

Research Trend and Impact on Student Learning Using Artificial Intelligence-Based Emotion Recognition: Systematic Bibliometric Analysis

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ABSTRACT: Emotions have a significant function in the learning process. Good emotions such as enjoyment and curiosity can increase attention and comprehension, whereas negative emotions such as fear and boredom might impair academic achievement. Therefore, identifying and managing students' emotions is a critical step in developing an effective learning environment. In recent years, there has been a substantial progress in the application of artificial intelligence to detect emotions through facial expression analysis. Systematic literature reviews based on bibliometric analysis of artificial intelligence-based emotion recognition studies are still difficult to locate. This paper aims to undertake bibliometric and visualization analyses with VOSviewer for artificial intelligence-based emotion recognition. The evaluation includes 230 scholarly publications on emotion detection investigations indexed by Scopus quartiles Q1–Q4 from the Scopus database in the recent decade, namely 2014–2024. This bibliometric analysis has major implications for increasing academic, practical, and policy-related elements of artificial intelligence-based emotion recognition in education. By recognizing trends and major contributions in this subject, researchers, practitioners, and policymakers may work together to develop a more flexible and supportive learning environment, thereby boosting the overall quality of education.

KEYWORDS: Bibliometric, Artificial Intelligence, Emotion Recognition, Education, Student Learning

I. INTRODUCTION

The increasing incorporation of artificial intelligence into educational frameworks has triggered revolutionary improvements in student learning (Hwang et al., 2020). Artificial intelligence-driven emotion detection technology, in particular, offers a sophisticated technique of evaluating student involvement, comprehension, and emotional well-being, hence increasing individualized learning settings (Wetcho & Na-Songkhla, 2022). This research employs a bibliometric approach to examine trends and implications in this new subject, emphasizing key contributions and detecting gaps within the existing body of literature. The integration of artificial intelligence in educational ecosystems marks a paradigm change, boosting innovation and collaboration while tackling special issues inherent in this sector (Kshirsagar et al., 2022; Okonkwo & Ade-Ibijola, 2021; Zhai et al., 2021). This study intends to map the research environment using bibliometric analysis, concentrating on artificial intelligence-based emotion recognition's significance in student learning.

Bibliometric analysis, a quantitative tool for studying scientific publications, provides a comprehensive overview of research trends, collaboration networks, and academic effect (Fu et al., 2021; Huertas-Valdivia et al., 2020; Sánchez et al., 2017). By leveraging tools such as VOSviewer, researchers can display co-authorship networks, keyword co-occurrences, and citation trends, hence enabling the

identification of prominent works and developing issues within the field (Al Husaeni & Nandiyanto, 2022; Pourkhani et al., 2019; Soegoto et al., 2022). This research applies such approaches to evaluate the corpus of literature on artificial intelligence in education, emphasizing emotion recognition.

A thorough analysis of how to maximize emotion detection technology to increase learning outcomes is important due to the burgeoning interest in artificial intelligence applications within education (Wartenberg et al., 2023). Recent research showed that knowing students' emotional states can greatly affect instructional practices, enabling more effective and responsive teaching methods (Sutherland et al., 2008). Consequently, our research not only tries to chart the academic discourse but also to provide actionable recommendations for educators and policymakers.

Given the crucial significance of emotions in learning processes, artificial intelligence-based emotion identification emerges as a pivotal tool in current educational contexts (Costescu et al., 2020; Y. Zhang & Srivastava, 2022). This study's bibliometric analysis will illuminate the trajectory of research in this domain, presenting a comprehensive view of its evolution, important contributions, and prospective future paths. It intends to contribute to the greater discourse on incorporating modern technology in education, ultimately boosting the efficacy and inclusivity of learning experiences.

The fundamental challenge addressed in this research is the integration of artificial intelligence-based emotion

identification technologies into educational frameworks to boost student learning results. The basic solution is in undertaking a complete bibliometric study to map the existing research environment, identify relevant trends, and expose gaps (Bernard et al., 2017; Fernández Herrero et al., 2023; Villegas-Ch et al., 2023). This analysis will inform the creation of more effective, evidence-based strategies for harnessing artificial intelligence in education. Recent study underlines the potential of artificial intelligence to personalize learning experiences by dynamically responding to students' emotional and cognitive states.

To answer the core research challenge, this study will undertake a complete bibliometric examination of relevant scientific publications (Fu et al., 2021; Huertas-Valdivia et al., 2020; Sánchez et al., 2017). Utilizing VOSviewer for visualization, the research will evaluate 230 Scopus-indexed publications across quartiles Q1–Q4. Key indicators will include the number of publications, citation counts, keyword occurrences, and co-authorship networks. The specific solution entails finding influential works, collaboration networks, and upcoming research issues within artificial intelligence-based emotion identification in education (Bernard et al., 2017; Shafait et al., 2021).

The integration of artificial intelligence with education, notably through emotion recognition technology, represents a cutting-edge frontier in pedagogical research (McKown, 2019; Zembylas & McGlynn, 2012). Recent improvements have enabled the real-time monitoring of emotional states, providing important data to adapt instructional approaches (Shmelova et al., 2024; Taj-Eldin et al., 2018). The state-of-the-art review demonstrates tremendous progress in developing algorithms capable of effectively detecting and understanding emotional cues, which are critical for tailored learning environments.

However, the research also identifies various obstacles, including privacy concerns, data security, and the ethical implications of monitoring emotional states (Shmelova et al., 2024). Addressing these difficulties demands an interdisciplinary approach, incorporating concepts from educational psychology, computer science, and ethics (McKown, 2019; Taj-Eldin et al., 2018). This study will explore these characteristics, building on current publications that advocate for ethical AI inclusion in education.

Furthermore, the application of bibliometric and network analysis tools, such as VOSviewer, has become increasingly widespread in educational research (Al Husaeni & Nandiyanto, 2022; Soegoto et al., 2022). These technologies provide a deeper understanding of the research ecosystem, enabling scholars to visualize trends, identify major contributors, and reveal collaborative patterns (Al Husaeni & Nandiyanto, 2022; Soegoto et al., 2022). This study will leverage these approaches to present a complete evaluation of

the state of artificial intelligence-based emotion recognition research in education.

Despite the hopeful advancements, there remains a major gap in the systematic application of bibliometric analysis to this topic (Phoong et al., 2022). Few studies have completely mapped the research trends, major publications, and collaborative networks relevant to Artificial Intelligence based emotion recognition in education (Shafait et al., 2021). This research attempts to fill this vacuum by presenting a complete bibliometric analysis, providing a framework for future research and policy development. Conduct a bibliometric analysis of Artificial Intelligence based emotion recognition research in education, identifying major trends, influential publications, and research gaps. Using VOSviewer, visualize cooperation networks and keyword co-occurrences. Provide actionable insights for educators and policymakers to promote student learning through Artificial Intelligence.

This work delivers a pioneering bibliometric analysis of Artificial Intelligence based emotion recognition in education, leveraging advanced visualization methods to map the research environment (Shafait et al., 2021; Sutherland et al., 2008). By identifying major patterns and gaps, it provides a framework for future study and guides evidence-based educational initiatives. The research comprises a detailed bibliometric examination of 230 Scopus-indexed articles throughout quartiles Q1-Q4. It features citation analysis, keyword co-occurrence, and co-authorship network visualization. The scope extends to examining the influence of Artificial Intelligence based emotion recognition on student learning outcomes and providing recommendations for integrating these technologies into educational frameworks.

II. ANALYSIS METHOD

This section discusses the bibliometric approaches adopted in this study, aimed to completely examine the landscape of Artificial Intelligence based emotion recognition research in education. The approaches are divided into three primary stages, leveraging a combination of bibliometric tools and databases to enable a comprehensive and thorough assessment of the relevant literature (Bahroun et al., 2023; Donthu et al., 2021). The initial stage comprised a thorough search for scientific articles using the Scopus database. The search was conducted with particular keywords: "Emotion Recognition", "Education", and "Student Learning," covering the publishing years from 2014 to 2024. The search was restricted to the topic field of Computer Science, and only papers published in English were included. The results were stored in both RIS and CSV formats for later analysis. This procedure yielded 471 items. From the initial pool of 471 publications, a refinement process was done to choose the most relevant studies. This included a rigorous examination

“Research Trend and Impact on Student Learning Using Artificial Intelligence-Based Emotion Recognition: Systematic Bibliometric Analysis.”

of abstracts and keywords to guarantee alignment with the study focus on Artificial Intelligence based emotion recognition in educational situations. Articles that did not satisfy the criteria were eliminated, resulting in a final selection of 230 relevant articles. These articles were stored in RIS and CSV forms for detailed analysis can be seen at Table 1.

Table 1. Article Search and Retrived Article in the field of Emotion Recognition, Education, and Student Learning indexed by Scopus

Data	Article Search	Rerived Article
Data Source	Database	Database
Keywords	Scopus Emotion Recognition AND Education	Scopus Emotion Recognition AND Education AND Student Learning
Number of Publications	471	230
Number of Citation	6867	3166
Citation per Year	606	316
Citation per Article	14	13

The third stage involves an in-depth bibliometric study of the 230 selected papers. This was accomplished using VOSviewer, a robust tool for creating and visualizing bibliometric networks (Alam et al., 2023; Fleming et al., 2023; Pourkhani et al., 2019; Soegoto et al., 2022). The analysis focuses on several essential aspects:

- Identifying the most often occurring keywords to determine the prevalent topics and patterns in the research subject.
- Mapping the collaboration networks among scholars to discover significant authors and research groups.

- Evaluating the impact of articles based on citation counts to discover the most influential works in the subject.

In addition to VOSviewer, Harzing's Publish or Perish (PoP) software was utilized to augment the bibliometric analysis (Adnan et al., 2022; Al Husaeni & Nandiyanto, 2022). PoP offered access to a huge database of scientific articles from Google Scholar, enabling a detailed study of citation metrics and author influence.

- Utilized to retrieve citation metrics and author impact statistics from Scopus.
- Chosen for its comprehensive coverage of scientific subjects and accessible to all researchers.
- Employed for reference management and collaboration among scholars.
- Used to assess the quality and impact of journals.
- Key tool for viewing bibliometric networks, including co-authorship and keyword co-occurrence networks.

The combination of these methods and databases gave a complete and multi-faceted approach to the bibliometric study, ensuring a thorough and credible examination of the research landscape. To preserve methodological rigor, the study conformed to acknowledged best practices in bibliometric research. This included:

- Ensuring consistency in keyword selection and search parameters.
- Applying systematic inclusion and exclusion criteria during the refinement step.
- Utilizing several techniques and data sources to cross-validate findings and boost reliability.

By following these rigorous methodological methods can be seen at Figure 1, this study presents a thorough analysis of Artificial Intelligence based emotion detection research in education, offering significant insights and identifying relevant trends and gaps for future research.

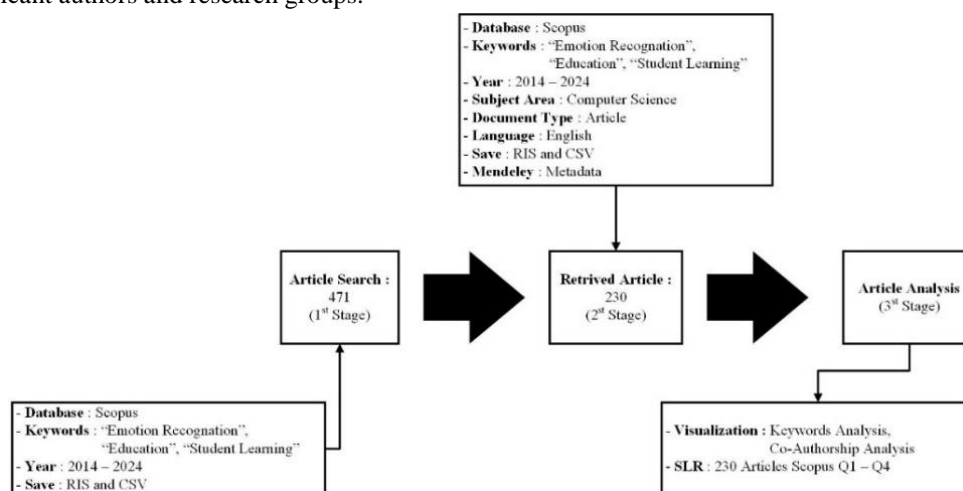


Figure 1. Research Method and Strategy

III. RESULT AND DISCUSSION

The bibliometric analysis undertaken in this study gives a complete summary of the trends in scientific articles focused on artificial intelligence-based emotion recognition in education during the previous decade. The analysis covers publishing trends, citation metrics, and the influence of different quartiles of journals. The examination of publication trends may be observed in Figure 2, which demonstrates large changes in the number of scientific articles produced between 2014 and 2024. The data reveals a considerable increase in the number of publications in recent years, particularly from 2020 onwards. The number of articles in the Q1 and Q2 quartiles has showed consistent rise, with the most noteworthy growth occurring in 2020 and 2022. This contrasts with the patterns in the Q3 and Q4 quartiles, where a considerable growth is noted, showing a shift towards higher-quality publications in this subject.

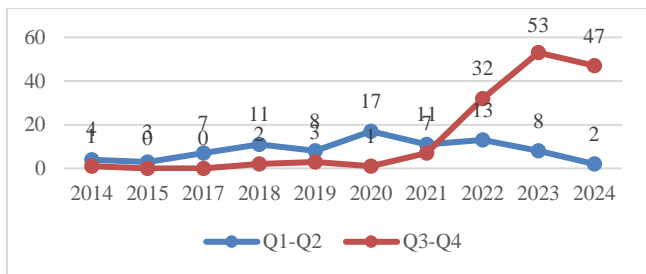


Figure 2. Trends in Scientific Articles in the field of Emotion Recognition, Education, and Student Learning indexed by Scopus

It demonstrates the comparison of citation metrics across different quartiles and the initial search results that can be found in Table 2. The Q1 and Q2 quartile papers demonstrate much higher citation metrics, with an average of 13.77 citations per paper. This suggests that articles with higher quartiles have a bigger impact on following research. Similarly, the authors per paper metric shows greater values for Q1 and Q2 quartiles, as well as Q3 and Q4 quartiles, indicating the stronger collaboration and effect of top-tier publications. The research identifies all publishers contributing to the corpus of literature, with the top publishers accounting for the majority of publications in Scopus quartile Q1-Q4.

A full evaluation of yearly citation metrics can be seen in Table 2, which demonstrates the large fluctuations in the influence of publications over time. The highest citation count per publication was observed in 2018, with 893 citations over 13 publications, averaging 68.69 citations per item. This peak represents a rise in high-impact research during that year. In contrast, the citation metrics for 2024 reveal a low citation rate with only 19 citations across 49 publications, indicating either a reduction in high-impact publications or the recency of these papers, which may

dramatically grow with time. The data demonstrated a shifting trend in the number of publications, with a considerable increase in Q1 to Q4 quartile papers, particularly in 2018. This year saw a substantial jump in publications, showing a 400% increase compared to the prior years.

Table 2. Trends in Scientific Articles in the field of Emotion Recognition, Education, and Student Learning indexed by Scopus

Year	Publication	Cite of Publication	Citation	Cite/publication
2014	5	4	181	36.4
2015	3	3	43	14.3
2016	0	0	0	0
2017	7	7	220	31.4
2018	13	13	893	68.69
2019	11	11	276	25
2020	18	18	644	35.7
2021	18	17	354	19.1
2022	45	37	345	7.6
2023	61	45	200	3.2
2024	49	13	19	0.39

Analysis of the obtained data to determine the most productive publishers in terms of related article publications. Based on our analysis, the top six publishers that are the most productive in publishing scientific articles in Scopus quartiles Q1 to Q4 are: Multidisciplinary Digital Publishing Institute (MDPI) 26 articles; Institute of Electrical and Electronics Engineers Inc. (IEEE) 25 articles; Springer 23 articles; Elsevier Ltd. 13 articles; Hindawi Limited 12 articles; and Sciendo 12 articles. These results are displayed in Figure 3.

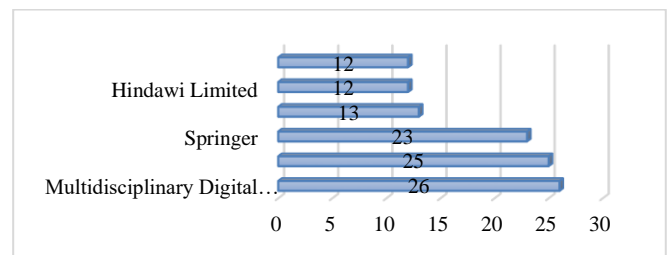


Figure 3. TOP 6 Publishers that Publish Articles in the field of Emotion Recognition, Education, and Student Learning indexed by Scopus

The research also identified the top publishers and journals contributing to the topic. The top six publishers, as depicted in Figure 2, included MDPI, IEEE, Springer, Elsevier, Hindawi, and Sciendo. Among these, MDPI and IEEE were the most prolific, producing 26 and 25 publications, respectively. Similarly, the top journals, displayed in Figure 3, included IEEE Access, Applied Mathematics and Nonlinear Sciences, and Multimedia Tools and Applications,

“Research Trend and Impact on Student Learning Using Artificial Intelligence-Based Emotion Recognition: Systematic Bibliometric Analysis.”

with IEEE Access leading with 13 published papers that can be seen in Figure 4. The top 6 journals that publish scientific publications.

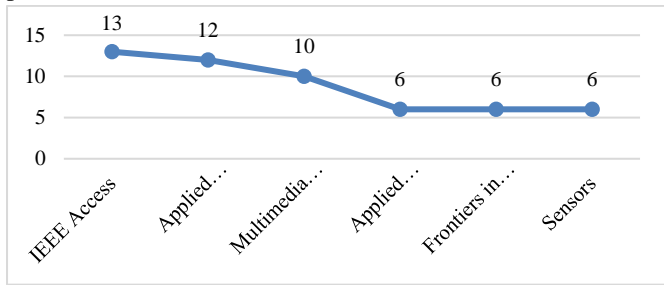


Figure 4. TOP 6 Journals in the field of Emotion Recognition, Education, and Student Learning indexed by Scopus

a. Citation Analysis

The top 11 can be shown in Table 3. that generated the most citations over the past decade come from publisher

Multidisciplinary Digital Publishing Institute AG (MDPI AG) with 476 citations from articles written by Ko B.C. entitled "A brief review of facial emotion recognition based on visual information" (Ko, 2018), and this scientific article is also the most superior in citations per year. It is followed by a work written by Hussain A. Cambria E. entitled "Semi-supervised learning for big social data analysis" (Hussain & Cambria, 2018) with 173 citations. The third rank is the article entitled "Artificial intelligence within the interplay between natural and artificial computation: Advances in data science, trends, and applications", published by Górriz J.M. Ramírez J. et al. (Górriz et al., 2020), with 149 citations from publisher Elsevier B.V. In these TOP 11, publishers Elsevier and the Institute of Electrical and Electronics Engineers contributed the most to the number of articles, consisting of three scientific publications with a total of 924 citations.

Table 3. TOP 11 Citation Papers in the field of Emotion Recognition, Education, and Student Learning indexed by Scopus

Rank	Citation	Authors	Title	Year	Jounal	Publisher
1	476	Ko B.C.	A brief review of facial emotion recognition based on visual information	2018	Sensors (Switzerland)	MDPI AG
2	173	Hussain A.; Cambria E.	Semi-supervised learning for big social data analysis	2018	Neurocomputing	Elsevier B.V.
3	149	Górriz J.M.; Ramírez J.; Ortíz A.; Martínez-Murcia F.J.;et all	Artificial intelligence within the interplay between natural and artificial computation: Advances in data science, trends and applications	2020	Neurocomputing	Elsevier B.V.
4	130	Kim Y.; Soyata T.; Behnagh R.F.	Towards Emotionally Aware AI Smart Classroom: Current Issues and Directions for Engineering and Education	2018	IEEE Access	Institute of Electrical and Electronics Engineers Inc.
5	126	Yadegaridehkordi E.; Noor N.F.B.M.; Ayub M.N.B.; Affal H.B.; Hussin N.B.	Affective computing in education: A systematic review and future research	2019	Computers and Education	Elsevier Ltd
6	122	Koduru A.; Valiveti H.B.; Budati A.K.	Feature extraction algorithms to improve the speech emotion recognition rate	2020	International Journal of Speech Technology	Springer
7	108	Zhang Q.; Chen X.; Zhan Q.; Yang T.; Xia S.	Respiration-based emotion recognition with deep learning	2017	Computers in Industry	Elsevier B.V.
8	88	Awais M.; Raza M.; Singh N.; Bashir K.; Manzoor U.; Islam S.U.; Rodrigues J.J.P.C.	LSTM-Based Emotion Detection Using Physiological Signals: IoT Framework for Healthcare and Distance Learning in COVID-19	2021	IEEE Internet of Things Journal	Institute of Electrical and Electronics Engineers Inc.
9	77	Parthasarathy S.; Busso C.	Semi-Supervised Speech Emotion Recognition with Ladder Networks	2020	IEEE/ACM Transactions on Audio Speech	Institute of Electrical and

Rank	Citation	Authors	Title	Year	Jounal	Publisher
					and Language Processing	Electronics Engineers Inc.
10	74	Guo H.; Gao W.	Metaverse-Powered Experiential Situational English-Teaching Design: An Emotion-Based Analysis Method	2022	Frontiers in Psychology	Frontiers Media S.A.
11	73	Tonguç G.; Ozaydın Ozkara B.	Automatic recognition of student emotions from facial expressions during a lecture	2020	Computers and Education	Elsevier Ltd

b. Keywords Analysis (Co-occurrence)

This study evaluates 230 scholarly publications on emotion recognition, education, and student learning indexed by Scopus in quartiles Q1–Q4 using VOSviewer software. The analysis found that research in the recent decade in the disciplines of emotion identification, education, and student learning is related to roles, actors, collaboration, and dominating platform capabilities. By establishing a minimum co-occurrence number of five, 56 keywords were discovered, separated into seven clusters, as shown in Figure 1.

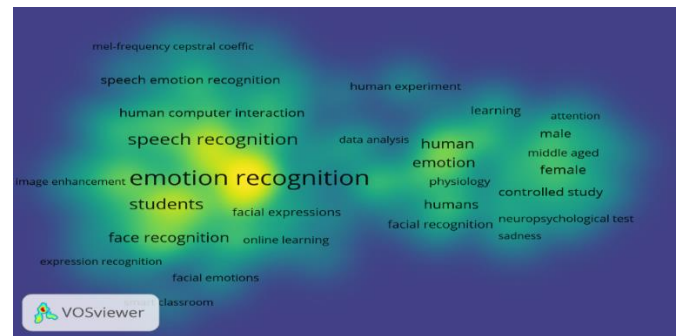


Figure 6. Keyword Density Visualization

The lowest density denotes new research themes that are still rarely studied in the business ecosystem field, where these research topics only began to be discussed in 2014, highlighted in yellow in Figure 7. Furthermore, Cluster 4 (yellow) is composed of eight study subjects, with emotion identification, education, and student learning being the most discussed, as represented by the largest node. The larger the node, the more popular and frequently discussed the topic is relative to other study themes in the same cluster.

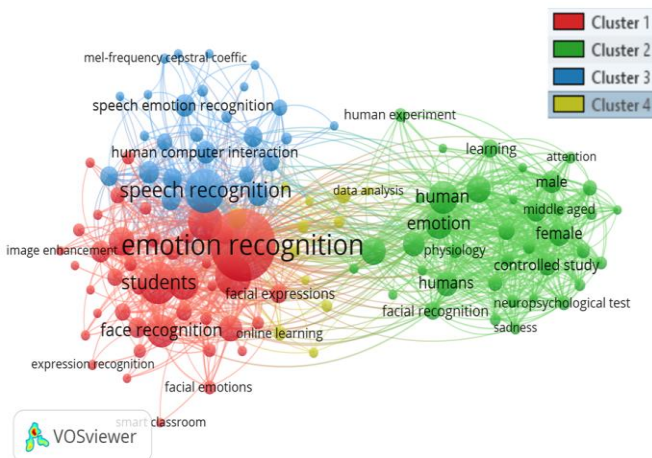


Figure 5. Keywords Co-occurrence Network

Cluster 1 (red) is correspondingly dominated by the categories “emotion recognition” and "student." Cluster 2 (green) and Cluster 3 (blue) comprise of numerous research areas, with the topics “emotion” and “speech recognition” being the major ones. Based on the VOSviewer visualization results in Figure 6, some study subjects in the fields of emotion identification, education, and student learning are still infrequently explored, including learning methodologies. The hue on the map in Figure 6 represents the density of study themes; blue indicates the lowest density, and yellow indicates the highest level.

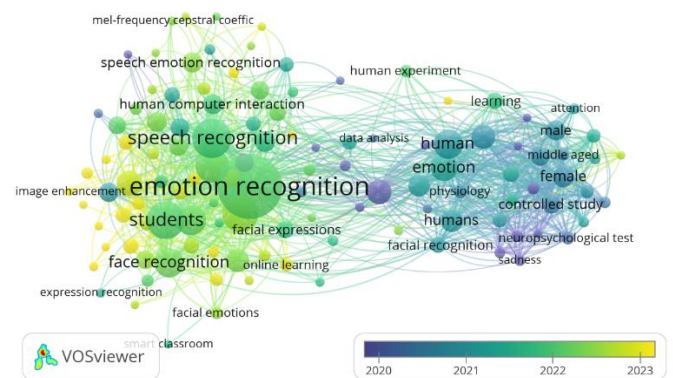


Figure 7. Top Keywords Visualization

Overall, of the keywords, the term “emotion recognition” was the most commonly found in the title and abstract, followed by the keywords “speech recognition” and "student," respectively, in Table 4. There is an indication that research related to emotion recognition, especially in the context of education and student learning, has started to gain more attention in recent years. This suggests a shift in research focus towards integrating emotion recognition technology in the learning process, which is expected to

enhance student learning outcomes and support more personalized and adaptive learning approaches (Bernard et al., 2017; Kshirsagar et al., 2022; Y. Zhang & Srivastava, 2022).

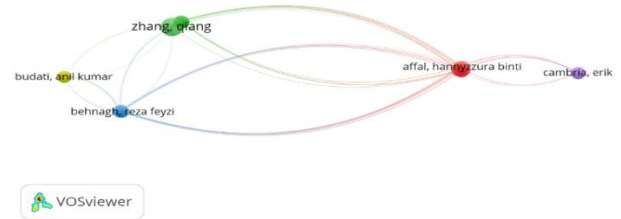


Table 4. TOP 11 terms in Emotion Recognition, Education, and Student Learning

Keyword	Occurrences
emotion recognition	169
speech recognition	70
students	66
deep learning	61
learning systems	55
e-learning	43
face recognition	41
human	41
emotion	36
education computing	33
education	31

c. Co-Authorship Analysis

Visualization analysis using VOSviewer Figure 8 demonstrates the interconnection and collaboration patterns among academics in the disciplines of emotion identification, education, and student learning who create scientific publications indexed by Scopus quartiles Q1–Q4. The data suggests that there are five researchers actively collaborating, creating a total of six scholarly articles over the past decade.

Zhang Qiang, from the Green Cluster, is the most productive author in this subject with two published documents, followed by Affal Hannyzzura Binti from the Red Cluster, who has one document but the highest amount of citations, totaling nine. Behnagh Reza Feyzi, from the Blue Cluster, also submitted one document that earned seven citations. Meanwhile, Budati Anil Kumar from the Yellow Cluster and Cambria Erik from the Purple Cluster each have one document with four and two citations, respectively.

Authors with the greatest nodes, such as Zhang Qiang and Affal Hannyzzura Binti, suggest strong links between authors and a significant number of scientific papers. The size of these nodes represents the number of scientific papers produced by each researcher.

The distribution of publisher nations also demonstrates a pattern of close links between publishing countries, with considerable contributions from certain major states. For instance, Zhang Qiang from China and Affal Hannyzzura Binti from Malaysia display excellent co-authorship relationships and high productivity in research on emotion perception, education, and student learning.

Figure 8. Network Visualization of Authors Collaborating to Emotion Recognition, Education, and Student Learning

A literature survey of recent publications supports these findings, indicating similar trends in increasing international collaboration and the significant impact of machine learning on mental health within the context of student learning (Nanath et al., 2022; Nash et al., 2023; R. Zhang, 2022). This research underlines the need of cross-disciplinary and cross-national collaboration in creating high-quality research focused on educational innovation and emotion recognition in student learning. The following table 5 highlights the contributions of the primary contributors in this analysis. These data imply that although the number of published documents is rather small, the impact of the citations received is fairly large, reflecting the quality of the study undertaken by these writers.

Table 5. Authors collaborating to Emotion Recognition, Education, and Student Learning

Author	Documents	Citations
Zhang, Qiang	2	6
Affal, Hannyzzura Binti	1	9
Behnagh, Reza Feyzi	1	7
Budati, Anil Kumar	1	4
Cambria, Erik	1	2

Based on visualization analysis with VOSviewer Figure 9, there are seven countries actively engaged in research in the fields of Emotion Recognition, Education, and Student Learning, producing scientific articles indexed by Scopus quartiles Q1-Q4. The analysis covers collaboration patterns and productivity over the past decade.

China emerges as the leading country in this domain, with a total of 78 documents, followed by India with 28 documents. The United States, Malaysia, the United Kingdom, Spain, and Turkey also contribute significantly with 21, 13, 12, 11, and 10 documents, respectively. These countries are divided into distinct clusters, indicating collaborative relationships within and across these regions.

China, which forms a significant cluster, has the most substantial node size, indicating a strong network of relationships among researchers and a high number of scientific publications. This dominance is further reflected in

“Research Trend and Impact on Student Learning Using Artificial Intelligence-Based Emotion Recognition: Systematic Bibliometric Analysis.”

the substantial number of citations received by Chinese publications.

Malaysia, despite having fewer documents (13), stands out with the highest number of citations, demonstrating the impactful nature of its research. Similarly, the United Kingdom, with only 12 documents, garners an impressive 435 citations, underscoring the high quality and influence of its publications in the field.

The United States, though producing 21 documents, has a relatively lower citation count of 1, which might indicate recent publications or niche topics with limited immediate impact. In contrast, Spain, with 11 documents, achieves a high citation count of 150, and Turkey, with 10 documents, receives 27 citations, reflecting moderate influence and engagement in the research community.

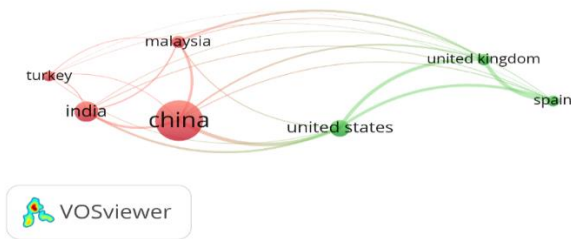


Figure 9. Network Visualization of Country Collaborating to Emotion Recognition, Education, and Student Learning

The distribution of publisher nations and the pattern of relationships between these countries emphasize the collaborative nature of research in emotion recognition, education, and student learning. The graphic underlines the relevance of worldwide collaboration in furthering research and addressing complex issues connected to mental health and student learning through the application of machine learning techniques. The following table 6 summarizes the main countries' contributions to this analysis. These data suggest that while the number of documents varies across nations, the impact as assessed by citations is large for countries like Malaysia and the United Kingdom, reflecting the high quality and relevance of their research in the worldwide academic community.

Table 6. Country collaborating to Emotion Recognition, Education, and Student Learning

Country	Documents	Citations
China	78	51
India	28	32
United States	21	1
Malaysia	13	112
United Kingdom	12	435
Spain	11	150
Turkey	10	27

CONCLUSIONS

The bibliometric analysis reveals a distinct upward trend in the number of publications on artificial intelligence-based emotion recognition in education, indicating growing interest and investment in this research area. The preponderance of Q1 and Q2 quartile publications shows the high quality and significance of the research being undertaken. Leading articles' strong citation counts indicate the crucial contributions of individual studies to the discipline. The examination of top journals and publishers provides insights into where the most influential research is being published, which can aid researchers in directing their submissions. The co-occurrence analysis of keywords offers an insight into the prominent themes and trends in this domain, revealing a considerable concentration on artificial intelligence and machine learning applications in educational contexts.

The impact of the bibliometric analysis undertaken in this work can be viewed from different perspectives: academic, practical, and policy-related. Here are the detailed impacts:

- The growth in publications in Q1 and Q2 journals suggests an increase in the quality of research in this discipline. This stimulates researchers to conduct more in-depth and high-quality studies.
- The provided data helps academics evaluate patterns in artificial intelligence-based emotion recognition in education, which may be utilized to steer future research directions.
- Researchers may identify which journals and publishers are most prominent in this discipline, which helps them find the best channels for their study.
- These findings can promote the development of more advanced and effective learning technologies, such as artificial intelligence-based emotion detection systems that help detect and respond to students' emotional needs in real-time.
- Implementing such technology can assist instructors and educators build more responsive and supportive learning environments, ultimately boosting the quality of education and student learning results.
- Data on author and research collaborations can stimulate greater international and interdisciplinary collaborations, potentially leading to new innovations and solutions in education.
- These findings provide vital data for educational policymakers about trends and needs in the development of educational technologies. This can aid in establishing policies that support research and the deployment of new technology in schools.
- Information on the most cited journals and papers might help funding agencies choose areas that need more support for research funding.
- The results of this investigation can serve as a foundation for building more data-driven educational

policies that include kids' emotional needs and their impact on learning outcomes.

Overall, our bibliometric analysis has major implications for enhancing academic, practical, and policy-related elements of artificial intelligence-based emotion recognition in education. By recognizing trends and major contributions in this subject, researchers, practitioners, and policymakers may work together to develop a more flexible and supportive learning environment, thereby boosting the overall quality of education.

Future research directions could study the practical deployment of emotion detection systems in varied educational environments, the ethical implications of deploying such technology, and the long-term impacts on student learning and well-being. As the area continues to evolve, regular bibliometric assessments will be vital in tracking its progress and detecting emerging trends and key contributors.

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