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International Journal of Neuroscience-Based Learning in Schools: A Bibliometric Analysis

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ABSTRACT

Neuroscience-based learning is an approach to learning that is based on knowledge of how the human nervous system functions and processes information. This approach utilizes neuroscience principles to understand how the learning process occurs in the brain and applies that knowledge to help students learn more effectively. This research aims to determine the publication of neuroscience-based learning in schools published in international journals. This research method utilizes a bibliometric approach to analyze international journals retrieved from Scopus. The obtained data is described with several topics that provide the necessary information. The research findings reveal that the publication of articles on neuroscience-based learning in schools is still concentrated in the United States and Europe. The utilization of information from neuroscience-based learning articles is also prominent in the United States and Europe. The authors of neuroscience-based learning articles in schools are predominantly from America and Europe, with fewer authors from Asia, Australia, and Africa publishing articles on neuroscience-based learning. From the research findings, it can be concluded that the publication of neuroscience-based learning articles is still unevenly distributed worldwide. This can be seen as an indication that neuroscience-based learning is not widely utilized globally.

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1. INTRODUCTION

Learning is acquiring or gaining new knowledge, skills, values, or attitudes through study, practice, or experience. Learning can occur formally, such as in schools or courses, or informally through everyday experiences or activities unrelated to formal education. Learning can also be structured, following predetermined learning programs, or unstructured, developing knowledge and skills based on personal needs and interests. Learning is an ongoing process that occurs during childhood and throughout a person's life. Individuals can learn through personal experiences, observing others, or receiving instructions from others. Learning can also occur individually or in groups and can be facilitated through various media such as books, the internet, or other means.

Neuroscience-based learning is an approach that utilizes knowledge about how the human nervous system works to understand and modify the learning process. Neuroscience is a branch of science that investigates the structure and function of the nervous system, including the brain, nerves, and nerve cells. Neuroscience-based learning uses knowledge about how the brain functions to understand and modify the learning process. This approach aims to tailor learning methods to how the brain absorbs, stores, and utilizes information. It also seeks to optimize learning by employing techniques aligning with the brain's operations [1].

Neuroscience-based learning can assist in shaping students' character by using techniques that align with how the brain works to facilitate understanding and information retention. Additionally, neuroscience-based learning can help students comprehend and strengthen desired attitudes and values, such as honesty, responsibility, and caring for others. Furthermore, neuroscience-based learning can also aid students in understanding how the nervous system functions and how certain factors can influence one's attitudes and behaviors. By understanding how the brain works, students can better grasp how their attitudes and behaviors are formed and how they can control them [2].

Higher Order Thinking Skills (HOTS) refer to students' abilities to engage in higher-level thinking, such as analysis, synthesis, evaluation, and application. Neuroscience can enhance students' HOTS by employing learning techniques aligning with the brain's operation. Some examples of neuroscience-based learning techniques can enhance students' HOTS. Neuroscience-based learning can also help students understand how the nervous system works and how certain factors impact an individual's learning ability. By understanding how the brain functions, students can more easily comprehend how their intelligence and HOTS are formed and how they can develop them[3].

The Fourth Industrial Revolution is a significant change in the way production, distribution, and consumption occur due to advancements in information technology. To face the challenges posed by the Fourth Industrial Revolution, students need to possess higher-order thinking skills (HOTS) and the ability to engage in lifelong learning. Neuroscience-based learning can help students tackle the challenges of the Fourth Industrial Revolution by utilizing learning techniques that align with the brain's workings. Neuroscience-based learning can also assist students in understanding how the nervous system functions and how certain factors can affect an individual's learning ability. By understanding how the brain works, students can more easily comprehend how their intelligence and higher-order thinking skills (HOTS) are formed and how they can develop them throughout their lives [4].

[5] The neuroscience approach helps students enhance their higher-order thinking abilities and enables teachers to improve their higher-order thinking skills. The challenges in 21st-century learning and the industrial revolution are to create relevant and useful learning to prepare students for future challenges. The transformation of abilities begins with teachers themselves, as they need to be prepared to face teaching issues and prepare for future learning. Based on various literature sources, neuroscience-based learning can assist teachers and students in addressing the challenges of future learning.

However, teachers' implementation of neuroscience-based learning is still not fully realized. This is evident from observations and discussions conducted. Several potential problems may arise in the use of neuroscience-based learning in the classroom, including: 1) Lack of neuroscience knowledge: Teachers may have limited understanding of the principles of neuroscience and how to apply them in the learning process, making it difficult for them to design and manage neuroscience-based learning. 2) Lack of resources: Neuroscience-based learning approaches may require additional resources, such as equipment or materials that align with neuroscience principles, which may not be available in schools or classrooms. 3) Technical issues: Using technology in neuroscience-based learning may encounter problems such as network issues or equipment malfunctions, disrupting the learning process. 4) Social issues: Students may have social problems affecting their learning ability, such as family or peer-related problems.

This research provides an overview and information from articles in Scopus journals on neuroscience-based learning in schools. The information from these articles can provide insights into implementing neuroscience-based learning in various parts of the world. This study aims to uncover the development of neuroscience-based learning articles published each year, the most relevant sources of neuroscience-based learning articles, the most relevant authors of neuroscience-based learning, the most relevant affiliations of neuroscience-based learning, the countries producing neuroscience-based learning articles, the most cited neuroscience-based learning articles, the clustering or linking of neuroscience-based learning articles, the trend of neuroscience-based learning article topics, and the collaboration networks among countries in neuroscience-based learning articles.

The information from this research is beneficial for identifying relevant sources of neuroscience-based learning. Additionally, the information from these articles will provide insights into the trends in neuroscience-based learning articles, which can be absorbed and applied by readers or used as a guide for researching neuroscience-based learning articles.

2. RESEARCH METHODS

[6] bibliometrics is the application of mathematical and statistical methods to books and other communication media. Bibliometrics is an application of quantitative methods used to analyze science as an information process. Bibliometrics measures scientific communication and is designed within a broader information process. The definition of bibliometrics, informetrics, also deals with electronic media and thus includes topics such as statistical analysis of (scientific) texts and hypertext systems, library circulation, information measurement in

electronic libraries, models for the production of information processes, and quantitative aspects of information retrieval as well. Currently, with technological advancements, data can be found from various sources. One of the largest research databases is Scopus. The data used in this study is obtained from the Scopus website. The data utilized spans from 1975 to 2023, using the following keywords: TITLE-ABS-KEY (neuroscience AND based AND learning) AND (LIMIT-TO (EXACTKEYWORD, "Learning") OR LIMIT-TO (EXACTKEYWORD, "Physiology") OR LIMIT-TO (EXACTKEYWORD, "Cognitive Neuroscience") OR LIMIT-TO (EXACTKEYWORD, "Teaching") OR LIMIT-TO (EXACTKEYWORD, "Emotion") OR LIMIT-TO (EXACTKEYWORD, "Child") OR LIMIT-TO (EXACTKEYWORD, "Motivation") OR LIMIT-TO (EXACTKEYWORD, "Cognitive Neurosciences").

3. RESULT AND DISCUSSION

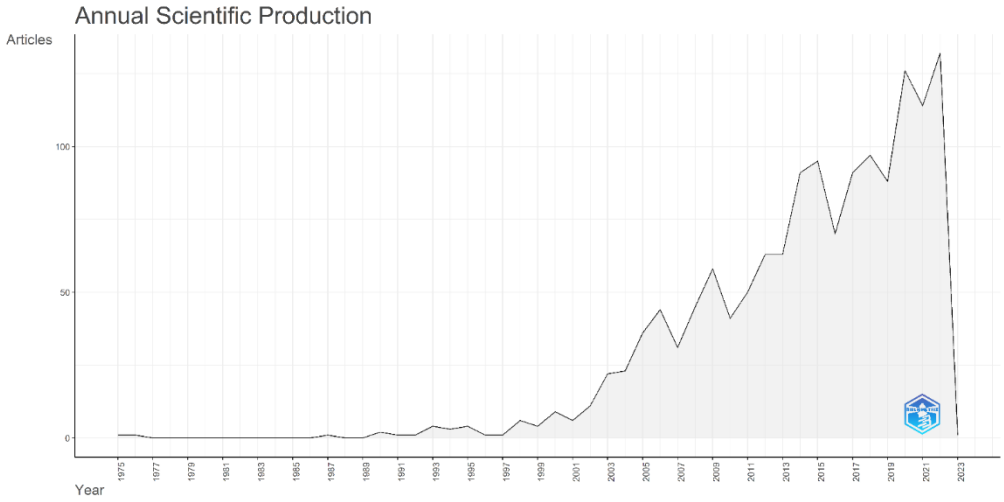

Figure 1. Annual Scientific Production

Articles on Neuroscience-based Learning began in 1975. From 1975, the development of articles publishing neuroscience-based learning was only one or two articles. After 1998, the development of articles started to rise, as seen in the graph. In 2020, the production of articles on neuroscience-based learning surpassed 100.

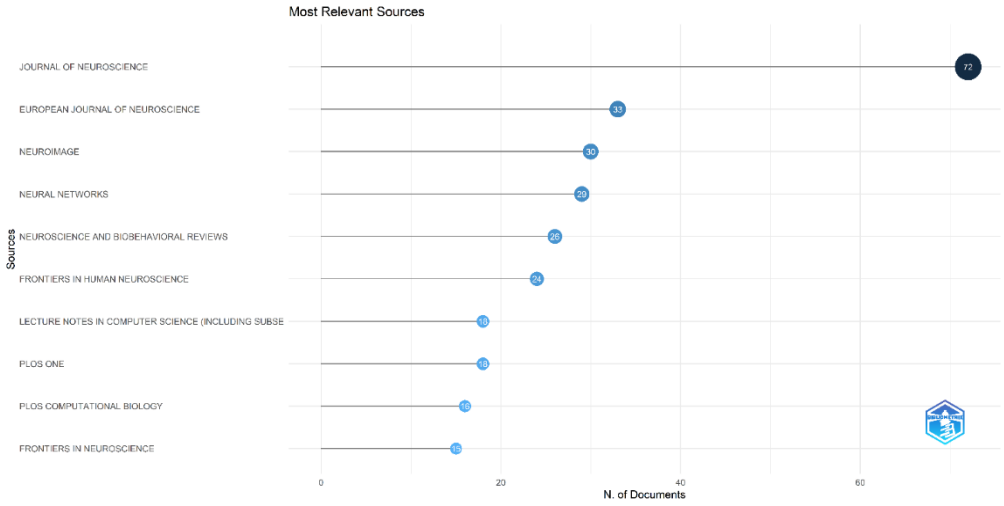

Figure 2. Most Relevant Sources

Journals that have published a significant number of articles on neuroscience-based learning, based on the top ten, include the Journal of Neuroscience with 72 articles, the European Journal of Neuroscience with 33 articles, Neuroimage with 30 articles, Neural Networks with 29 articles, Neuroscience and Biobehavioral Reviews with 26 articles, Frontiers in Human Neuroscience with 24 articles, Lecture Notes In Computer Science (Including Subseries Lecture Notes In Artificial Intelligence and Lecture Notes In Bioinformatics) with 18

articles, PLOS One with 18 articles, PLOS Computational Biology with 16 articles, and Frontiers in Neuroscience with 15 articles.

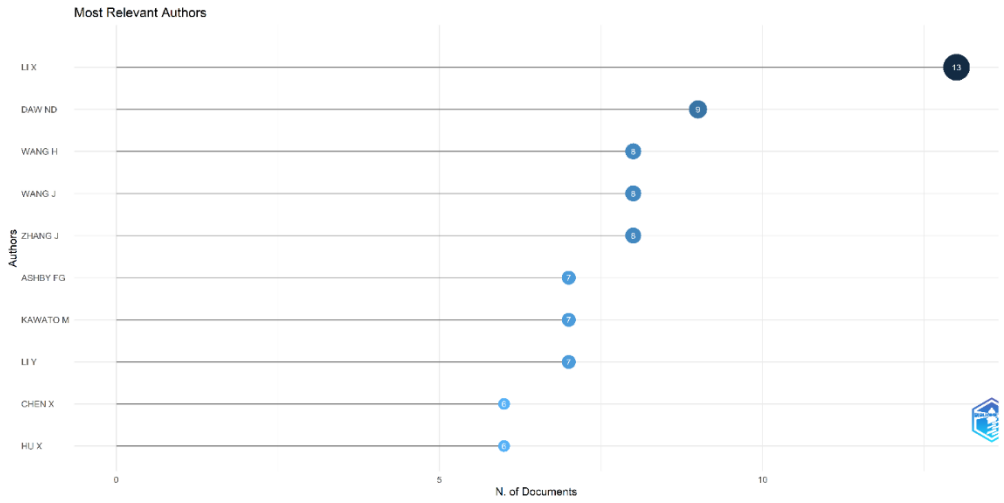

Figure 3. Most Relevant Authors

For the most relevant authors, based on the top ten, Li X has published 13 articles with a fractionalized article count of 2.36, Daw ND has published 9 articles with a fractionalized article count of 3.50, Wang H has published 8 articles with a fractionalized article count of 1.36, Wang J has published 8 articles with a fractionalized article count of 1.34, Zhang J has published 8 articles with a fractionalized article count of 2.74, Ashby FG has published 7 articles with a fractionalized article count of 2.07, Kawato M has published 7 articles with a fractionalized article count of 2.14, Li Y has published 7 articles with a fractionalized article count of 1.41, Chen X has published 6 articles with a fractionalized article count of 0.73, and Hu X has published 6 articles with a fractionalized article count of 0.71.

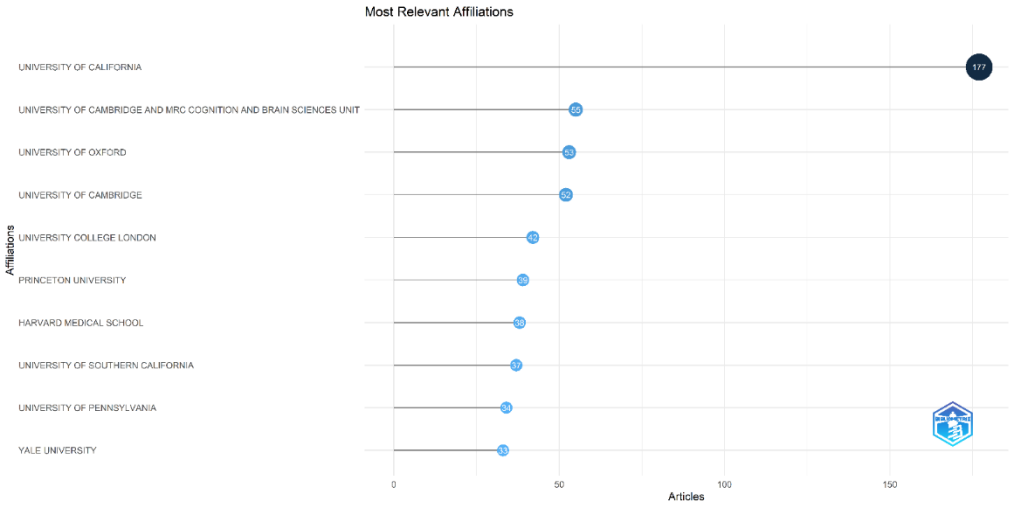

Figure 4. Most Relevant Affiliations

For the most relevant affiliations, based on the top 10 productive universities, the University of California has published 177 articles, the University of Cambridge and MRC Cognition and Brain Sciences Unit has published 55 articles, the University of Oxford has published 53 articles, the University of Cambridge has published 52 articles, University College London has published 42 articles, Princeton University has published 39 articles, Harvard Medical School has published 38 articles, the University of Southern California has published 37 articles, the University of Pennsylvania has published 34 articles, and Yale University has published 33 articles.

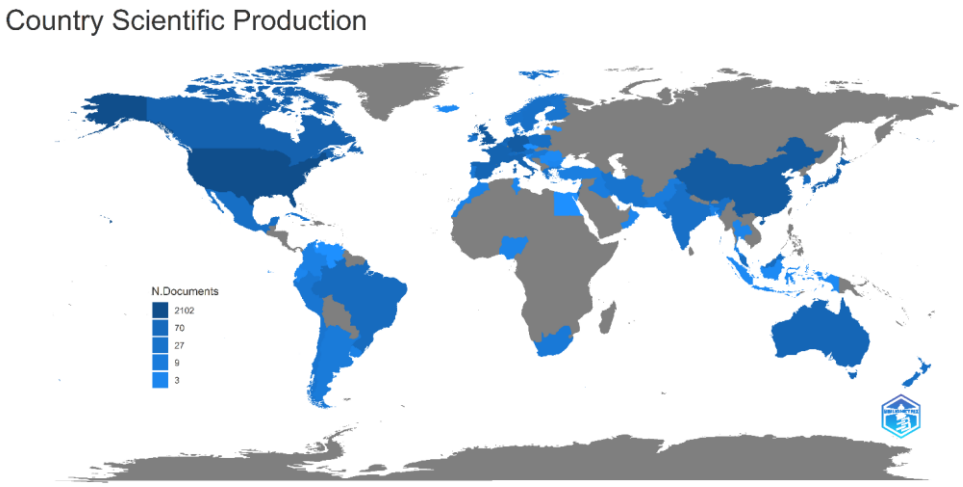

Figure 5. Most Relevant Affiliations

Based on the top 10 countries producing articles on neuroscience-based learning, the frequencies are as follows: USA with 2102 frequency, UK with 598 frequency, China with 448 frequency, Germany with 417 frequency, Japan with 201 frequency, Canada with 179 frequency, Italy with 169 frequency, France with 152 frequency, Netherlands with 129 frequency, and Spain with 126 frequency.

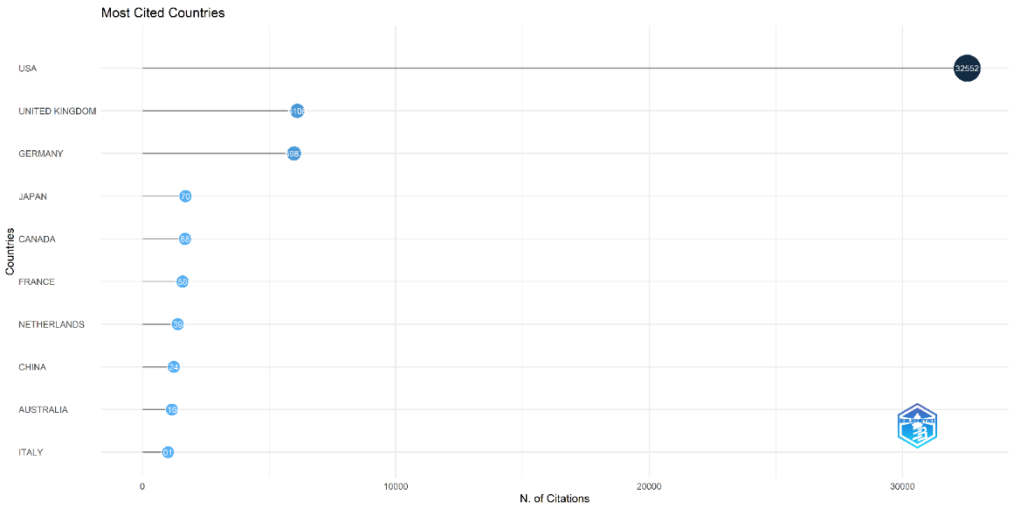

Figure 6. Most Cited Countries

For the top 10 most cited countries, the rankings are as follows: the USA with a total of 32,552 citations and average article citations of 69.70, the United Kingdom with a total of 6,108 citations and average article citations of 53.11, Germany with a total of 5,983 citations and average article citations of 74.79, Japan with a total of 1,703 citations and average article citations of 30.96, Canada with a total of 1,682 citations and average article citations of 46.72, France with a total of 1,585 citations and average article citations of 38.66, Netherlands with a total of 1,398 citations and average article citations of 42.36, China with a total of 1,241 citations and average article citations of 13.94, Australia with a total of 1,164 citations and average article citations of 48.50, and Italy with a total of 1,012 citations and average article citations of 28.91.

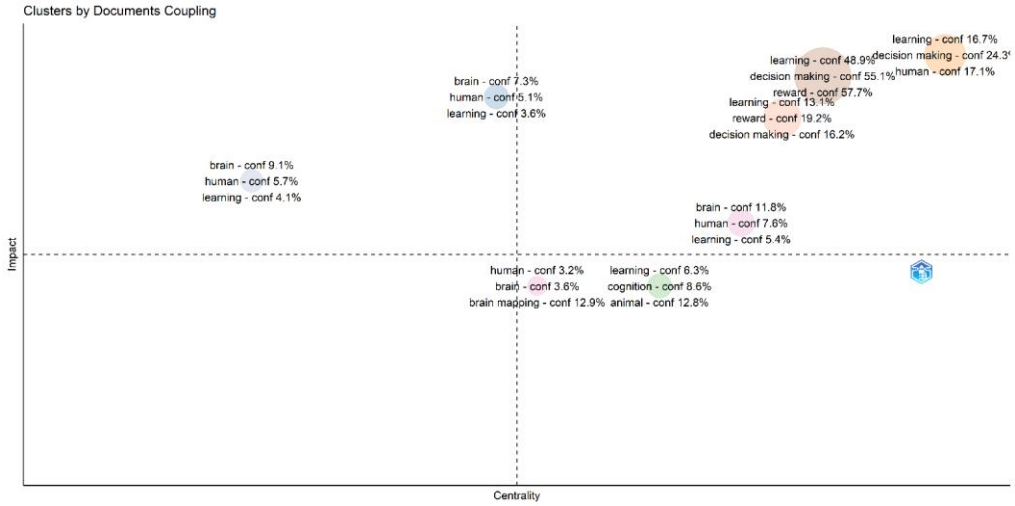

Figure 7. Cluster by Documents Coupling

If we look at the cluster by document coupling impact, the lowest impact from the first cluster is in learning at 6.3%, cognition at 8.6%, and animal at 12.8%. The next cluster has a higher impact than the previous one, with learning at 5.4%, human at 7.6%, and brain at 11.8%. The cluster above the previous one includes decision-making at 16.2%, reward at 19.2%, and learning at 13.1%. Moving higher from the previous cluster, we have learning at 48.9%, decision-making at 55.1%, and reward at 57%. Another cluster higher than the previous one includes learning at 16.7%, human at 17.1%, and decision-making at 24.3%.

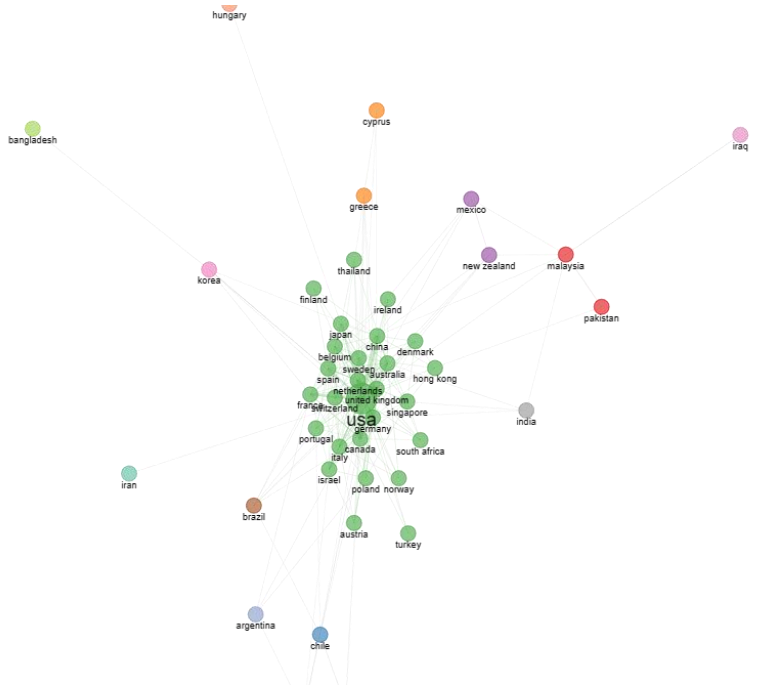

Figure 8. Collaboration Network

From the collaboration network graph, it can be observed that articles on neuroscience-based learning have close relationships among countries such as the USA, Germany, United Kingdom, Denmark, China, Japan, Netherlands, Belgium, Sweden, Australia, Spain, France, Switzerland, Portugal, Canada, Italy, Israel, Poland, and Norway. The second circle includes Iran, Brazil, Austria, Turkey, India, Pakistan, New Zealand, Mexico, Greece, and Korea. The third circle, which is the farthest, includes Bangladesh, Hungary, Cyprus, Iraq, Argentina, and Chile.

Based on several research findings published in Scopus, it can be concluded that neuroscience plays a crucial role in education. According to [7], neuroscience is fundamental to understanding the changes that occur in the human brain. Neuroscientific knowledge enables the identification of behavioral changes and declines. A

good understanding of neuroscience can improve brain care and enhance success. [8] state that brain imaging technology and performance measurements can be used to evaluate practices and principles of universal design for learning within the framework of professional training. The development of widely accessible brain imaging technology, such as wearable devices and high-performance computing, is expected to accelerate studies on universal design principles for learning.

[9] found that developing cognitive neuroscience-based learning using lesson study among learning communities has a positive impact, as validated by experts in learning technology, learning evaluation, and neuroscience. The research indicates that the communicative skills of students improve while their mathematical proficiency declines. According to [10], exercise science is compatible with physical education. Physical education contributes to brain and cognitive development. Neuroscientific-based physical education is a relatively new field in Indonesia, and many teachers have not yet integrated neuroscience into their teaching. The research findings suggest that neuroscience-based physical education benefits children by stimulating their physical and cognitive activities.

[11] found a correlation between neuroscience and learning outcomes. Active student involvement in learning was observed, and the classroom environment became more comfortable and enjoyable. The feedback received aligned with the expectations of the learning process. [12] emphasize the relevance of neuroscience in education. It provides valuable insights for teachers to determine the most effective instructional methods and allows students to utilize the instructional environment efficiently.

Further research is needed in the areas of brain recording and neuroimaging. Additionally, behavioral, pedagogical, and educational studies should accompany techniques within the academic learning context. Understanding the role of neuroscience can empower teachers to develop learning approaches that enable students to develop their intelligence and meaningfully face future challenges.

According to [13], neuroscience can inform research and psychological, educational practices. The articles discussed in their research shed light on the neural mechanisms involved in reading development, mathematical learning, and the impact of stress on development. The relationship between neuroscience and education should be reciprocal rather than one-sided. Psychology and neuroscience can provide insights into the neural and cognitive mechanisms underlying learning to maximize human potential and promote learning for all.

4. CONCLUSIONS

From the bibliometric analysis, it can be observed that neuroscientific-based learning studies are predominantly conducted in the countries of America and Europe. Compared to other continents, the implementation of neuroscience-based learning appears less prevalent. Researchers focusing on neuroscience are also predominantly found in America and Europe, with limited involvement of collaborators from other continents. Several scientific publications indicate that neuroscience has a positive impact on classroom teaching. Neuroscience offers numerous benefits to both teachers and students, including increased participation, cognitive enhancement, and the creation of an effective learning environment.

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