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A Bibliometric Analysis of Brain-Based Learning Research in Classroom Contexts (2010–2024): Trends, Influential Contributors, and Thematic Evolution

[تحليل بليومتري لأبحاث التعلم القائم على الدماغ في سياقات الفصول الدراسية (2010–2024)
(2024): الاتجاهات، والمساهمون المؤثرون، والتطور الموضوعي]

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Abstract

The present study investigates a discourse that has aroused general interest among educational scholars over the past few years: the influence of neuroscientific knowledge on educational research and brain-based learning within classroom contexts. The rapid growth of related research has generated a diverse body of literature with various orientations and sometimes conflicting findings, which has occasionally obscured a clear picture of its main directions and intellectual structure. To address this research gap, the current article performs a structured synthesis of the literature using a bibliometric analysis combined with a systematic review methodology. In accordance with the PRISMA 2020 protocol, this study utilizes the Scopus database to analyze publications over a 15-year period (2010–2024). The initial search retrieved 543 records. Overall, 180 publications were identified after deduplication and the application of database filters. Upon title and abstract screening, 119 articles were excluded, leaving 61 studies for full-text review. After eligibility assessment, 16 peer-reviewed articles were included in the final bibliometric and thematic analysis. The results show a significant increase in scholarly activity, as well as an obvious paradigm shift from predominant theoretical investigations to practical, application-related classroom research. Key countries, academic institutions, and authors contributing to the field are identified through various statistical indicators, and a thematic structure encompassing educational neuroscience, learning/the learner, cognition training, and teacher-related instructional tools is established. These trends reflect an evolution toward the operationalization of brain-based learning principles in naturalistic educational environments. The paper concludes by recommending that future research focus on experimentally informed, longitudinal, and comparative designs, as well as teacher preparation and professional development programs based on brain-based instructional models, to make the empirical grounds of this field more robust and its educational implications stronger.

Keywords: Brain-based learning; Educational neuroscience; Classroom contexts; Bibliometric analysis; Research trends; Thematic evolution; Instructional design; Teacher education.

ملخص البحث:

تتناول هذه الدراسة موضوعاً أثار اهتماماً واسعاً بين الباحثين التربويين خلال السنوات القليلة الماضية، ألا وهو تأثير المعرفة العصبية على البحث التربوي والتعلم القائم على الدماغ في سياقات الفصول الدراسية. وقد أدى النمو السريع للأبحاث ذات الصلة إلى ظهور كمٍّ هائل من المؤلفات ذات توجهات مختلفة ونتائج متضاربة أحياناً، مما حجب في بعض الأحيان صورة واضحة عن اتجاهاتها الرئيسية وبنيتها الفكرية. ولمعالجة هذه الفجوة البحثية، تُجري هذه المقالة توليفاً منظماً للأدبيات باستخدام تحليل بيليويمتري مقترن بمنهجية مراجعة منهجية. ووفقاً لبروتوكول PRISMA 2020، تستخدم هذه الدراسة قاعدة بيانات سكوبس لتحليل المنشورات على مدى 15 عاماً (2010-2024). أسفر البحث الأولي عن 543 سجلاً. وبعد إزالة التكرارات وتطبيق فلاتر قاعدة البيانات، تم تحديد 180 منشوراً. وبعد فحص العناوين والملخصات، تم استبعاد 119 مقالة، ليتبقى 61 دراسة للمراجعة الكاملة. بعد تقييم الأهلية، أُدرجت 16 مقالة محكمة في التحليل البيليويمتري والموضوعي النهائي. تُظهر النتائج زيادة ملحوظة في النشاط البحثي، فضلاً عن تحول نموذجي واضح من الدراسات النظرية السائدة إلى البحوث التطبيقية العملية في الفصول الدراسية. وقد حددت الدول والمؤسسات الأكاديمية والمؤلفون الرئيسيون المساهمون في هذا المجال من خلال مؤشرات إحصائية متنوعة، ووُضع هيكل موضوعي يشمل علم الأعصاب التربوي، والتعلم/المتعلم، والتدريب المعرفي، والأدوات التعليمية المتعلقة بالمعلمين. تعكس هذه التوجهات تطوراً نحو تفعيل مبادئ التعلم القائمة على الدماغ في بيئات تعليمية طبيعية. وتختتم الورقة البحثية بالتوصية بأن تركز البحوث المستقبلية على التصميم التجريبية والطولية والمقارنة، بالإضافة إلى برامج إعداد المعلمين والتطوير المهني القائمة على نماذج تعليمية قائمة على الدماغ، وذلك لتعزيز الأسس التجريبية لهذا المجال وتعميق آثاره التربوية.

الكلمات المفتاحية: التعلم القائم على الدماغ؛ علم الأعصاب التربوي؛ سياقات الفصول الدراسية؛ التحليل البيليويمتري؛ اتجاهات البحث؛ التطور الموضوعي؛ التصميم التعليمي؛ إعداد المعلمين.

1. Introduction

This study is situated within the field of brain-based learning, an interdisciplinary domain that connects brain functions and cognitive processes with day-to-day classroom activities. It focuses on researching learning as a neurocognitive process and exploring how these insights can directly inform pedagogical practice. The interdisciplinary roots of the field have helped broaden the scope of scientific inquiry, giving rise to new pathways for investigating how human beings acquire knowledge (Tokuhamma-Espinosa, 2018).

Brain-based learning is a rapidly expanding and fast-moving field. Historically, foundational research struggled to filter down effectively to daily classroom practices. However, this expansion and intensification of academic output can be explained by a rapidly deepening understanding of brain functioning and its relationship to psychological phenomena like learning, memory, and attention (Thomas et al., 2019). Moreover, global shifts in learning practices, techniques, and teaching strategies—along with increasing interest in assessing their real-world impact—have fueled academic curiosity, contributing to an accelerating volume of literature in this area (Immordino-Yang, 2016).

The heterogeneity in research traditions within brain-based learning is evident in classroom studies as well. The methodologies of these studies vary widely, ranging from quantitative designs to qualitative or mixed-method approaches. They also differ depending on the target population, education level, and specific application. This empirical richness has resulted in an explosion of theory and practice under the umbrella of "brain-based learning," originating from various theoretical standpoints and utilizing diverse methodological frameworks (Bruer, 1997).

Notwithstanding the abundance of research conducted in the name of brain-based learning, a close reading of the literature suggests that findings are not always unanimous. Mixed effects regarding achievement motivation, cognitive variables, and learning outcomes have been observed across educational neuroscience studies (Howard-Jones, 2014). These inconsistencies may stem from differences in research designs, teaching modalities, fields of study, and participant demographics. Combined, these variations indicate a clear need for well-designed, methodologically rigorous synthesis. Consequently, this paper adopts a holistic perspective to address these discrepancies and provide an integrated overview of the findings across the field.

Though several individual research articles have successfully explored this domain, they remain limited in the generalizability of their conclusions across diverse parameters. This is due to the inherent heterogeneity that characterizes student populations, study designs, and educational landscapes. Hence, an integrative literature review is required to synthesize fragmented evidence so that reported findings are not read in isolation, but rather compiled to form stronger, more meaningful generalizations than stand-alone effects (Donthu et al., 2021). Systematic reviews represent a rigorous means of synthesizing prior research. They are rooted in clearly defined inclusion and exclusion criteria, which minimize bias during selection. Such strict scrutiny ensures that conclusions are based on verifiable evidence, thereby making the findings scientifically defensible. Systematic reviews also highlight research gaps to be addressed by future works and uncover emerging trends within the domain (Page et al., 2021). Answering this need, the current study synthesizes a large number of diverse studies through a systematic bibliometric analysis, focusing on the scope of brain-based learning in peer-reviewed articles published from 2010 to 2024. This timeframe

represents a particularly productive window for publications in the field. Ultimately, this review aims to construct a comprehensive mapping of the literature to help scholars identify research gaps and guide their future investigations. The structure of this study is aligned with its research objectives. It begins with the theoretical framework and methodology, which describe how studies were searched, screened, and selected. This is followed by a presentation of the bibliometric findings and a discussion of the results in relation to established literature on brain-based learning. Finally, the paper summarizes the core insights synthesized from the analysis and outlines prospective avenues for future research.

2. Research Problem

The integration of neuroscientific knowledge into classroom contexts has contributed to the development of educational practices that are closely aligned with the nature of human learning, particularly in relation to attention, memory, motivation, and cognitive processing. However, this growing body of knowledge has not yet been sufficiently organized at the conceptual and methodological levels. Studies on brain-based learning are characterized by considerable diversity in educational contexts, research designs, target populations, and theoretical analyses. This diversity has resulted in variation across findings and has made it difficult to identify the most prominent research trends in the field. The literature also reveals divergent perspectives regarding the application of neuroscientific knowledge in classroom settings. Bruer (1997) highlighted the difficulty of establishing a direct connection between brain research findings and learning, while Howard-Jones (2014) argued that oversimplifying neuroscientific concepts in educational practice may lead to inaccurate interpretations. Accordingly, there is a clear need to analyze the scientific production in this field, identify its trends, and determine its major sources, authors, and thematic development over time. A review of studies related to this area between 2010 and 2024 indicates a noticeable expansion in research production, encompassing theoretical and applied studies as well as systematic reviews. Bibliometric analysis, with its systematic procedures, represents an appropriate approach for this purpose, as it enables the construction of a research map that identifies patterns of scholarly production, publication trends, the most contributing countries, institutions, and authors, as well as the most frequent keywords and related themes. Such an approach provides a more comprehensive understanding of the field of brain-based learning research. Based on the foregoing, the research problem of the present study lies in the need to define the conceptual and methodological landscape of studies on brain-based learning within educational contexts. It further calls for a bibliometric and systematic analysis to reveal trends in scientific production during the period from 2010 to 2024, identify the most prominent contributing researchers, institutions, and countries, and trace the thematic evolution of the field. This, in turn, may help guide future research toward more applied and methodologically rigorous research designs.

3. Research Objectives

The present study aims to analyze the scientific production in the field of brain-based learning during the period from 2010 to 2024 by employing both bibliometric analysis and systematic review. This is intended to investigate the intellectual structure and research trends in this field. More specifically, the study seeks to achieve the following objectives:

- 1- To examine the temporal trends of scientific publication in the field of brain-based learning within classroom contexts during the period from 2010 to 2024.
- 2- To identify the countries and geographical regions that have contributed most significantly to research on brain-based learning in relation to classroom settings.
- 3- To identify the most influential authors in the field in terms of research productivity, citation counts, and indicators of scholarly impact.
- 4- To determine the academic and research institutions that have contributed to the production of knowledge on brain-based learning.
- 5- To analyze the most frequently occurring keywords in the reviewed studies and to explore the thematic evolution of the field, whether at the theoretical or applied level.
- 6- To highlight the research and methodological gaps in the existing literature.
- 7- To provide research-based indicators that may inform the design of educational and training programs grounded in the principles of brain-based learning.

4. Research Questions

1. What are the temporal trends in scholarly publication on brain-based learning in classroom settings from 2010 to 2024?
2. Which countries or geographical regions have been leading contributors to research on brain-based learning in classroom contexts during the period 2010–2024?
3. Who are the most influential authors in the field of brain-based learning research in classroom settings between 2010 and 2024?
4. Which academic institutions have made notable contributions to knowledge production on brain-based learning in classroom settings from 2010 to 2024?
5. Which keywords have been most frequently used in this research area, and how have the core thematic foci evolved over the period 2010–2024?

Through addressing these research questions, the present study seeks to contribute to the enrichment of scholarly discourse on brain-based learning in classroom contexts. It further aims to offer analytical insights that may inform the design and implementation of more effective educational practices aligned with the principles of brain-based learning across diverse instructional settings.

5. Significance of the Study

The significance of the present study lies in its focus on a field that connects brain research with cognitive psychology. This intersection entails both theoretical and practical dimensions, with the latter being more complex in terms of educational application. In this regard, the study contributes to developing an analytical map of scientific production in this field within classroom contexts, with the aim of understanding the trajectory of research conducted during the period from 2010 to 2024.

Another aspect of the study's significance stems from its reliance on the Scopus database, which provides broad coverage of peer-reviewed studies in the fields of education, social sciences, and psychology, and offers a bibliographic structure suitable for bibliometric analysis (Falagas et al., 2008; Mongeon & Paul-Hus, 2016).

This enhances the reliability of the findings, particularly as the analysis is limited to peer-reviewed studies directly related to classroom contexts, selected through systematic procedures consistent with the PRISMA 2020 guidelines (Page et al., 2021).

The study also contributes to organizing the existing body of literature and identifying key terms such as educational neuroscience, brain, learning, teaching, and cognition. It further helps clarify the process through which theoretical concepts are translated into practical classroom applications, including instructional practices and professional training for teachers. This transition is particularly important because it transforms neuroscientific knowledge into practices that can be implemented within classroom settings.

At the practical level, policymakers and designers of educational and training programs may benefit from research findings grounded in scientific principles. The study may also assist researchers in identifying future research topics by highlighting existing gaps in the literature, such as examining the effectiveness of instructional strategies based on brain-based learning, determining their impact, and comparing them with other educational strategies.

The methodological significance of the study is evident in its use of bibliometric analysis, which provides a systematic quantitative examination of publications, citations, authors, institutions, and countries. In addition, it enables the identification of keywords, related themes, intellectual structures, and future research directions in an organized manner (Donthu et al., 2021; van Eck & Waltman, 2010; Zupic & Čater, 2015).

6. Research Terms

Brain-Based Learning:

An educational approach aligned with our understanding of brain functions and the cognitive, emotional, and social processes involved in learning. It aims to apply such knowledge in designing instructional practices that are consistent with the nature of human learning. This requires the presence of an educational and methodological mediator that takes into account the nature of this knowledge and the limits of its application in education (Bruer, 1997; Thomas et al., 2019).

Educational Neuroscience:

An interdisciplinary field concerned with studying learning mechanisms from the perspectives of neuroscience and cognitive psychology. It seeks to examine how brain research can inform educational theories and practices, while cautioning against oversimplifications that lead to misinterpretations when applied in classroom contexts (Howard-Jones, 2014; Tokuhamma-Espinosa, 2018).

Classroom Context:

The educational environment surrounding the learner in which teaching and learning processes take place. It includes the instructional strategies practiced by the teacher within the classroom setting, the interaction between teacher and learner, the learner's interaction with educational tools and activities, and the use of assessment instruments.

Bibliometric Analysis:

An approach that combines quantitative and descriptive procedures to analyze scientific production within a specific period. It focuses on publication outputs,

citation patterns, authorship, contributing countries, keywords, conceptual co-occurrence, and the mapping of a research field in terms of its features, trends, and themes (Donthu et al., 2021; Zupic & Čater, 2015).

Systematic Review:

A structured research procedure that examines studies according to clearly defined criteria and selects them through transparent steps, including inclusion and exclusion filters. The present study adopts the PRISMA 2020 guidelines for conducting the systematic review (Page et al., 2021).

Thematic Evolution:

The transformation of research themes over time in the field of brain-based learning. It is reflected in the emergence of keywords and conceptual networks, as well as in the shift from a pure focus on neuroscientific concepts to educational and instructional practices.

7.Previous Studies

The literature indicates a foundational relationship between brain research and the educational sciences. However, debate has continued regarding how neuroscientific knowledge can be appropriately applied to educational practices. Bruer (1997) pointed to the complexity of this pathway, arguing that educational applications have sometimes produced premature interpretations, particularly when neuroscientific findings are not mediated through cognitive psychology and learning theories. Bruer's study is therefore considered an important critical foundation in this field, as it cautioned against oversimplifying neuroscientific concepts and transferring them directly into classroom practice.

Within the same critical perspective, Howard-Jones (2014) examined neuromyths and misunderstandings concerning the relationship between neuroscience and education. He emphasized the need for teachers to be aware of the distinction between findings derived from neuroscience laboratories and unverified educational interpretations. In this regard, bibliometric studies are useful for investigating the circulation of such concepts and examining how they have moved from theoretical foundations toward educationally regulated applications.

Immordino-Yang (2011), in turn, emphasized the importance of attending to the emotional and social dimensions of learning. Understanding cognitive processes alone is insufficient without considering learners' emotions, motivation, and social relationships, as these elements directly influence learning. This dimension is particularly important because the organization of information in effective education occurs within learning environments that take into account cognition, emotion, and social context.

Thomas et al. (2019) provided a comprehensive review of studies examining the relationship between neural processes and learning. Their work highlights the need for more empirical research in this area and calls for further analysis of the published literature in order to clarify the relationship between the theoretical and applied dimensions of brain-based learning.

At the level of bibliometric analysis methodology, Donthu et al. (2021) indicated that this type of study helps researchers understand a given research field, identify its trends and themes, and determine its prominent authors and most influential institutions. Similarly, Zupic and Čater (2015) explained that bibliometric methodology allows for a systematic analysis of research production. Van Eck and

Waltman (2010) also contributed to the development of bibliometric analysis tools through VOSviewer, which is widely used to create maps and conduct analyses of keywords and research co-occurrence based on specific bibliographic data. In the context of systematic reviews, Page et al. (2021) presented the PRISMA 2020 statement as a scientific framework for selecting research publications, identifying studies, screening them, assessing their relevance, and reaching the final body of studies for analysis. The present study benefited from this framework in the process of selecting studies, beginning with the initial records retrieved from Scopus, followed by screening, eligibility assessment through full-text review, and finally arriving at the final sample.

Falagas et al. (2008) showed that research databases vary considerably, and that there is a pressing need to select reliable studies from databases such as Scopus, Web of Science, PubMed, and Google Scholar, each of which differs in coverage, strengths, and limitations. Mongeon and Paul-Hus (2016) further explained that Scopus and Web of Science occupy an important position in the analysis of scientific production, despite differences in their discipline coverage. Accordingly, the present study's reliance on Scopus provides an appropriate bibliographic foundation, particularly in the fields of education and the social sciences.

Based on the foregoing, brain-based learning appears to be a promising field; however, it requires a rigorous methodology and a careful reading of the literature, along with caution against scientifically inaccurate interpretations. The reviewed studies also emphasize the need to understand the development of the field, identify research gaps, and explore future directions that may contribute to the design of instructional models suitable for classroom application.

8. Delimitations of the Study

The present study is delimited by several thematic, temporal, methodological, and source-related boundaries. These delimitations are as follows:

Thematic delimitations: The study is limited to research that explicitly addresses brain-based learning, neuroeducation, or brain-based education within educational and classroom contexts. Studies dealing with purely clinical or medical neuroscience, as well as studies not directly related to education, were excluded.

Temporal delimitations: The study is limited to publications issued during the period from 2010 to 2024.

Source-related delimitations: The study relied on the Scopus database as the primary source for data extraction, given its broad coverage of peer-reviewed studies in education and the social sciences.

Methodological delimitations: The study employed bibliometric analysis and systematic review. Therefore, its findings are associated with the nature of the data available in Scopus and with the predefined inclusion and exclusion criteria adopted.

9. METHODOLOGY

9.1 Research Design

This study utilizes a bibliometric design, combining quantitative and descriptive statistical techniques to analyze the scientific production of research conducted at the intersection of brain-based learning and classroom contexts. This design is engineered to map the dimensions of publication output, track citation and dissemination patterns,

and trace thematic emergence over time. It represents an ideal methodology for an analytical literature review aiming to evaluate pre-existing research bodies (Donthu et al., 2021; Zupic & Čater, 2015).

To meet the methodological standards applicable to systematic literature reviews, the study follows a validated procedure that ensures transparency throughout the review process—from study identification and screening to data filtering and synthesis (Tranfield et al., 2003; Kitchenham & Charters, 2007). Specifically, the review was conducted based on the PRISMA guidelines, providing a strict protocol for the systematic search and selection of studies included in the final analytical sample (Page et al., 2021).

9.2 Research Procedures and Instruments

The study adopted a bibliometric approach, which provides both quantitative and descriptive outputs for analyzing research publications in the field of brain-based learning. This approach enables the investigation of publication trends in the field, identifies research contributions by countries, institutions, and authors, and provides an analysis of keywords and thematic evolution. It is particularly appropriate for research areas characterized by rapid thematic development, as it offers researchers a structured map of the field (Donthu et al., 2021; Zupic & Čater, 2015).

The Scopus database was selected because of its coverage of educational publications, as well as studies related to psychology and the social sciences. In addition, Scopus provides embedded bibliographic data that are suitable for scholarly analysis (Falagas et al., 2008; Mongeon & Paul-Hus, 2016). The search strategy relied on terms directly related to the topic of the study, such as brain-based learning , neuroeducation , educational neuroscience , and brain-based instruction , combined with terms related to education and classroom contexts, such as classroom , teaching , learning , instruction , and education .

The following search string was used within the title, abstract, and keyword fields in Scopus:

`'TITLE-ABS-KEY ("brain-based learning" OR neuroeducation OR "educational neuroscience" OR "brain-based instruction") AND (classroom OR teaching OR learning OR instruction OR education) AND (PUBYEAR > 2009 AND PUBYEAR < 2025)'`

Prior to the analysis, the researcher established a set of inclusion and exclusion criteria. The inclusion criteria comprised publications issued between 2010 and 2024, peer-reviewed journal articles, studies addressing brain-based learning within educational contexts, studies related to educational neuroscience in classroom settings, studies published in English only, and studies indexed within the fields of education, social sciences, humanities, psychology, and educational technology. The exclusion criteria included publications outside the 2010–2024 period, non-peer-reviewed publications, medical or non-educational studies, studies published in languages other than English, and records with incomplete bibliographic data.

The study followed the PRISMA 2020 procedures for identifying, screening, assessing the eligibility of, and including studies in the final analysis (Page et al., 2021). The initial search yielded 543 records. Database filters related to publication year, document type, language, and subject area were then applied, leaving 180 records for screening. After examining titles and abstracts, studies that were irrelevant or not connected to classroom contexts were excluded, leaving 61 studies for full-text review. Following the full-text assessment based on the eligibility criteria, 45 studies were excluded, and the final sample consisted of 16 peer-reviewed journal articles.

Regarding data collection and preparation, the 16 scientific articles were organized in a structured table. The extracted data included publication year, author names, country or geographical region, academic institution, journal name, keywords, and citation count. These data formed the basis for analyzing publication trends, identifying the most influential contributors, and revealing the thematic structure of the field.

With respect to quality assessment, the study was limited to peer-reviewed articles indexed in Scopus, thereby enhancing the reliability of the research sample. The inclusion and exclusion criteria, together with the PRISMA procedures, also supported the transparency and replicability of the study selection process. The data were analyzed using quantitative bibliometric indicators, including the number of publications, citation counts, and productivity by country, institution, and author. In addition, keyword analysis and conceptual co-occurrence networks were employed to reveal temporal, geographical, institutional, and thematic trends in the field of brain-based learning.

9.3 Data Source

The Scopus database was utilized in this study due to its extensive coverage of peer-reviewed scientific literature in the educational and social sciences. Apart from broad coverage, Scopus applies strict indexing quality standards, ensuring a high level of academic credibility (Falagas et al., 2008; Mongeon & Paul-Hus, 2016). The use of Scopus allowed the author to obtain clean bibliographic datasets, which are required for executing reliable bibliometric mapping and revealing the intellectual foundations of the domain (Donthu et al., 2021; van Eck & Waltman, 2010).

9.4 Search Strategy

A systematic and comprehensive search strategy was used to identify studies of interest, using the Scopus database as major data source. Scopus was chosen because of its extensive coverage of high-quality peer reviewed journal articles in the fields of education, psychology and interdisciplinary educational research (Falagas et al., 2008).

The publication date was limited between 2010 and 2024 to include contemporary issues in the brain-based education field. The resultant time filter was then applied: (PUBYEAR > 2009 AND PUBYEAR < 2025)

The first phase of the search strategy employed a combination of carefully selected keywords and controlled descriptors directly related to brain-based learning and its educational applications. Searches were conducted across the title, abstract, and keyword fields (TITLE-ABS-KEY) using Boolean operators to ensure both precision and breadth of coverage.

The final search query applied in Scopus was as follows:

TITLE-ABS-KEY ("brain-based learning" OR neuroeducation OR "educational neuroscience" OR "brain-based instruction") AND (classroom OR teaching OR learning OR instruction OR education) AND (PUBYEAR > 2009 AND PUBYEAR < 2025)

This iterative searching process promoted a specific definition of the dataset at which resources belonged, yet provided adequate scope to ensure widespread coverage of the primary streams. This procedure is compatible with the principles of good bibliometric research to ensure that both reliable mapping and trend analysis results can be obtained (Donthu et al., 2021; Zupic & Čater, 2015).

9.5 Inclusion and Exclusion Criteria

The initial search retrieved 543 academic papers that were subsequently screened via a multistep process according to the PRISMA 2020 statement (Page et al., 2021).

After the exclusion of database specific format, language, subject areas and publication years limits 180 publications were available for further investigation. To ensure the selection of studies was exclusively indicative of in-classroom based brain-based learning titles and abstracts were subsequently screened against predefined inclusion/exclusion criteria. Next, 116 articles have been eliminated as irrelevant, duplicate or not in educational and only clinical neuroscience settings. This resulted in 61 studies for full-text screening.

A full screening was performed during the subsequent stage to verify full-text availability and compliance with the final eligibility criteria. Using this protocol, 45 articles were excluded because they were not relevant for brain-based learning in the classroom or methodological deficiencies and being conducted in non-classroom setting. Eighteen peer-reviewed journal articles met the inclusion criteria and a total of 16 were analyzed for their bibliometric analysis. Table 1 All inclusion and exclusion criteria in system were entered systematically.

This formal screening ensured that the subsequent stages of this review would be transparent, reproducible and methodologically rigorous as per the systematic reviews and bibliometric study protocols (Page et al., 2021; Donthu et al., 2021).

Table 1: Criteria for inclusion and exclusion

Inclusion criteria	Exclusion criteria
1 Studies published between 2010 and 2024	Studies published before 2010 or after 2024
2 Peer-reviewed journal articles	Conference papers, books, book chapters, theses, editorials, reports, blogs
3 Studies explicitly addressing brain-based learning, neuroeducation, or educational neuroscience in educational/classroom contexts	Studies focusing on clinical neuroscience, medical neuroscience, or non-educational contexts
4 Studies written in English	Publications in languages other than English
5 Journals indexed in Social Sciences, Arts and Humanities, Psychology, Education, or Computer Science (educational technology)	Journals outside these subject areas
6 Studies providing sufficient bibliographic data for bibliometric analysis	Studies with incomplete bibliographic records

9.6 PRISMA

Selection of studies The review process was described in detail, according to the PRISMA 2020 guidelines (study identification, screening and eligibility assessment) (Page et al., 2021), resulting in a final list of publications. A total of 543 articles were found during the first search on Scopus. By the use of filters at database level, including time span, document type, language and subject area, 180 records remained for further review.

In the first step of screening, titles and abstracts were reviewed to ascertain relevance to brain-based learning in classrooms. A total of 116 studies were removed through this process and 61 papers were included for full text review.

Full texts of the other studies were subsequently reviewed in detail in order to determine eligibility according to predefined study selection criteria. In this phase, 45

articles were excluded (full text not available; relevance for brain-based learning in the classroom setting was too low; no methodological quality present or lack of meeting the analytical needs of bibliometric research). The final sample of 16 peer-reviewed journal publications was then included as the analysis sample for this bibliometric examination.

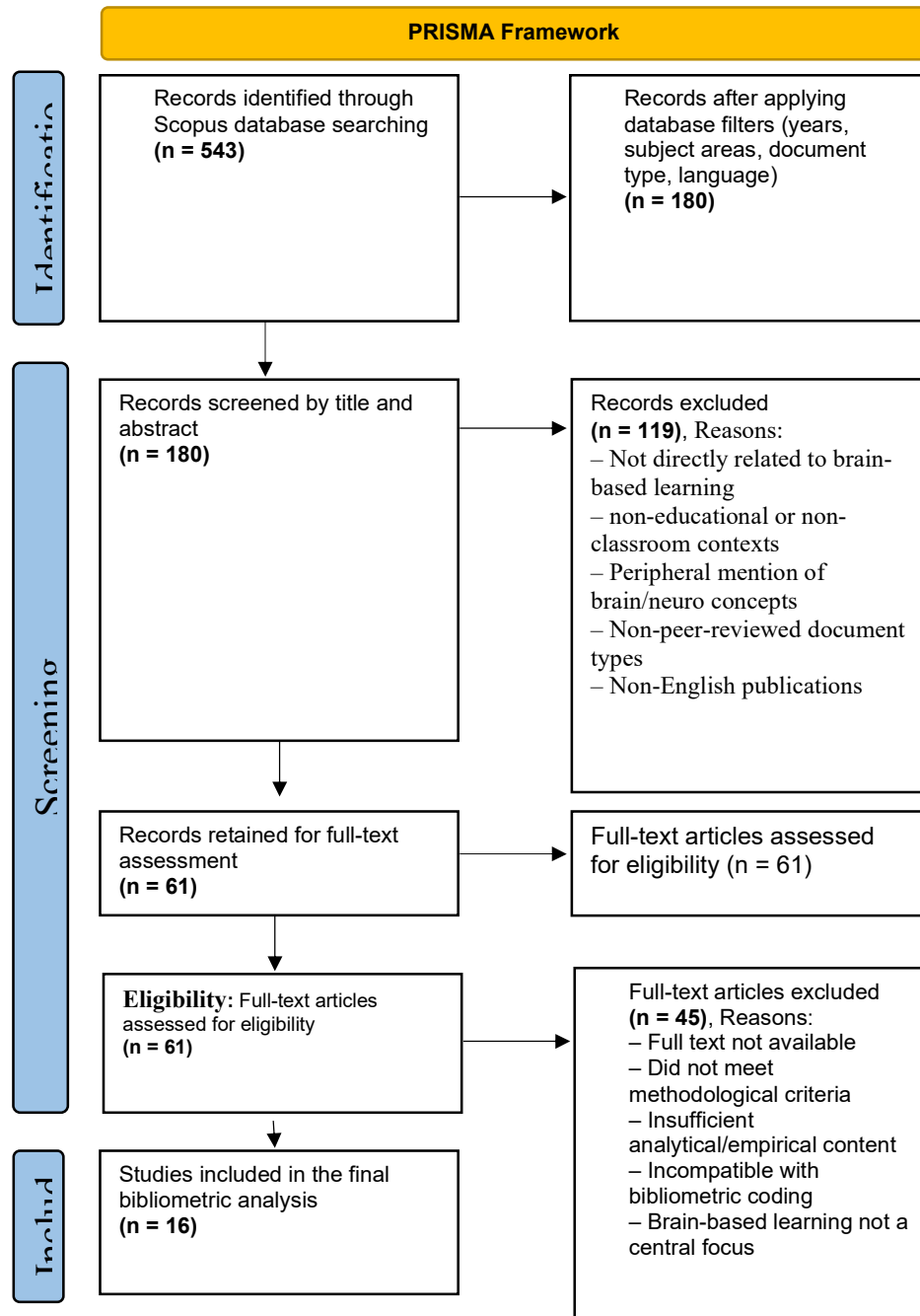


Figure 1. PRISMA 2020 flow diagram of the study identification, screening, eligibility, and inclusion process for the brain-based learning bibliometric review (2010–2024).

All studies included in the final dataset directly addressed brain-based learning within classroom contexts. The entire selection process was documented and is presented in the PRISMA flow diagram (Figure 1), ensuring transparency, replicability, and

methodological rigor in accordance with established standards for systematic and bibliometric reviews.

9.7 Data Collection and Synthesis

The final dataset of 16 peer-reviewed journal articles was processed using established bibliometric coding software (Zupic & Čater, 2015; Donthu et al., 2021). The articles were manually verified to confirm their adherence to the study parameters. Data extraction pulled the following metadata fields from each record: year of publication, author names, countries of affiliation, institutional affiliations, publishing journal, author-selected keywords, and citation counts. These fields provided the baseline data used to evaluate publication trajectories, productivity across regions, and thematic evolution.

9.8 Quality Assessment

The quality consideration in bibliometric monitoring systems is, essentially, the traceability of the source of data from absolute sources (Zupic & Čater, 2015). Therefore, the present investigation utilized the Scopus database and covered only peer-reviewed indexed journals, a restriction that helps to confer scholarly robustness to the sample by adopting a stringent set of technological and methodological criteria for science indexing (Falagas et al., 2008; Mongeon & Paul-Hus, 2016).

9.9 Data Analysis

Sixteen peer-reviewed journal articles were collected to be used as the study corpus and analysis using a bibliometric analytic framework. This study was designed to have an overview of publishing trends, the pattern of keyword usage and the most influential authors/institutions/countries which were related to brain-based learning research (Zupic & Čater, 2015; Donthu et al., 2021). Moreover, the study used quantitative indicators and advanced bibliometrics (e.g., co-authorship network analysis and keyword co-occurrence mapping widely used in studies dealing with relational structures within scientific domains) dominant topics in the area. In that way, the intellectual structure of the field was depicted and its thematic development over time was examined.

The corpora were compiled to enable the organized and complete illustration of academic research in brain-based learning as applied in classroom. It offered a further overview of the forerunners and lines of research in vogue, found in literature. This cross-comparison also served to confirm the identification of significant knowledge gaps and new fertile areas in research, some of which may contribute important findings by being incorporated into broader visions.

10. Study results

This section presents the empirical findings of the bibliometric analysis in an analytically rigorous manner. It highlights prominent authors, institutional nodes, geographic footprints, and core keyword networks that have shaped the intellectual structure of brain-based learning research (van Eck & Waltman, 2010; Aria & Cuccurullo, 2017). Beyond basic productivity metrics, the analysis evaluates theoretical foundations, measurement models, and research methodologies to map the shift from conceptual debates to practice-oriented applications (Donthu et al., 2021; Zupic & Čater, 2015; Page et al., 2021).

10.1 Temporal Trends in Brain-Based Learning Research

Research Question 1: What are the temporal trends in scholarly publication on brain-based learning in classroom settings from 2010 to 2024?

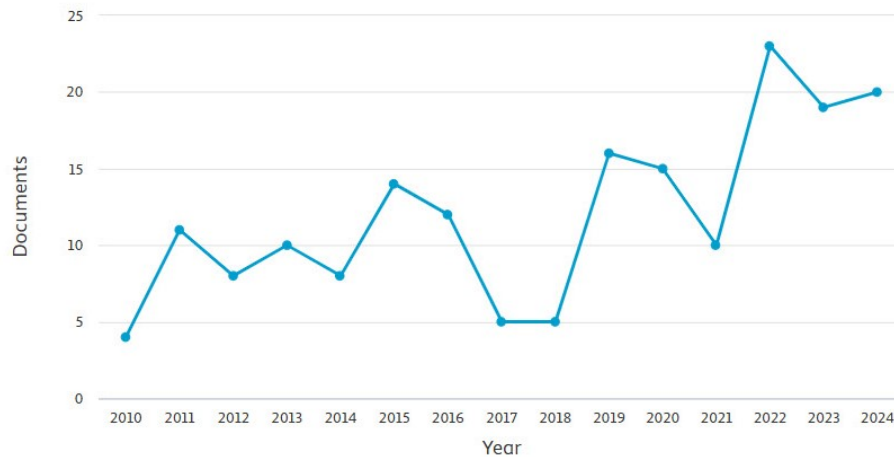


Figure 2. Temporal Trends in Publication Output on Brain-Based Learning (2010–2024)

Figure 2 traces the chronological trajectory of publications regarding classroom-centered brain-based learning from 2010 to 2024. The output displays distinct variations over time, demonstrating an accelerating yet non-linear growth path.

Early Phase (2010–2013): The volume of publications remained low, reflecting brain-based learning's status as an emerging, novel field.

Developmental Phase (2014–2018): From 2014 onward, the field gained increased academic visibility, punctuated by minor fluctuations and scarcer output in 2017 and 2018.

Expansion Phase (2019–2024): Publication volume showed a sharp upward trend after 2019, reaching its apex in 2022, which stands as the most productive year in the reviewed window. While output dipped slightly in 2023, it remained high through 2024, signaling sustained scholarly commitment to translating neuroscientific insights into classroom instruction.

10.2 Geographical Distribution of Publications

Research Question 2: Which countries or geographical regions have been leading contributors to research on brain-based learning between 2010 and 2024?

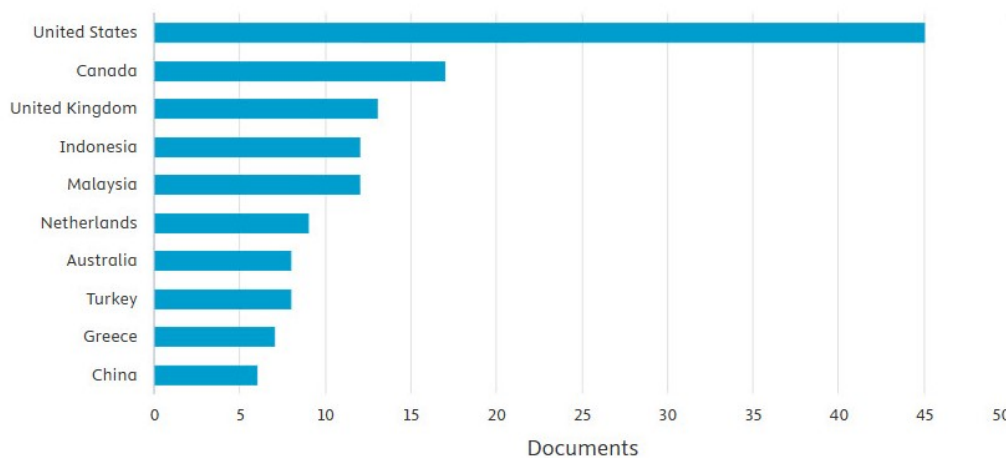


Figure 3. Worldwide Publication Output on Brain-Based Learning by Country (2010–2024)

Geographic scope of recent studies dedicated to brain-based learning in classroom
Figure 3 illustrates the global distribution of educational research articles addressing brain-based learning from 2010 to 2024. The data show an extensive international scope, drawing contributions from across multiple continents.

The United States maintains clear dominance within the scholarly landscape, accounting for the highest share of research production with 45 publications. Canada (17 publications) and the United Kingdom (13 publications) follow, indicating a highly active research corridor spanning North America and Europe.

Concurrently, a substantial expansion in research productivity is visible across Asian and Middle Eastern nations, led by Indonesia (12), Malaysia (12), China, and Turkey (8). This highlights a broadening international effort to deploy neuroscientifically informed teaching methods. Additional steady contributions from the Netherlands, Australia, and Greece underscore the global democratization of this research area, pointing to a well-distributed international community of scholars.

10.3 Leading Journals, Authors, and Institutions

Research Question 3: Who are the most influential authors in research on brain-based learning between 2010 and 2024?

Table 2 Figure 4 illustrates the leading authors within brain-based learning over the 2010–2024 period, determined by multi-metric rankings across Total Publications (TP), Total Citations (TC), and H-index values (Donthu et al., 2021; Aria & Cuccurullo, 2017).

The results also reveal a diverse range of leading authors within educational neuroscience, cognitive development and technology-enhanced learning. L. C. Krabbendam emerges as the top author by citation impact (TC = 25,332; H-index = 67), exercising profound scientific influence. S. H. A. Chen (TC = 5,904; H-index = 32) and K. W. Fischer (TC = 3,865; H-index = 30) represent foundational pillars who established highly integrated conceptual frameworks.

At the level of applied research, N. Ashari (TC = 1,219; H-index = 18), A. P. Goldin (TC = 1,409; H-index = 14), and A. J. Privitera (TP = 4) serve as critical nodes bridging laboratory neuroscience with actual classroom operations. Regional authorship hubs, particularly in Southeast Asia and Europe, are visibly anchored by S. Saleh, S. F. Mat Noor, S. R. Z. Abidin, and S. Doukakis, reflecting deepening institutional integration with brain-based learning theory. These patterns indicate that the field's intellectual core relies on a combination of basic cognitive science and applied instructional designs.

Table 2. Most Influential Authors in Brain-Based Learning Research (2010–2024)

#	Author	Scopus ID	TC	TP	H-index	Most cited publication	Times cited	Affiliation
1	Privitera, Adam John	57208189753	319	4	9	A scoping review of research on neuroscience training for teachers (2021)	50	Nanyang Technological University, Singapore
2	Saleh, Salmiza	36192220300	394	4	7	A review on artificial intelligence in education (2021)	231	Universiti Sains Malaysia, Malaysia
3	Abidin, Saffa Raihan Zainal	57203166516	31	3	3	Low-fidelity prototype design for serious game for slow-reading students (2019)	12	Universiti Kebangsaan Malaysia, Malaysia
4	Ashari, Noraidah	26423275000	1,219	3	18	Exploring the affective, motivational and cognitive effects of pedagogical agent enthusiasm... (2017)	103	Universiti Kebangsaan Malaysia, Malaysia
5	Doukakis, Spyridon	36554053900	177	3	7	Generative AI tools as educators' assistants... (2024)	44	Ionian University, Greece
6	Fischer, Kurt W.	7403153835	3,865	3	30	A theory of cognitive development: The control and construction of hierarchies of skills (1980)	1,041	Harvard Graduate School of Education, USA
7	Goldin, Andrea P.	54395324000	1,409	3	14	BDNF is essential to promote persistence of long-term memory storage (2008)	578	Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina
8	Krabbendam, Lydia C.	6604013856	25,332	3	67	A systematic review and meta-analysis of the psychosis continuum: Evidence for a psychosis proneness-persistence-impairment model of psychotic disorder (2009)	1,932	Vrije Universiteit Amsterdam, Netherlands
9	Mat Noor, Siti Fadzilah	35748676600	238	3	9	Framework for Gamification of Online Training Platforms for Employee Engagement	25	Universiti Kebangsaan Malaysia, Bangi, Malaysia

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						Enhancement (2022)		
10	Chen, Shen-Hsing Annabel	7410263846	5,904	2	32	NeuroKit2: A Python toolbox for neurophysiological signal processing (2021)	954	Nanyang Technological University, Singapore

TP= total publications, TC= Total citations within the dataset context.

10.4 Institutional Contributions to Brain-Based Learning Research

Research Question 4: Which academic institutions have made notable contributions to knowledge production in the field of brain-based learning between 2010 and 2024?

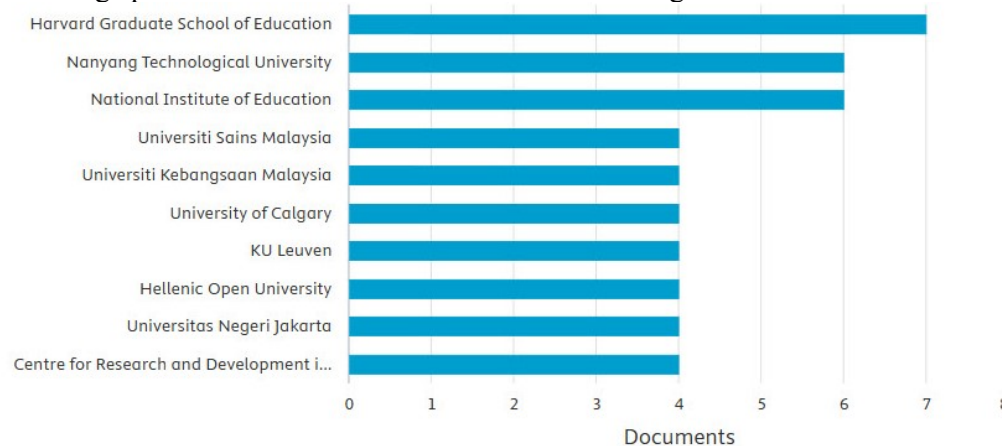


Figure 5. Institutional Productivity in Brain-Based Learning Studies (2010–2024)

#	institutions	TP
1	Harvard Graduate School of Education	7
2	National Institute of Education	6
3	Nanyang Technological University	6
4	Universiti Sains Malaysia	4
5	Universiti Kebangsaan Malaysia	4
6	University of Calgary	4
7	KU Leuven	4
8	Hellenic Open University	4
9	Universitas Negeri Jakarta	4
10	Centre for Research and Development in Learning	4

TP= total publications

Figure 5: Institutions with scholarly articles on brain-based learning published between 2010 and 2024, illustrating participation from universities in Asia, Europe, Oceania and North America.

Universitas Negeri Jakarta is the first contributor (TP = 6), which indicates that Indonesia has a strong presence in this area. Gaziantep Üniversitesi and Université du Québec à Montréal are at the second place with each having four papers edited. Third were Universiti Kebangsaan Malaysia, Central Michigan University, Universität Klagenfurt, Kennesaw State University and Universiti Teknologi Malaysia with three papers each.

Top institutions including Nanyang Technological University, UCL Institute of Education, The University of Pennsylvania and The University of British Columbia make the research accessible to an international audience. This variety of spaces is a reflection of growing international attention to the use of neuroscience in education.

Overall, the findings support not only regional research hot spots and leading world-class universities, supported by a handful of other global players, but also that working in collaboration is essential to knowledge advancement in this area.

10.5 Keyword Co-Occurrence and Thematic Evolution

Research Question 5: What are the most frequently used keywords in research on brain-based learning, and how have the core thematic foci evolved between 2010 and 2024?

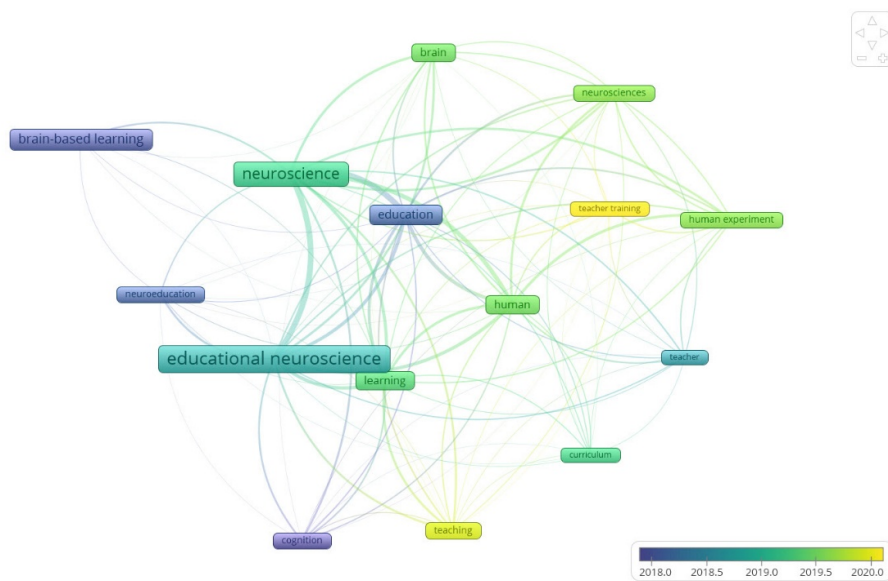


Figure 6 is a list of the most frequent author keywords in research on brain-based learning from 2010 through 2024. The core concept organizing the map is "educational neuroscience," acting as a bridge linking communities in neuroscience, experimental psychology, and educational practice. Anchoring terms such as "neuroscience," "brain," "learning," and "education" serve as the bibliographic bedrock of this literature.

The network displays structural links to terms like "teaching," "teacher," "cognition," and "human experiment," indicating a distinct focus on practical classroom environments and empirical validation. Associated nodes like "brain-based learning (BBL)" and "neuroeducation" underscore this integration. Crucially, the co-occurrence map highlights a clear temporal transition: early terminology focused heavily on laboratory and neuroscience concepts, whereas more recent terms center on instructional design, curriculum building, and teacher professional development. This structural evolution signals a field shifting from basic theoretical inquiry to practical, scalable classroom utility.

11. Discussion

The empirical results reveal that research linking brain functions to classroom contexts is an evolving field characterized by expanding publication volumes and growing thematic diversity. However, the synthesis also reveals that rigorous, empirical research testing brain-based methods in authentic, naturalistic classroom settings via validated instruments remains relatively limited in the broader literature.

The findings emphasize that future investigations must pivot toward the structured design, systematic deployment, and formal assessment of brain-based educational programs. Furthermore, longitudinal and comparative methodologies are essential to clarify long-term cognitive and behavioral outcomes. This structural progression is a prerequisite for transitioning the field toward fully evidence-based educational practice. The specific research questions are addressed in further detail below:

Discussion of Research Question 1: What are the temporal trends in scholarly publication on brain-based learning in classroom settings from 2010 to 2024?

The temporal trajectory of this publication activity in brain-based learning has been steeply rising (upward) from 2010–2024, signifying interest and consolidation of the line of research into educational studies on these topics (Donthu et al., (Zupic & Čater, 2015). There has been an explosion in this number, the result of a rapidly tightening knot between education and

neuroscience, as well as increasing diversity in the topics under study by classroom learning researchers.

Past decades trends would not converge because of "immaturity" of the discipline in both theoretical and methodological terms. Such variance of pattern is the norm in maturing interdisciplinary disciplines (Aria & Cuccurullo, 2017). In contrast, the acceleration for subsequent years indicates a shift to broader empirical engagement and more evidence-based practice taking place.

Overall, these trends show that while brain-based learning is consolidating rapidly, it remains a young discipline that requires continuous, methodologically rigorous, comparative, and longitudinal investigation to maximize its classroom utility.

Discussion of Research Question 2: Which countries or geographical regions have been leading contributors to research on brain-based learning between 2010 and 2024?

The geographic distribution of publications highlights the internationalization of brain-based learning research, with the United States operating as the most prolific knowledge producer over the 2010–2024 window. This position is largely attributable to well-established research infrastructures, reliable funding mechanisms, and a robust history of cross-departmental collaboration between cognitive sciences and schools of education (Donthu et al., 2021; Zupic & Čater, 2015). The high output from the United Kingdom, Canada, and China similarly reflects strategic national investments in connecting cognitive research to public education systems.

Concurrently, the emergence of prominent research hubs in Malaysia, Indonesia, Turkey, Taiwan, Australia, and Spain demonstrates that the field has transcended its original regional boundaries. This geographical dispersion is a reliable sign of institutional maturity, enabling cross-cultural validation, comparative analysis, and broader theoretical generalizability across distinct educational systems (Aria & Cuccurullo, 2017; Donthu et al., 2021). Brain-based learning has successfully evolved from a localized endeavor into a global research enterprise.

Discussion of Research Question 3: Who are the most influential authors in research on brain-based learning between 2010 and 2024?

This study of author-level bibliometric patterns shows that brain-based learning scholarly influence is organized around a heterogeneous research group with some authors being more influential than others in terms of productivity, citation intensity and intellectual centrality. As presented in Table 2, the authors such as (Privitera and Saleh, 2013) demonstrate the most publication activity with TP = 4 each which means they have maintained a momentum of interests on class oriented and applied research themes. Their impact is moderate in citation terms, indicative of a more recent and practice-oriented publication record.

On the other hand, researchers and coauthors like Ashari, Fischer, Goldin Krabbendam and Chen exhibit significantly more scientific impact with considerably larger citation counts and H-index values. Especially Krabbendam (TC = 25,332; H-index = 67), Chen (TC = 5,904; H-index = 32) and Fischer (TC = 3,865; H-index = 30) constitute a core group of influential scholars who primarily come from the fields of neuroscience, psychology, cognitive science and whose theoretical/methodological contributions have had a lasting effect on educational research in brain-based learning. The strong stepping down of highly cited foundational papers—Fischer's cognitive development theory and Chen's neurophysiological toolbox, both of which are cited a lot—indicate this is a field that strongly seems to be grounded in non-educational interdisciplinary knowledge bases.

This pattern of representation arguably reflects the dual and interacting strands of influence within this field: (a) contributors who are educationally oriented, conducting classroom-based applications, teacher-focused studies and (b) foundational researchers whose neuroscientific and cognitively informed research provides the conceptual and methodological frame on which brain-based learning is built. This is a typical pattern observed in interdisciplinary

research domains, i.e., the applied educational questions are developed parallel to developments of the core science (Zupic & Čater, 2015; Donthu et al., 2021).

These bibliometric results support the claim that multiple indicators (TP, TC and H-index), rather than sole research volume, should be taken into account when selecting influential authors on any field. Taken together, findings from this study present brain-based learning research as an emerging and unfolding complex system of knowledge with its internal clicking towards integration between newborns in the educational researcher to prominent scientists. Future research could include mapping co-authorship, and citation networks to trace collaboration structures and intellectual lineages in the field (Aria & Cuccurullo, 2017.).

Discussion of Research Question 4: Which academic institutions have made notable contributions to knowledge production in the field of brain-based learning between 2010 and 2024?

Brain-based learning research: Knowledge production in brain-based learning is concentrated within university education departments that maintain strong interdisciplinary ties to psychology, neuroscience, and the learning sciences. Harvard Graduate School of Education leads in total productivity (TP = 7), while Nanyang Technological University and the National Institute of Education in Singapore serve as critical institutional ecosystems (TP = 6 each) backed by targeted investments in innovative pedagogies.

The active contributions of entities like Universiti Sains Malaysia, Universiti Kebangsaan Malaysia, the University of Calgary, and KU Leuven (TP = 4 each) confirm the global reach of this scholarship and highlight the necessity of international cross-institutional research designs. Furthermore, the prominence of specialized bodies like Universitas Negeri Jakarta and Hellenic Open University underscores a healthy institutional mix, where research-intensive universities work alongside applied colleges to balance theoretical discovery with practical instructional execution. Building future critical mass will require establishing national and international consortia capable of executing large-scale, multi-site empirical evaluations.

Discussion of Research Question 5: What are the most frequently used keywords in research on brain-based learning, and how have the core thematic foci evolved between 2010 and 2024?

The analysis of keyword co-occurrence map can be observed, that brain-based learning research consists simply on a well-established conceptual core build up towards high frequency items as educational neuroscience, neuroscience, brain, learning education and human. Finally the centrality and intensification of educational neuroscience and neurosciences speaks to the structuring role of cross-disciplinary hybrids of brain sciences with education inquiry, which is symptomatic by how anatomies of these divisions are now relatively more encased in cocoons about a bind for building shaped around an enlarged educational neuroscience rather than free-standing pedagogies.

Furthermore, the presence of interconnected applied clusters are visible through the network structure like teaching, teacher, Curriculum, Teacher training, Cognition and human experiment. This is the point of departure here from a conceptually-orientated thematically-focused discussion based on previous periods to class and practice led research that focused on what it looks like in action. Specifically, the paramount links between educational neuroscience and learning and teaching underscore growing pressure to translate neuroscientific concepts—cognition, attention, human learning—into instructional design, teacher education, and curricular creation.

Additionally, the temporal overlap indicates that more recent terms are associated with practical education contexts, supporting interpretation of this evolved state as reflecting empirical manifestation of brain-based principles in real-world learning. At the bibliometric level, this thematic evolution is characteristic of a research field in spring (Zupic & Čater,

2015; Aria & Cuccurullo, 2017), where one constructs are already well established and ready to be applied or practiced-based ones continue to develop.

These patterns collectively offer a flexible, stratified pattern language that merges neuroscience theory with pedagogy in an emergent thematic landscape. They also point the direction of the further researches need to be made in terms of classroom experimentation, teachers' professional development, curriculum building and systematic examination on brain-based interventions to improve field empirical support and educational implication.

12. Conclusion

A bibliometric investigation on the evolution of brain-based learning research in publication trends, geographical origins and institutional sources, country or institution collaboration patterns and major themes was performed from 2010 to 2024. The results demonstrate that the literature is expanding steadily, and brain-based learning has successfully transitioned from an ambiguous concept into a structured, mature, interdisciplinary field of study. This trajectory closely mirrors the broader growth of cross-disciplinary partnerships across neuroscience, cognitive psychology, and education.

Geographically, we discovered that research contributions were global but centered around United States, China and the UK, with vibrant research landscapes. The productivity analysis of the institutions also substantiated the relevance of research universities and specialized learning centers to sustain academic inquiry in this field. On the level of individual authors however, we find a heterogeneous group of influential ones that link basic features in science with more practically oriented educational research.

Results of thematic mapping showed that the field is based on a few focal themes (e.g., educational neuroscience, neuroscience, brain, learning, and education as core terms) to which authors in the field cumulatively add context-specific or disciplinary emphasis over time. These trends reflect the growing interest researchers have with translating findings from neuroscience to pedagogy and classroom application.

However, despite this maturation, significant empirical gaps remain. Specifically, there is a clear shortage of rigorous experimental interventions testing brain-based pedagogical protocols and teacher-training programs within authentic, everyday school environments. Future scholarship must move toward experimental, longitudinal, and comparative designs, complemented by professional development models that equip educators to critically evaluate and safely apply neuroscientific principles. Expanding the literature along these pathways will enhance the theoretical coherence, empirical validity, and practical value of brain-based learning across diverse educational contexts.

13. Recommendations

In light of the findings of the study, a number of scientific and practical recommendations can be proposed.

1. **Expand Experimental Interventions:** There is a critical need to increase the volume of experimental studies evaluating the direct impact of brain-based learning models across diverse subject areas and student populations.
2. **Prioritize Longitudinal Studies:** Researchers should design longitudinal studies to trace the cognitive, behavioral, and developmental effects of brain-based instructional programs over extended periods, moving away from a reliance on short-term evaluations.
3. **Incorporate Comparative Frameworks:** Future studies should implement comparative research designs to rigorously measure the effectiveness of brain-based learning strategies against other established pedagogical approaches, such as constructivism, active learning, inquiry-based learning, and problem-based learning.

4. **Develop Critical Teacher Professional Development:** Teacher training curricula must be updated to include the principles of educational neuroscience, with an explicit emphasis on cultivating critical evaluation skills. Programs should empower educators to accurately distinguish between verified, applicable neuroscientific data and unverified "neuromyths" or laboratory findings that cannot be transferred directly to a classroom setting.
5. **Strengthen Cross-Institutional Collaboration:** Research institutions, cognitive laboratories, and schools of education should form strategic alliances to share data, pool resources, and broaden the empirical base of the discipline.
6. **Broaden Bibliometric Index Sources:** Future bibliometric mappings should expand their data collection parameters to integrate additional major indexes, such as the Web of Science, ERIC, and Google Scholar, while maintaining clear, transparent inclusion and exclusion controls.
7. **Align Curriculum Design with Practical Indicators:** Educational content developers and instructional designers should actively build modern curricula in alignment with validated bibliometric findings and concrete empirical indicators arising from applied educational neuroscience.

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TRANSLITERATION

a. Consonant

Arabic	Latin	Example	
		Arabic	Latin
ء	‘	فَأَرْ	fārun
أ	(a,i,u)	أَحْكَام	aḥkāṃ
ب	b	بَابُ	bābun
ت	t	تَمْرٌ	tamr
ث	th	ثَلَاثُ	thalātha
ج	j	جَبَلٌ	Jabal
ح	ḥ	حَدِيثٌ	ḥadīth
خ	kh	خَالِدٌ	khālid
د	d	دِينٌ	dīn
ذ	dh	مَذْهَبٌ	madhhab
ر	r	رَاهِبٌ	rāhib
ز	z	زَكِيٌّ	zakī
س	s	سَلَامٌ	salām
ش	sh	شَرَبٌ	sharaba
ص	ṣ	صَدْرٌ	ṣodrun
ض	ḍ	ضَارٌ	ḍār
ط	ṭ	طَهْرٌ	ṭahura
ظ	ẓ	ظَهْرٌ	ẓohr
ع	‘	عَبْدٌ	‘abdun
غ	gh	غَيْبٌ	ghayb
ف	f	فَاتِحَةٌ	Fātihah
ق	q	قَبَسٌ	qabas
ك	k	كِتَابٌ	kitāb
ل	l	لَيْلٌ	layl

The Role of Islamic Finance and Government Support in Enhancing the Financial Performance of SMEs in Libya

م	m	مُنِير	munīr
ن	n	نِقَاب	niqāb
و	w	وَعَدَ	wa ^c ada
هـ	h	هَدَفَ	hadaf
ي	y	يُوسُف	Yūsuf

b. Short Vowel

Arabic	Latin	Example	
		Arabic	Latin
اَ	a	كَتَبَ	kataba
اِ	i	عَلِمَ	‘alima
اُ	u	غُلِبَ	ghuliba

c. Long Vowel

Arabic	Latin	Example	
		Arabic	Latin
اَ ، اِ ، اُ	ā	عَالَمَ ، فَتَى	‘ālam , fatā
يِ	ī	عَلِيمَ ، دَاعِي	‘alīm , dā‘ī
وِ	ū	عُلُومَ ، أَدْعُو	‘ulūm , ‘ud‘ū

d. Diphthong

Arabic	Latin	Example	
		Arabic	Latin
أَوْ	aw	أَوْلَادَ	aulād
أَيَّ	ay	أَيَّامَ	ayyam
إِيَّ	iy	إِيَّكَ	iyyāka