



Research trend of emotional intelligence in biology learning: A bibliometric analysis in the last ten year

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Abstract. Research that explicitly examines emotional intelligence (EI) in biology learning is still limited, even though extensive evidence shows that EI supports motivation, interaction quality, and learning effectiveness, which are relevant competencies in collaborative tasks and complex biology practicums. This study analyzes research trends and opportunities related to emotional intelligence in biology learning (EIBL) through a bibliometric approach. A literature-based bibliometric analysis was conducted using 339 screened documents retrieved from the ScienceDirect (2015-2024), and the dataset was visualized using VOSviewer to map publication distribution, subject areas, publisher sources, and keyword networks. The findings indicate an increasing number of publications, dominance of empirical studies, and multidisciplinary dissemination across psychology, education, biomedicine, and social sciences. Network visualization identified five thematic clusters (research challenges, methodological approaches, educational contexts, emotional-systemic aspects, and developmental issues) reflecting broader patterns in the dataset rather than trends specific to biology learning. Overall, the dataset suggests emerging opportunities for integrating emotional intelligence into biology learning practices, while highlighting the limited number of studies explicitly situated in biology education and the need for further empirical exploration.

Abstrak. Penelitian yang secara eksplisit mengkaji kecerdasan emosional (EI) dalam pembelajaran biologi masih terbatas, meskipun bukti luas menunjukkan bahwa EI mendukung motivasi, kualitas interaksi, dan efektivitas belajar, yaitu kompetensi penting dalam tugas kolaboratif dan praktikum biologi yang kompleks. Penelitian ini menganalisis tren dan peluang penelitian emotional intelligence in biology learning (EIBL) melalui pendekatan bibliometrik. Analisis bibliometrik berbasis literatur dilakukan menggunakan 339 dokumen hasil penyaringan dari ScienceDirect (2015-2024), dan dataset ini divisualisasikan menggunakan VOSviewer untuk memetakan sebaran publikasi, subject area, sumber penerbit, serta jejaring kata kunci. Hasil analisis menunjukkan peningkatan jumlah publikasi, dominasi artikel empiris, dan penyebaran multidisipliner pada bidang psikologi, pendidikan, biomedis, dan ilmu sosial. Visualisasi jaringan mengidentifikasi lima kluster tema (tantangan penelitian, pendekatan metodologis, konteks pendidikan, aspek emosional-sistemik, dan isu perkembangan) yang mencerminkan pola umum dalam dataset, bukan tren spesifik pembelajaran biologi. Secara keseluruhan, dataset menunjukkan peluang berkembangnya integrasi kecerdasan emosional dalam praktik pembelajaran biologi, sekaligus menegaskan terbatasnya studi yang secara eksplisit berada dalam konteks biologi serta kebutuhan eksplorasi empiris lanjutan.

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Introduction

Emotional intelligence (EI) in biology learning has received limited specific attention in existing literature, resulting in students potentially missing opportunities to develop important interpersonal and self-regulation skills. Learning research tends to emphasize cognitive aspects (Yang et al., 2020; Srimaharaj et al., 2020), while the affective dimension, particularly emotion management that supports understanding and motivation remains underexplored in the context of biology education. Without the integration of EI, students may be less able to interact effectively in collaborative work (Fernandez-Perez & Martin-Rojas, 2022; Törmänen et al., 2022). In addition, a lack of emotional preparation can hinder students' readiness to navigate complex laboratory or field-based situations, limiting the balance between scientific knowledge and essential social competencies.

Research related to EI more broadly shows that strengthening emotional skills in students and educators has significant implications for learning effectiveness and motivation. Napolitano et al. (2023) reported that learning strategies designed to enhance EI in nursing students can improve the quality of patient care. In educational settings, EI has been found to correlate negatively with internet addiction, where higher EI combined with mobile learning can reduce such tendencies (Baghcheghi & Koohestani, 2022). Interactive learning environments are also more effective than static ones in increasing EI among music education students (Liang, 2024). Although these studies do not specifically involve biology learning, they highlight the broad relevance of EI in supporting learning processes, suggesting potential benefits if integrated into biology education.

Other studies emphasize the role of EI in leadership and organizational learning (Kaur & Hirudayaraj, 2021). During the COVID-19 pandemic, EI enhancement programs were found to increase student motivation and academic achievement (Tang & He, 2023), and teachers' EI played an important role in strengthening students' motivation to learn. Additionally, EI has been associated with improved achievement in English learning (Hasibuan & Irwandi, 2024). Collectively, this evidence underscores the importance of EI in educational contexts, yet it also indicates that its application in domain-specific learning such as biology remains insufficiently examined.

Based on previous research, EI has been studied from various educational perspectives, but explicit investigations of EI within biology learning are still scarce. This gap highlights the need to map and understand the extent to which EI-related studies intersect with biology education. Bibliometric analysis offers a systematic approach to exploring publication patterns, collaboration networks, topic development trajectories, and frequently used keywords. This method enables researchers to identify areas where EI research connects or fails to connect with biology learning, thereby revealing opportunities for more targeted investigations.

Bibliometric studies in biology education have shown trends dominated by the development of interactive media and digital learning tools. For example, Wilsa et al. (2023) found that interactive technology improves learning outcomes; Hizqiyah et al. (2023) reported that digital modules support critical-thinking skills and independent learning; and Kusmahardhika et al. (2024) together with Yuliani et al. (2022) showed that multimedia and Android-based applications help simplify complex biological concepts. However, these studies focus primarily on technological innovation rather than the emotional or socio-affective aspects of student learning.

Based on these trends, it appears that research in biology education has largely emphasized designing and improving learning environments through technology. Far fewer studies have examined how students' emotional intelligence influences their interactions, engagement, and responses within biology learning contexts. Emotional intelligence components such as self-control, empathy, and motivation are crucial because they may shape how students interact with learning media and process biological content. Therefore, this study aims to analyze trends and opportunities for research on emotional intelligence in biology learning through a bibliometric analysis, positioning EI as an important yet underexplored factor in biology education.

Research Methods

The type of research that is suitable for the research objectives is bibliometric analysis. Bibliometric analysis is used to examine research trends and opportunities on a topic by utilizing scientific publication databases as data sources. The research data was collected from the ScienceDirect platform, which functions as a publisher database rather than a citation index, and therefore the retrieved documents may include materials from various disciplines beyond biology education. The data were collected in October 2025 using a combination of the keywords "emotional intelligence," "biology," and "learning," with the acknowledgment that this keyword set may capture cross-disciplinary articles within the last ten years (2015-2024). After applying these search parameters, a total of 339 documents were retrieved and subsequently screened for relevance. The screened dataset was then exported for further visualization using VOSviewer version 1.6.20. Details of the visualization settings can be seen in Table 1.

Table 1 Details of Network Visualization Settings for Creating Maps with VOSviewer

Stages	Setting
Choose type of data	Create a map base on text data
Choose data source	Read data from reference manager files
Choose fields	Fields from which terms will be extracted: Title and abstract fields; Ignore structured abstract labels; Ignore copyright statements
Choose counting method	Full counting
Choose threshold	Minimum number of occurrences of a term: 10 of 5883 terms, with 132 terms meeting the threshold
Choose number of terms	132 selected terms

Based on the visualization results, research trends and opportunities were analyzed descriptively according to cluster color patterns and year colors. Supporting data such as document distribution based on publication year, subject area, and publisher source were analyzed descriptively. In addition, the ten most-relevant documents within the dataset were identified for further content-based examination to understand influential themes, while recognizing that these influential works may not necessarily originate from biology education. This step was conducted to provide deeper insight into research developments related to emotional intelligence across the broader dataset and to identify implications for the context of biology learning.

Results and Discussion

The review of 339 documents revealed several data points that illustrate research patterns within the broader dataset retrieved using the keywords “emotional intelligence,” “biology,” and “learning,” rather than trends that exclusively represent EIBL. These patterns can be identified from the dynamics of annual publication counts, document types, publisher sources, subject-area distributions, and keyword co-occurrence networks. Based on Figure 1, the number of publications shows an upward trend over the past decade, despite fluctuations. After reaching around 30 documents in 2015–2016, the number declined in 2017, then rose steadily to its first peak in 2021. The decline in 2022 was temporary, followed by strong growth in 2023 and the highest value in 2024. This pattern reflects increasing attention within the broader EI-related literature captured by the dataset, even though these publications do not necessarily focus on biology learning.

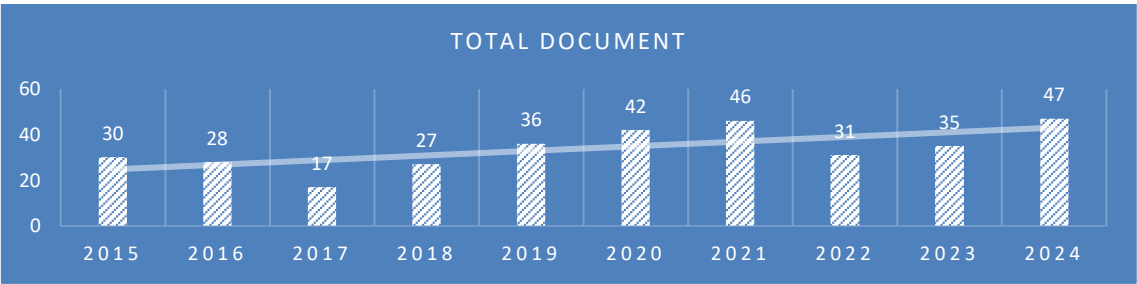


Figure 1 Dynamics of the number of documents per year

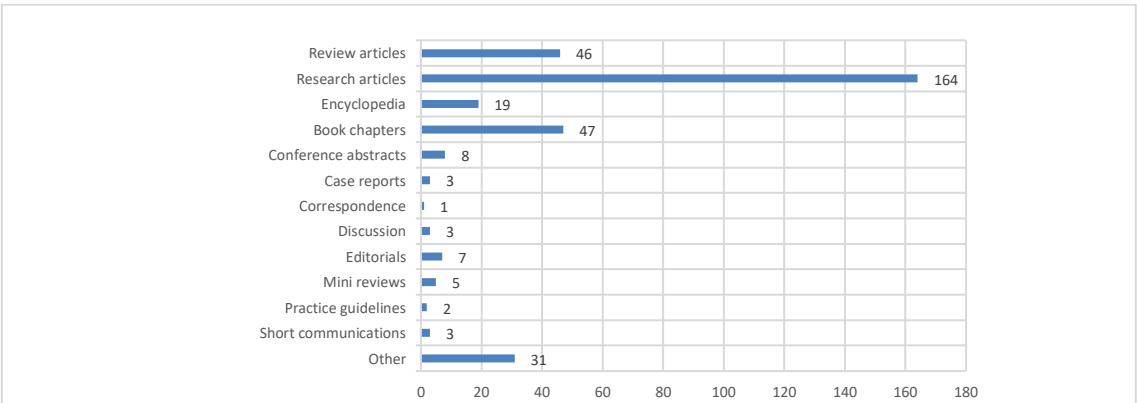


Figure 2 Distribution of document types

According to previous research, the number of documents indicates the degree of scholarly attention given to a topic (Fajeriadi et al., 2024). In Indonesia, EI-related studies in biology contexts have been conducted for several purposes, including its correlation with learning motivation which influences higher-order thinking skills (Misliyanti et al., 2024) its impact on biology learning outcomes through targeted learning strategies (Pratama & Corebima, 2016), and its moderate relationship with students' self-regulated learning (Mustofa et al., 2022). Although these studies situate EI within biology learning more explicitly than most documents in the dataset, they remain limited in number, reinforcing the gap identified in this work.

Figure 2 shows that research articles are the most dominant type of publication, with far higher counts than other categories. This indicates that empirical studies constitute the main body of work within the retrieved dataset, whereas book chapters and review articles appear in smaller numbers. Because the dataset is multidisciplinary, the dominance of research articles should be interpreted as a general trend in EI-related literature rather than specific evidence of empirical growth in EIBL. Similar bibliometric work by Gurung et al. (2022) systematically assessed EI-related research across health, self-management, and emotional intelligence domains, providing insights into available information sources. More recently, Ojha et al. (2024) discussed the integration of artificial intelligence with EI in higher education institutions, further emphasizing the breadth of fields intersecting with EI research.

Table 2 Top Ten Publication Title

No.	Publication title	Total
1.	Procedia Computer Science	9
2.	American Journal of Pharmaceutical Education	9
3.	Thinking Skills and Creativity	6
4.	Neuroscience & Biobehavioral Reviews	5
5.	Biological Psychiatry	5
6.	The Leadership Quarterly	5
7.	International Journal of Radiation Oncology*Biology*Physics	4
8.	Teaching and Teacher Education	4
9.	Nurse Education Today	4
10.	International Encyclopedia of the Social & Behavioral Sciences (Second Edition), 2015	4
11.	Learned Mindfulness, 2019	4
12.	Computers in Biology and Medicine	3
13.	Schizophrenia Research	3
14.	Technological Forecasting and Social Change	3
15.	Personality and Individual Differences	3
16.	Journal of Professional Nursing	3
17.	Educational Research Review	3
18.	Success Strategies from Women in STEM (Second Edition), 2015	3
19.	Encyclopedia of Mental Health (Second Edition), 2016	3
20.	Intelligence Science, 2021	3
21.	Executive Brain Vitality, 2024	3
22.	International Journal of Manpower	3
23.	Psychoneuroendocrinology	2
24.	Future Generation Computer Systems	2
25.	Journal of Cleaner Production	2

Table 3 Subject Area Distribution

No.	Subject areas	Total
1.	Psychology	88
2.	Medicine and dentistry	87
3.	Social sciences	84
4.	Computer science	47
5.	Neuroscience	44
6.	Business, management and accounting	44
7.	Nursing and health professions	21
8.	Biochemistry, genetics and molecular biology	18
9.	Agricultural and biological sciences	18
10.	Engineering	12

Table 2 shows that publications within the dataset are distributed across diverse journals and scientific outlets, with *Procedia Computer Science* and the *American Journal of Pharmaceutical Education* appearing most frequently. This distribution demonstrates that the retrieved publications span multiple disciplines including computer science, pharmacy education, psychology, and biomedical sciences rather than indicating concentrated attention to EI in biology learning.

Table 3 shows that psychology, medicine and dentistry, and social sciences represent the most common subject areas, followed by computer science and neuroscience. These subject areas align with research emphasizing mental processes, behavioral patterns, health-related outcomes, and social interactions. Meanwhile, fields directly related to biology education such as agricultural and biological sciences appear relatively minimally, reinforcing that explicit EIBL research remains limited within the dataset. Manjarres et al. (2023), for example, identified foundational EI works such as Salovey and Mayer (1990) as “root” knowledge sources, underscoring the psychological origins of EI concepts.

To complement the analysis of publication sources and subject areas, the ten most relevant and influential documents within the dataset were further examined to identify their main research gaps, methodological trends, and key findings. This content-level inspection provides additional insight into how various studies approach issues related to EI, learning processes, and educational practices across different disciplines. The summary of these documents is presented in Table 4.

Table 4 Top Ten Most-Relevant Documents

Authors (Year)	Research Gap	Method	Findings
Lei (2024)	Limited understanding of factors influencing digital readiness among health students.	Quantitative survey.	Readiness shaped by ICT competence and institutional support.
Li et al. (2021)	Effectiveness of interprofessional learning strategies remains unclear.	Mixed methods.	Collaborative learning improves communication and clinical teamwork.
Tsarkov et al. (2021)	Insufficient evidence on the impact of simulation on clinical judgment.	Experimental design.	Simulation boosts clinical decision-making and confidence.
Samsonovich & Eidlin (2021)	Lack of evidence on competency-based curriculum adaptation processes.	Qualitative case study.	Effective when supported by training, management, and regular evaluation.
Egger et al. (2019)	Limited explanation of barriers to mobile learning in health education.	Quantitative survey.	Main barriers: connectivity, low digital skills, and motivation issues.
Jose et al. (2020)	Minimal exploration of students' experiences in telehealth education.	Qualitative interviews.	Telehealth strengthens remote communication and digital literacy.
Abdellaoui et al. (2024)	Few studies link emotional intelligence, mobile learning tendency, and Internet addiction.	Correlational quantitative study.	EI reduces addiction risk; mobile learning tendency plays a moderating role.
Longhini et al. (2024)	Limited insight into how students learn to care for families/caregivers.	Grounded theory.	Learning occurs through observation, direct interaction, and reflection.
Tavakoli et al. (2024)	Lack of evaluation on OSCE effectiveness for clinical competence.	Quantitative evaluation.	OSCE enhances procedural skills and clinical preparedness.
Saifi et al. (2024)	Insufficient studies on factors affecting students' satisfaction with e-learning.	Descriptive survey.	Satisfaction driven by material quality, accessibility, and instructor interaction.

The patterns in Table 4 show that the highly cited and methodologically diverse studies rarely address biology learning directly, but they consistently highlight the importance of emotional, psychological, instructional, and technological factors in shaping learning outcomes. These cross-disciplinary findings reinforce the earlier observation that explicit research on EIBL remains limited, while at the same time suggesting potential directions for future empirical work in biology education.

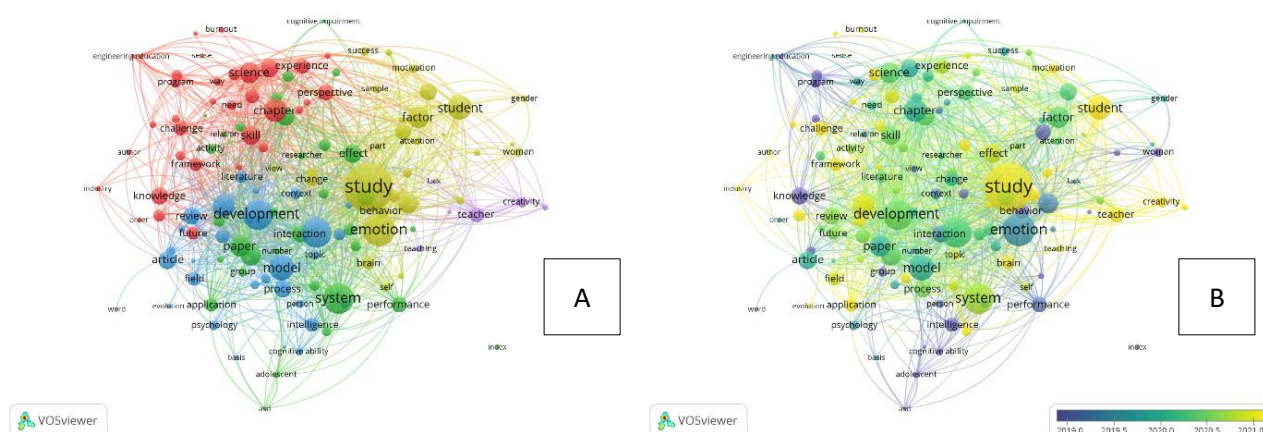


Figure 3 Visualization results (A) co-occurrence, and (B) overlay

Based on bibliometric visualization using VOSviewer, Figure 3(A) shows several interconnected keyword clusters representing the thematic landscape of the dataset. The red cluster includes keywords such as research, paper, challenge, and review, indicating a strong emphasis on conceptual discourse and research synthesis across EI-related studies. The green cluster includes study, approach, experience, and role, reflecting methodological discussions and experiential factors. The yellow cluster highlights education, teacher, student, and creativity, pointing to educational settings where EI is examined although not necessarily biology education. The blue cluster includes emotion, effect, interaction, and system, illustrating psychological and systemic perspectives. The purple cluster contains ASD and adolescent, showing developmental themes such as autism and adolescence. Taken together, these clusters show that the dataset captures a broad multidisciplinary landscape rather than a focused map of EIBL research.

The overlay visualization in Figure 3(B) depicts temporal development using color gradients representing publication years. Bright yellow keywords such as creativity, teacher, and student correspond to recent research (around 2022), showing increasing attention to educational innovation. Keywords in green to blue such as emotion, system, and technology represent themes that grew around 2020-2021. Darker blue terms like cognitive impairment, ASD, and adolescent correspond to earlier research. These shifts illustrate thematic evolution in the overall EI domain, not specifically within biology learning.

Based on the visualization analysis, the dataset indicates that EI-related research has evolved from psychologically oriented themes toward more education-centered topics over time. The keyword clusters reflect major themes such as research challenges, methodological approaches, teacher-student dynamics, creativity in learning, and developmental issues. When viewed temporally, early topics centered on individual development before shifting toward themes involving emotion, systems, technology, and more recently, educational creativity and experiences. However, because the dataset is multidisciplinary, these findings cannot be interpreted as direct evidence of trends within EIBL. Instead, they point to a broader research landscape in which biology education remains underrepresented. This gap highlights opportunities for future studies to explicitly integrate EI components such as self-regulation, empathy, and motivation into biology learning frameworks and empirical interventions.

Conclusion

Bibliometric results from the 339 retrieved documents indicate broader trends within emotional intelligence research captured by the keyword-based dataset, rather than direct evidence of EIBL. The thematic patterns identified spanning psychology, education, biomedicine, technology, and developmental studies form multidisciplinary clusters that have evolved temporally from psychologically oriented themes to more recent educational applications. These findings suggest that while EI-related research continues to grow, explicit studies situated within biology learning remain limited in number within the dataset. Accordingly, the results highlight opportunities rather than established trends for integrating emotional aspects into biology learning practices. The presence of educational, affective, and interaction-focused themes in the broader EI literature points to potential directions for future work, especially in exploring how emotional intelligence can shape students' engagement, collaboration, and learning processes in biology contexts. This study has limitations because it relies on a single publisher database (ScienceDirect), which does not function as a comprehensive citation index, does not evaluate the methodological rigor of the included studies, and does not assess the direct applicability of the findings to classroom-based biology learning. Therefore, further research is recommended

to expand data sources using citation indexes, conduct methodological quality assessments, and develop empirical studies or instructional interventions that explicitly examine emotional intelligence within biology learning settings, so that insights from this bibliometric analysis can be translated into more targeted and effective educational practices.

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