research topic. The first dimension, also referred to as the negative dimension, accounts for 73.87% and includes keywords such as "human," "education," "student," "teaching," "female," "male," and others. This dimension represents more general keywords that are widely connected to the topic of learning styles in higher education. In contrast, the second dimension, or positive dimension, accounts for 12.21% and includes keywords like "curriculum," "article," "academic achievement," "human experiment," and several others. This dimension reflects specific keywords more directly related to particular aspects within the topic.

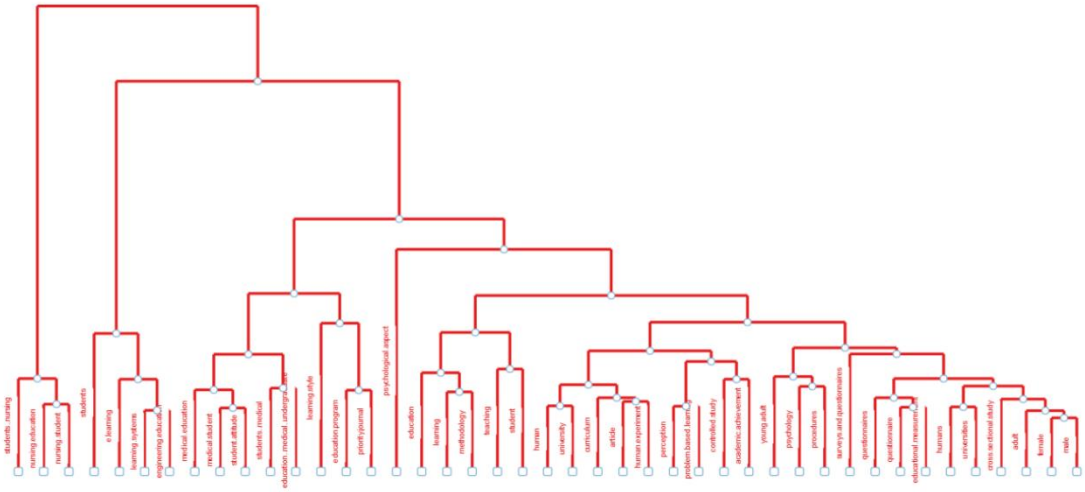

Figure 17. Thematic Dendrogram

The thematic dendrogram illustrates the delineation of conceptual dimensions widely connected to learning styles. Figure 17 reveals that various dimensions emerge within this topic, encompassing concepts such as "learning," "education," "psychology," "humanity," and others. This observation indicates that the subject of learning styles has evolved into multiple conceptual dimensions from 1973 to 2024.

3.6.2. Intellectual Structure

The intellectual structure is presented as a co-citation network, established by numerous authors from 1973 to 2024.

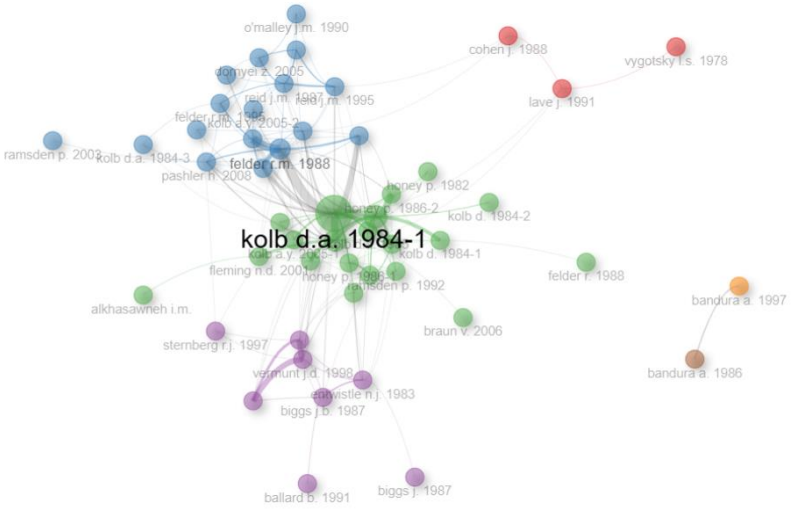

Figure 18. Co-citation Network

Figure 18 illustrates the co-citation network utilized in articles on learning styles from 1973 to 2024. Based on the colored lines, five distinct clusters are visible: green, blue, purple, red, and yellow. The cluster with green lines is the most significant, indicating the highest frequency of co-citation within a single article. The primary reference most frequently cited within the green cluster is the article authored by Kolb D.A. in 1984. The next most extensive network is represented by the blue cluster, with a notable article authored by Felder R.M. in 1988. These two authors' works are among the most frequently cited in subsequent research.

3.6.3. Social Structure

The social structure can be observed through the collaborative authorship network and an international collaboration map.

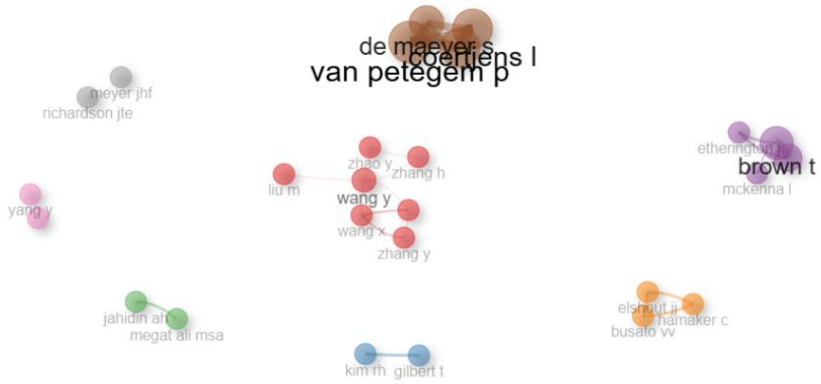

Figure 19. Collaboration Network

Figure 19 presents eight distinct collaborative author groups. The most significant group consists of Van Petegem P, Coertjens L, Donche V, and De Maeyer S, who rank among the top authors in terms of published articles. Another noteworthy group includes Brown T, Williams, McKenna J, and Etherington J, with Brown T recognized as the most prolific author on learning styles. Additionally, the largest author group, comprised of Wang Y, Wang X, Zhang H, Zhang Y, Liu M, and Liu Y, all hail from China, a country that ranks fourth globally in terms of the volume of publications on learning styles.

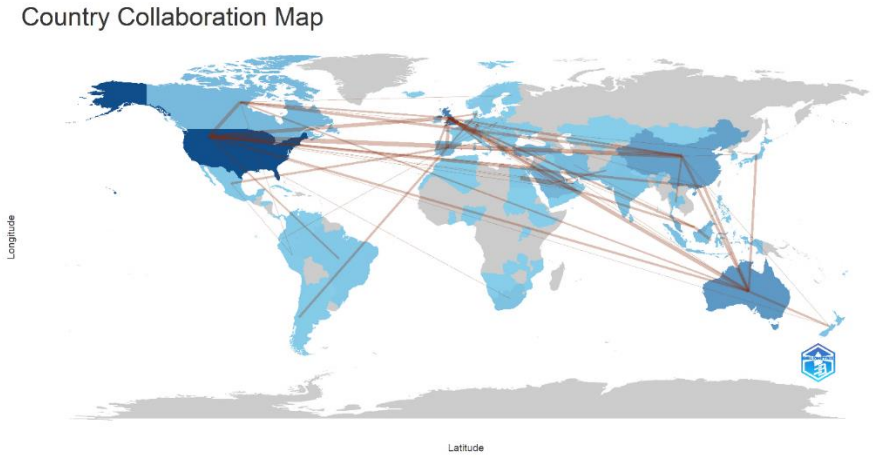

Figure 20. Country Collaboration Map

Figure 20 illustrates international collaboration through a mapped representation. According to bibliometric data, the countries with the highest frequency of co-authorship are primarily in Asia and Africa, with Saudi Arabia and Egypt collaborating on 11 articles. In addition, significant collaboration has occurred between countries in the Asia and Americas, notably the China and USA, which have jointly published 10

articles. These patterns reflect a substantial amount of intercontinental and international collaboration on the topic of learning styles.

4. DISCUSSION

3.1. Main Information

3.1.1 Trends in Published Research

Learning styles have garnered significant research interest only since 2001, although it is anticipated that this area will continue to be explored further in light of ongoing developments in the education sector. Learning styles represent a crucial factor influencing educational effectiveness. Each individual possesses unique methods for comprehending and processing knowledge, highlighting the necessity for both educators and prospective teachers to recognize students' learning styles and tailor instruction to meet contemporary educational needs. Learning approaches are not confined to a singular methodology; rather, they encompass a diverse range of strategies, including observation, reading, auditory processing, critical thinking, and experiential learning. By considering these various styles, the learning process can be adapted to align with students' needs (Ucar & Yilmaz, 2023).

3.1.2 Thematic Development

The thematic evolution of learning styles is depicted through a Sankey diagram. This diagram serves as a visualization method that highlights the progression of research themes over time. It effectively summarizes data, providing insights into research trends while emphasizing the relevance and generalizability of the topic (Otto et al., 2022).

3.2. Profiles of Researchers and Source Publications

3.2.1 Top Authors

Analysis reveals the three authors with the greatest publication output in this domain are Brown T., Van Petegem P., and Vermunt JD. Brown T. is a professor at Monash University in Australia. One of his articles, published in 2020, investigates the relationship between dimensions of learning styles and psychological well-being, instructional methods, social skills, levels of emotional intelligence, social responsibility, situational anxiety and characteristics, empathy, and self-identity (Morales-Rodríguez et al., 2020).

The next prominent author, Van Petegem P., is a professor at the University of Antwerp, Belgium. In 2010, he published a study examining the correlation between learning style attributes and academic outcomes in first-year higher education students. This research underscores the significance of early semester assessments for students, particularly in relation to learning style characteristics, offering valuable insights for student counseling and monitoring, especially for those identified as at risk (Donche & Petegem, 2010).

Lastly, Vermunt J.D. is a professor at Eindhoven University of Technology in the Netherlands. In 2020, he authored an article exploring the correlation between learning patterns and learning environments in universities through empirical research analyzed using the Inventory of Learning Styles (ILS) (Yu et al., 2020).

3.2.2 Top Sources

The analysis identifies BMC Medical Education as the leading journal publishing research on learning styles in higher education, followed by Medical Teacher and Nurse Education Today. BMC Medical Education, published by Springer in Germany, has released a total of 33 articles on this topic. One notable article, authored by Liew et al. in 2015, aims to identify various learning styles and approaches utilized by undergraduate medical students at the pre-clinical level, and it analyzes the correlation between learning

preferences and their summative exam outcomes (Liew et al., 2015). Following this, Medical Teacher, a publication of Taylor & Francis Online in the UK, has published 27 articles related to learning styles. One significant contribution by David W. Laight in 2004 investigates students' attitudes towards pre-prepared concept maps based on their preferred learning styles, utilizing the Felder–Silverman model (Laight, 2004). In addition, Nurse Education Today, an Elsevier journal from the Netherlands, has also published 27 articles on this subject. One of its articles, written by Manchester and Roberts in 2024, compares the use of learning styles represented through infographics with conventional text-based evaluation standards for undergraduate nursing students, including those with and without specific learning difficulties (SpLDs) (Manchester & Roberts, 2024).

The development of journal publication sources is further elucidated through a Bradford's Law graph, which illustrates the relationship between journals and the articles they publish over time. This law explains that while some journals publish significantly, others may do so at a moderate rate, and some may publish very little (Alabi, 1979).

3.3. Most Influential Literature

Based on bibliometric analysis, the most cited article was authored by Kolb A.Y. in 2005. This article investigates the concept of learning spaces as a framework for exploring the relationship between institutional environments and learning styles. It also discusses the application of experiential learning across various educational settings, long-term outcome assessment, curriculum development, student development, and faculty development. This article has been cited a total of 2,921 times, with an average citation rate of 146.05 per year (Kolb & Kolb, 2005).

Additionally, an article by Margaryan in 2011, found that only a small percentage of students actively utilize digital technologies. The study revealed that younger generations exhibit differing learning styles. This article has received a total of 649 citations, averaging 46.36 citations per year (Margaryan et al., 2011).

3.4. Leading Countries and Affiliations

The analysis presented in Table 5 identifies the ten countries possessing the greatest number of publications on the topic of learning styles from 1973 to 2024. The United States and Canada are located in North America, while the United Kingdom, Spain, and parts of Turkey are situated in Europe. Australia is located in Oceania, and China, Malaysia, Iran, Saudi Arabia, and other regions of Turkey are part of Asia.

The countries with the greatest publication output are the United States and the United Kingdom. The United States has taken a leading role in this area due to significant government investment in research since World War II. Many foreign physician-scientists have been trained in the U.S., and they have become significant competitors, often publishing their work in U.S. journals. Journal editors maintain the reputation of their publications by upholding high standards and publishing the most relevant and interesting research papers, irrespective of the authors' countries of origin. Furthermore, the U.S. engages in numerous international collaborations, which are frequently cited by other countries (Stossel & Stossel, 1990). For example, a publication from the U.S. explores the correlation between personality characteristics and learning styles among graduate and undergraduate students in computer information systems courses, taking into account the gender and age of the subjects (Kovalchick et al., 2023).

The next leading country in terms of publication volume is the United Kingdom. One notable article, authored by Ijeoma G. Ukeni in 2023, discusses the use of film as an andragogical learning medium for audiovisual learning styles and others, providing a cinematic experience (Ukeni, 2023).

In addition to countries, several affiliations or universities have also significantly contributed to publications on this topic. Monash University is the leading institution in this regard. One of its articles investigates the role of international students in contributing to independent schools in Australia, aiming to enhance cultural understanding and competence, introduce culturally sensitive teaching strategies, and diversify teaching materials and methods (Zhang & Chan, 2023).

3.5. Keywords Trend

Overall, the keywords related to the topic of learning styles pertain to humans, gender, learning, and education. The relevant keywords include "human," "learning," "female," "article," "male," "humans," "learning styles," "teaching," "adult," and "education." Some of these keywords can be found in recent publications by Aboregela (2023), Cardozo et al. (2024), Di Natale et al. (2024), and Huang et al. (2024).

Aboregela's study in 2023 explored learning style preferences and academic performance among medical students within an integrated curriculum (Aboregela, 2023). Cardozo et al. (2024) identified the learning style characteristics of students enrolled in medical schools in Brazil using the Felder-Solomon Learning Style Index (ILS) (Cardozo et al., 2024). Di Natale et al. (2024) published an article discussing the impact of various individual factors, such as students' learning styles, perceived ease of use, personal innovation, and their attitudes toward immersive virtual reality (IVR) (Di Natale et al., 2024). Lastly, Huang et al. (2024) measured empathy levels among medical students based on factors such as university category, only-child status, gender, self-assessment regarding patient-doctor relationships in hospitals, interest in the medical field, and learning styles (Huang et al., 2024).

3.6. Analysis of Knowledge Structures

3.6.1. Conceptual Structure

The conceptual structure is illustrated through thematic dimensions related to the topic, as represented in a thematic map. This map is categorized into four categories: motor themes, niche themes, basic themes, and emerging and declining themes. These four groups are arranged along two axes: the X-axis representing the topic's relevance and the Y-axis reflecting the level of development. Niche themes consist of topics with minimal relevance to the research field, while basic themes encompass topics that are less developed yet crucial for the research area. Notably, there are no niche or basic themes identified within the topic.

Motor themes, on the other hand, are well-developed and highly pertinent to the research topic. In this context, five groups of motor themes are identified, all of which relate to human factors, learning, education, and educational technology. Emerging and declining themes comprise topics that are underdeveloped and of lesser importance to the research area. This category contains four groups of themes generally associated with types of learning, learning systems, technical education, and information technology (Kaiser & Kuckertz, 2023).

3.6.2. Intellectual Structure

The intellectual structure is represented through a co-citation network. The most frequently cited works originate from articles written by Kolb D.A. in 1984. David A. Kolb has extensively published research on experiential learning and learning styles. One of his notable articles, published in 2009, discusses the role of culture in shaping an individual's learning style through the lens of experiential learning and the Kolb Learning Style Inventory (Joy & Kolb, 2009). Another widely cited article was authored by R.M. Felder in 1988. This article explores the adaptation of teaching styles to learning styles, addressing effective teaching strategies that align with diverse learning preferences (Felder, 1988).

3.6.3. Social Structure

The social structure is illustrated through a network of collaborative authorship. Two significant groups emerge from this collaborative writing. The first group consists of Van Petegem P., Coertjens L., Donche V., and De Maeyer S. Their collaboration resulted in a 2017 publication examining how learning styles influence study strategies during the transition from secondary to university (Coertjens et al., 2017). The second group includes Brown T., Williams, McKenna J., and Etherington J. Their 2020 article explores learning styles preferences among undergraduate social work students, emphasizing the need for educators to understand these preferences when designing relevant curricula for social work students (Williams et al., 2013).

The social structure is further represented by a map of international collaborations. The foremost collaboration occurred between Saudi Arabia and Egypt, where one article authored by Shehata et al. in 2023 found that electronic learning styles affect ethical practices and violations in education. The study underscores the need to enhance competencies related to ethics in e-learning environments (Shehata et al., 2023). Another collaboration between the United States and China produced an article by Chen and Liu in 2019, which discusses the correlation between lifelong learning styles and motivation, along with various influencing factors stemming from social, individual, family, and educational contexts (Chen & Liu, 2019).

5. CONCLUSION

Table 6 provides a comprehensive overview from the bibliometric analysis on the topic of learning styles. A total of 2,190 documents were analyzed, demonstrating an average growth rate of 9.84%. The number of authors researching this topic amounts to 5,892, with the leading author being T. Brown, who has published 33 articles. The analysis includes publications from 1,059 journals, with BMC Medical Education being the most prolific source, contributing 33 articles. The most frequently cited article is authored by A.Y. Kolb in 2005, which explores the correlation between learning styles, experiential learning, and the institutional environment within a learning space. The country with the greatest number of scholarly publications is the United States, contributing 1,138 articles, while the top-affiliated institution is Monash University, with 46 articles.

Table 6. Overview of the Results

Criteria	Data
Total documents	2190
Annual growth percentage (%)	9.84
Author count	5892
Leading author	Brown T (n = 7)
Total sources	1059
Most prolific source	BMC Medical Education (n = 33)
Most cited article (DOI)	10.5465/AMLE.2005.17268566
Country with the greatest publication output	USA (n = 1138)
University with the largest document contribution	Monash University (n = 46)
Most frequently used keywords	Human, learning, female, article, male, humans, learning styles, teaching, adult, education

The topic of learning styles has been extensively linked to various research themes. Several studies have established connections between learning styles and academic outcomes (Liew et al., 2015), learning objects (Wanapu et al., 2016), attitudes (Laight, 2004), and learning strategies (Coertjens et al., 2017). This illustrates that the topic can be broadly developed in accordance with the evolving needs of knowledge. Consequently, this article aims to serve as a reference for further exploration, investigation, and expression of additional aspects, themes, and ideas related to the topic.

A limitation of this study is that the database utilized was exclusively sourced from Scopus. Future researchers may consider employing a broader and more diverse range of databases when examining the topic of learning styles. Nevertheless, the implications of this research for educators include an enhanced comprehension of the impact of learning styles in the educational process. For educational institutions, the findings may serve as a basis for curriculum design that aligns with student needs.

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