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REVIEW

Trends in Promoting Cultural Awareness in Biology Education: A Comprehensive Bibliometric Mapping Analysis

Tendencias en la Promoción de la Conciencia Cultural en la Educación Biológica: Un Análisis Bibliométrico Integral

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ABSTRACT

Introduction: biology education is essential in enhancing students' cultural awareness by integrating local wisdom. However, does the reality align with these expectations? Therefore, this bibliometric analysis is conducted as an initial step to address the following questions: 1) Mapping the trends in cultural awareness studies within biology education. 2) Identifying research gaps in cultural awareness studies within biology education. 3) Proposing alternative solutions to bridge these gaps.
Method: this study employs a bibliometric approach. Data were obtained from the Scopus database using the following keywords: TITLE-ABS-KEY ("cultural sensitivity" OR "cultural awareness" OR "cultural competence" OR "intercultural understanding" OR "cultural intelligence" OR "cultural appreciation" OR "cross-cultural knowledge" OR "intercultural awareness" OR "global awareness" OR "diversity awareness") AND TITLE-ABS-KEY (biology) AND TITLE-ABS-KEY (education OR learning). Data analysis was conducted using VOSviewer and Microsoft Excel.
Results: a total of 32 scientific publications were recorded from 2003 to March 2025, with an average of two publications per year. The most frequently occurring keyword is evolution, appearing seven times, while the strongest linked keyword is cultural competence, with a total link strength of 192.
Conclusions: the trends in cultural awareness studies within biology education remains very low and stagnant. There is a notable gap in ethnobiology education, which should play a crucial role in promoting students' cultural awareness but is rarely studied. The proposed solution is to expand the ethnobiology education approach beyond an intradisciplinary ecological perspective to include an interdisciplinary social approach, thereby enhancing students' cultural awareness.

Keywords: Cultural Awareness; Education; Biology; Bibliometric Mapping Analysis.

RESUMEN

Introducción: resumen estructurado en: La educación en biología es fundamental para mejorar la conciencia cultural de los estudiantes mediante la integración de la sabiduría local. Sin embargo, ¿la realidad se alinea con

estas expectativas? Por lo tanto, este análisis bibliométrico se lleva a cabo como un paso inicial para abordar las siguientes cuestiones: 1) Mapear las tendencias en los estudios sobre conciencia cultural en la educación en biología. 2) Identificar las brechas de investigación en los estudios sobre conciencia cultural en la educación en biología. 3) Proponer soluciones alternativas para cerrar estas brechas.
Método: este estudio emplea un enfoque bibliométrico. Los datos fueron obtenidos de la base de datos Scopus utilizando las siguientes palabras clave: TITLE-ABS-KEY ("cultural sensitivity" OR "cultural awareness" OR "cultural competence" OR "intercultural understanding" OR "cultural intelligence" OR "cultural appreciation" OR "cross-cultural knowledge" OR "intercultural awareness" OR "global awareness" OR "diversity awareness") AND TITLE-ABS-KEY (biology) AND TITLE-ABS-KEY (education OR learning). El análisis de datos se realizó utilizando VOSviewer y Microsoft Excel.
Resultados: se registró un total de 32 publicaciones científicas desde 2003 hasta marzo de 2025, con un promedio de dos publicaciones por año. La palabra clave más frecuente es "evolution", que aparece siete veces, mientras que la palabra clave con el vínculo más fuerte es "cultural competence", con una fuerza de enlace total de 192.
Conclusiones: las tendencias en los estudios sobre conciencia cultural en la educación en biología siguen siendo muy bajas y estancadas. Existe una brecha notable en la educación en etnobiología, que debería desempeñar un papel crucial en la promoción de la conciencia cultural de los estudiantes, pero que rara vez se estudia. La solución propuesta es ampliar el enfoque de la educación en etnobiología más allá de una perspectiva ecológica intradisciplinaria para incluir un enfoque social interdisciplinario, mejorando así la conciencia cultural de los estudiantes.

Palabras clave: Conciencia Cultural; Educación; Biología; Análisis de Mapeo Bibliométrico.

INTRODUCTION

Cultural awareness plays a crucial role in shaping students' character, making them more open-minded, tolerant, and capable of interacting with diverse social groups.[1,2,3] In an increasingly diverse environment, understanding cultural differences helps students avoid prejudice and fosters mutual respect. Additionally, cultural awareness encourages them to appreciate their own cultural heritage while also recognizing the values of other cultures.[4] As a result, they can develop stronger social skills, such as effective communication and empathy when engaging with individuals from different backgrounds. Education that instills cultural awareness not only prepares students for life at the local level but also equips them with a global perspective that is valuable for their future careers and social interactions.[5]

Biology education plays a crucial role in enhancing students' cultural awareness by teaching the interconnections between living organisms, the environment, and local wisdom within society.[6,7] Through biology learning, students can understand how a community's culture develops based on its surrounding ecological conditions.[8] Examples include the use of plants in traditional rituals, medicinal plant applications, and environmentally friendly agricultural practices. Moreover, biology helps uncover cultural values related to the sustainable use of natural resources, fostering students' appreciation for and preservation of their ancestral heritage.[9] Thus, biology education not only provides scientific knowledge but also instills a sense of environmental and cultural responsibility in daily life.

Integrating cultural awareness into biology education is essential for fostering a more inclusive, relevant, and globally conscious learning experience, particularly when aligned with international educational frameworks such as UNESCO's Sustainable Development Goals (SDGs).[3] By acknowledging and incorporating diverse cultural perspectives—especially Indigenous knowledge systems and local ecological practices—biology education can move beyond a purely scientific lens to one that emphasizes sustainability, equity, and respect for biodiversity. For example, teaching about ecosystems can be enriched by exploring traditional land management techniques or local medicinal plant knowledge, which supports SDG 4 (Quality Education) and SDG 15 (Life on Land). This approach not only enhances students' understanding of biological concepts but also cultivates global citizenship, encouraging learners to appreciate the interconnectedness of human cultures and the natural world. Ultimately, embedding cultural awareness in biology classrooms empowers students to become more thoughtful stewards of the environment while promoting social inclusion and interdisciplinary thinking across global contexts.[9]

Ethnobiology is the interdisciplinary study of the relationships between people and the biological world, particularly how different cultures understand, use, and manage plants, animals, and ecosystems.[8] It explores traditional ecological knowledge, including how communities classify natural resources, develop medicinal practices, engage in agriculture, and sustain biodiversity through cultural practices. Ethnobiology draws from fields such as anthropology, botany, zoology, ecology, and linguistics to examine how biological knowledge

is embedded in cultural traditions and how it evolves over time. This field is vital for preserving Indigenous knowledge systems, supporting conservation efforts, and promoting sustainable development by integrating local wisdom with scientific understanding.[29]

Ethnobiology plays a crucial role in promoting cultural awareness by highlighting the deep connections between traditional knowledge systems and the natural environment.[29] Through the study of how different communities interact with plants, animals, and ecosystems, ethnobiology reveals the cultural significance of biodiversity and the ways in which local practices contribute to sustainable living. This understanding fosters respect for diverse worldviews and values, encouraging a more inclusive approach to science and conservation. By acknowledging the wisdom embedded in Indigenous and local traditions, ethnobiology supports the preservation of cultural heritage while enhancing our collective ability to address environmental challenges. Ultimately, it bridges scientific and cultural perspectives, promoting mutual understanding and global awareness in both education and policy-making.[30]

However, does the reality align with expectations? To what extent has cultural awareness been accommodated in biology education? Therefore, this bibliometric analysis is conducted as an initial step to address these questions. Specifically, this bibliometric analysis aims to:

1. Map the trends in studies on cultural awareness in biology education.
2. Identify gaps in research on cultural awareness in biology education.
3. Propose alternative solutions to bridge these gaps.

METHOD

Data Search Strategy

This study employed a bibliometric approach to analyse scientific publications related to cultural awareness in biology education. The PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram was adopted to guide the data search strategy (figure 1). Scientific publication data were retrieved from the Scopus database. Scopus was selected due to its extensive coverage of high-quality, peer-reviewed journals, making it suitable for credible academic research.[10,11] The Scopus database offers significant advantages for bibliometric analysis due to its comprehensive coverage, high-quality indexing, and advanced analytical tools. As one of the largest abstract and citation databases of peer-reviewed literature, Scopus includes a vast range of disciplines, ensuring researchers have access to diverse and multidisciplinary sources. Its robust citation tracking capabilities enable detailed analysis of research impact, collaboration networks, and publication trends over time. Additionally, Scopus provides reliable author profiles and institutional affiliations, which help ensure accurate data for performance assessment and mapping scholarly influence. The user-friendly interface and integration with various research tools further enhance its utility, making Scopus a valuable resource for conducting in-depth, data-driven bibliometric studies across academic fields.[11] Moreover, its citation analysis features allow researchers to track scholarly developments and assess the impact of scientific work. The data sources, keywords, filters, and data formats used are detailed in table 1.

Table 1. Summary of data search strategies

Category	Inclusion criteria
Database	Scopus
Search query	(TITLE-ABS-KEY (“cultural sensitivity” OR “cultural awareness” OR “cultural competence” OR “intercultural understanding” OR “cultural intelligence” OR “cultural appreciation” OR “cross-cultural knowledge” OR “intercultural awareness” OR “global awareness” OR “diversity awareness”) AND TITLE-ABS-KEY (biology) AND TITLE-ABS-KEY (education OR learning))
Time span	From inception-March 2025
Documents type	All document type
Subject area	All subject area
Data export format	comma separated values (CSV).

Analysis Parameters

Data analysis was conducted based on several parameters, including the number of scientific publications per year, the most productive sources, the most prolific authors, the most productive affiliations, the most productive countries, the most influential documents, and the most popular keywords.

Analysis Tools

The software used for data processing and analysis includes VOSviewer and Microsoft Excel. VOSviewer was chosen for its advantages in interactive bibliometric visualization and analysis, supporting various types

of network analysis, user-friendly interface, and free accessibility.[12,13] VOSviewer is utilized to identify trends and patterns in scientific publications. Meanwhile, Microsoft Excel is used to process and present data in tables and graphs.

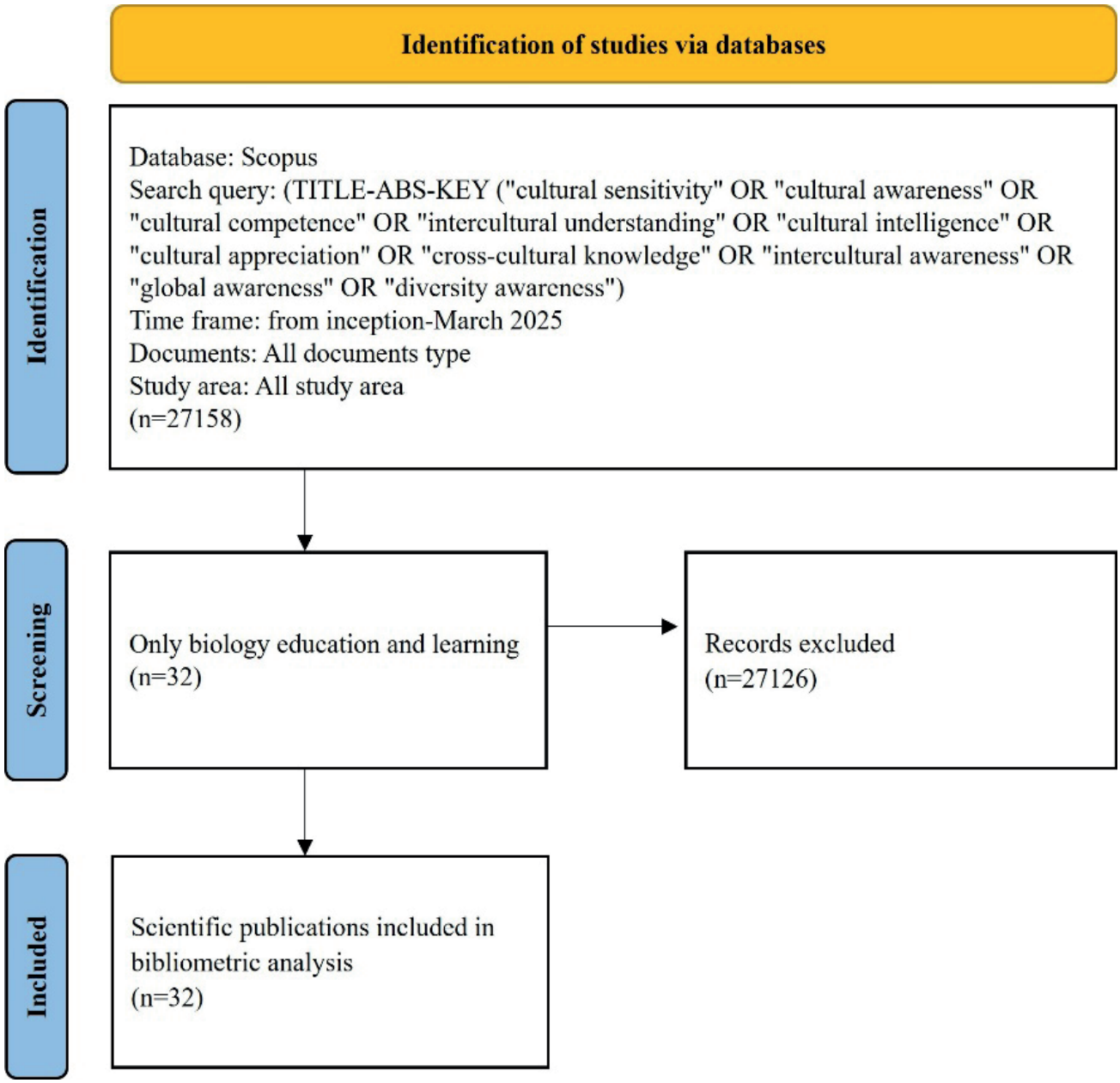

Figure 1. PRISMA flow diagram on the identification and screening of scientific publications. Modification from PRISMA Statement 2020

RESULTS

Annual Trends in Scientific Publications

Based on keyword searches in the Scopus database, a total of 32 scientific publications related to cultural awareness in biology education were identified (figure 2). The first publication on this topic appeared in 2003. From 2003 to March 2025, the number of scientific publications on cultural awareness in biology education has fluctuated but remained relatively stagnant, averaging two documents per year. The highest number of publications was recorded in 2022, with a total of five documents.

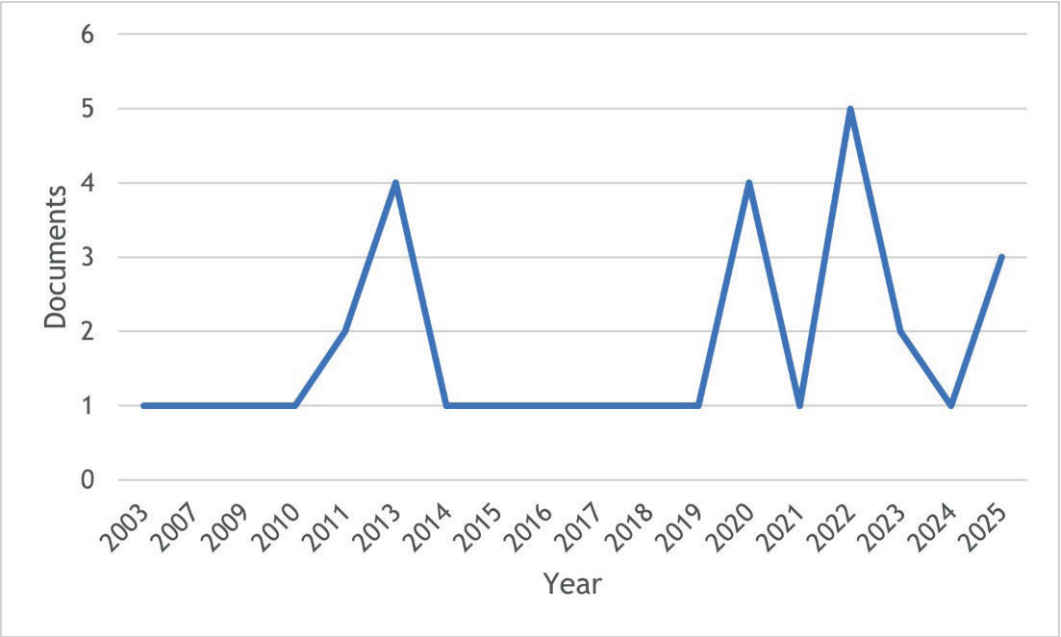

Figure 2. Trends in scientific publications related to cultural awareness in biology education per year

Most Productive Sources

The ten most productive scientific publication sources related to cultural awareness in biology education are presented in figure 3. *Journal of Microbiology and Biology Education* ranks first with a total of three documents, accounting for 21,43 %. *International Journal of Sustainability Education* and *CBE—Life Sciences Education* rank second and third, each contributing two documents (14,29 %). The remaining sources each have only one document (7,14 %). In terms of document types, articles hold the highest percentage at 75 %, followed by book chapters (9,4 %), reviews (9,4 %), and conference papers (6,3 %).

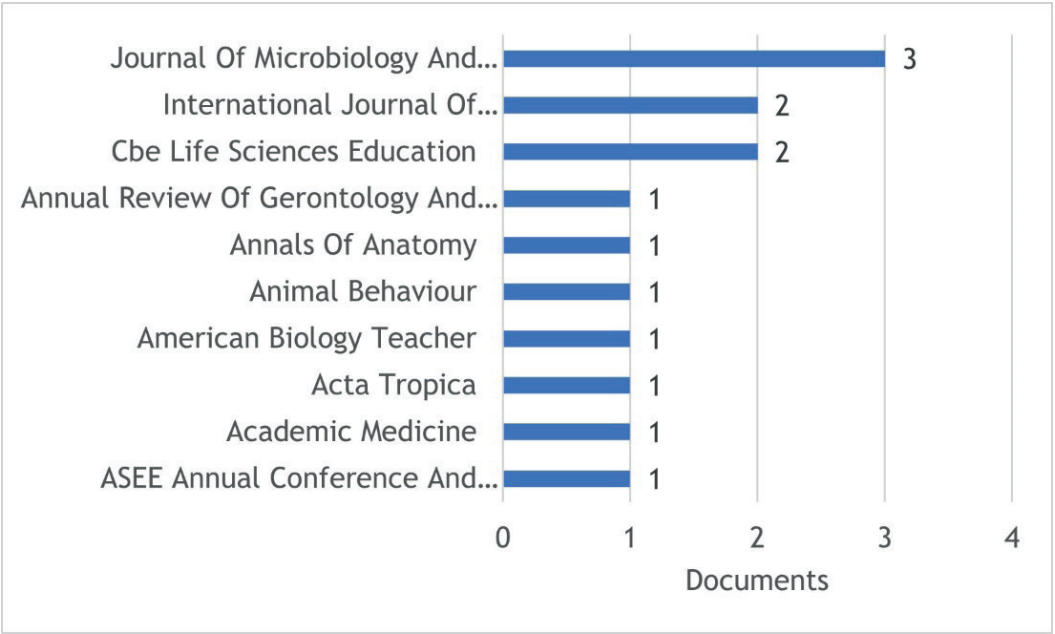

Figure 3. The ten most productive sources of scientific publications related to cultural awareness in biology education

Most Productive Authors

The ten most productive authors in scientific publications related to cultural awareness in biology education are shown in figure 4. Brownell, S.E. ranks first with a total of four documents, accounting for 26,67 %. Barnes, M.E. follows in second place with three documents (20 %). The remaining authors have each contributed one document (6,67 %).

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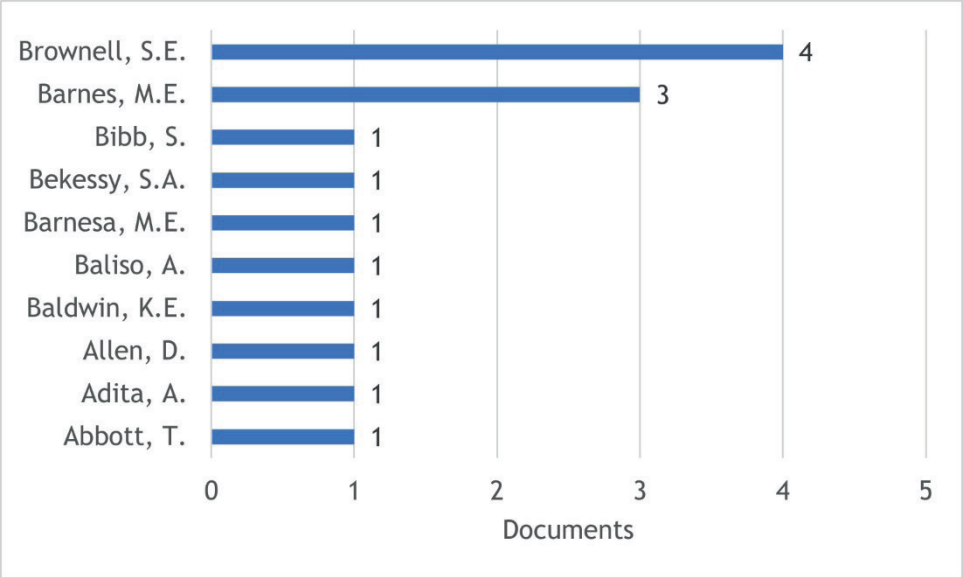

Figure 4. The ten most productive authors in scientific publications related to cultural awareness in biology education

Most Productive Affiliations

The ten most productive affiliations in scientific publications related to cultural awareness in biology education are shown in figure 5. Arizona State University and the School of Life Sciences rank first, each contributing four documents (23,53 %). Virginia Polytechnic Institute and State University ranks third with two documents (11,76 %). The remaining affiliations each contributed one document (5,88 %).

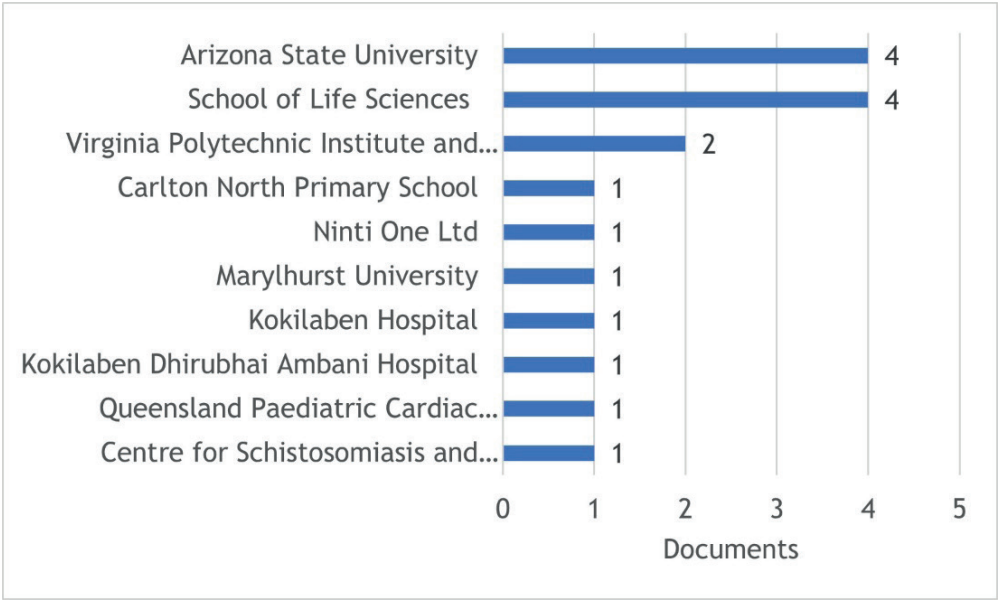

Figure 5. The ten most productive affiliations in scientific publications related to cultural awareness in biology education

Most Productive Countries

The most productive countries in scientific publications related to cultural awareness in biology education are shown in figure 6. The United States ranks first with 17 documents, accounting for 53,13 %. It is followed by Australia, Switzerland, and the United Kingdom, each contributing three documents (9,38 %). Meanwhile, Indonesia has only one document (3,13 %).

The dominance of the United States can be attributed to its high ethnic, racial, and cultural diversity. Research on cultural awareness in the U.S. highlights how multiculturalism and ethnic identity influence various aspects of life, including education, business, and public policy.[14] In education, for instance, studies emphasize the importance of an inclusive curriculum that reflects diverse cultural backgrounds to enhance students' understanding and tolerance.[15]

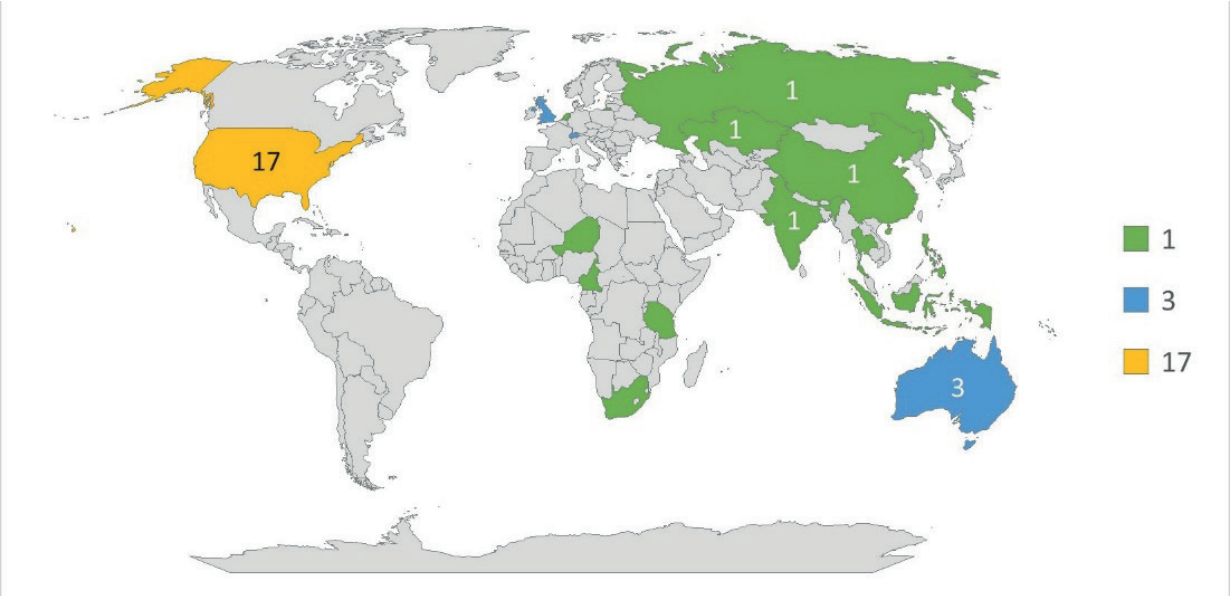

Figure 6. The most productive countries in scientific publications related to cultural awareness in biology education

Most Influential Scientific Publications

Based on the VOSviewer analysis, the ten most cited scientific publications related to cultural awareness in biology education are presented in table 2. This list provides an overview of the most influential publications in the field. The study by Rollinson is the most impactful, with a total of 448 citations. These ten publications serve as key references and potential collaboration opportunities for efforts to enhance cultural awareness in biology education.

Table 2. The ten most influential scientific publications

Rank	Author	Year	Document title	Source	Total citations
1	Rollinson D, et al	2013	Time to set the agenda for schistosomiasis elimination	Acta Tropica	448
2	Barnes M.E & Brownell S.E	2017	A Call to Use Cultural Competence When Teaching Evolution to Religious College Students: Introducing Religious Cultural Competence in Evolution Education (ReCCEE)	CBE—Life Sciences Education	76
3	Tanner K. & Allen D.	2007	Cultural Competence in the College Biology Classroom	CBE—Life Sciences Education	56
4	Johnson A. & Elliott S.	2020	Culturally Relevant Pedagogy: A Model to Guide Cultural Transformation in STEM Departments	Journal of Microbiology & Biology Education	44
5	Barnes M.E & Brownell S.E	2018	Experiences and practices of evolution instructors at Christian universities that can inform culturally competent evolution education	Science Education	30
6	Barnes M. E. et al	2020	Differential Impacts of Religious Cultural Competence on Students' Perceived Conflict with Evolution at an Evangelical University	The American Biology Teacher	14
7	Schultz R. et al	2019	Australian Indigenous Land Management, Ecological Knowledge and Languages for Conservation	EcoHealth	13
8	Sparks R.A et al	2020	Using Culturally Relevant Pedagogy to Reconsider the Genetics Canon	Journal of Microbiology & Biology Education	10
9	Shultz M. et al	2022	The role of epistemological beliefs in STEM faculty's decisions to use culturally relevant pedagogy at Hispanic-Serving Institutions	International Journal of STEM Education	9

10	Bibon M.B.	2022	Indigenous Medicinal Plants and Practices in Cagraray Island: Resources for Culture-Based Lessons in Biology	Journal of Education	2

Keyword Trends

The occurrence and relationships between keywords related to cultural awareness in biology education are presented in table 3 and figure 7. The most frequently appearing keyword is evolution, with seven occurrences. Based on the network visualization diagram from the VOSviewer analysis, keywords are grouped into three main clusters, distinguished by red, green, and blue colors. All keywords are interconnected, with the strongest link belonging to cultural competence, which has a total link strength of 192. Interestingly, the term cultural competence is used more frequently than cultural awareness. The popularity of the keyword evolution is linked to several scientific studies on evolutionary theory and students' cultural backgrounds. These studies emphasize the relationship between students' religious beliefs and their acceptance of evolutionary theory.[16,17,18,19]

Table 3. Occurrence and total link strength of the top ten keywords

Keyword	Occurrences	Total link strength
Evolution	7	122
Cultural competence	6	192
Biology	6	160
Cultural Anthropology	5	148
Education	5	148
Culture	5	108
History, 20th century	3	154
History, 21st century	3	154
Interpersonal communication	3	135
Health education	3	134

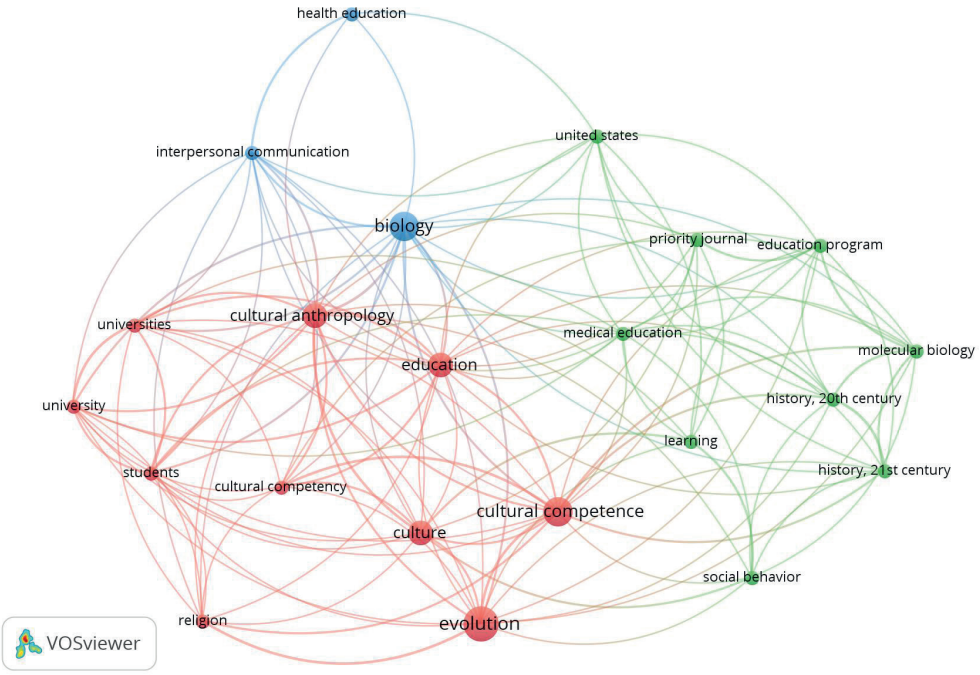

Figure 7. Network visualization keywords related to cultural awareness in biology education

DISCUSSION

Gap in the Number of Scientific Publications

According to the Scopus database, from its initial appearance in 2003 until March 2025, the total number of scientific publications related to cultural awareness in biology education is only 32 documents. This number is significantly lower compared to other 21st-century skills topics. For instance, based on the Scopus database:

Critical thinking in biology education has 542 documents, Problem-solving skills have 1002 documents, Communication skills have 189 documents, Collaboration skills have 242 documents, and Literacy skills have 898 documents. This gap indicates that biology education tends to emphasize literacy and cognitive skills more than character development. Therefore, further studies are needed to identify the reasons behind this disparity, enabling efforts to increase scientific publications related to cultural awareness in biology education.

The Need for More Studies on Cultural Awareness

Research on cultural awareness needs to be expanded, as it is crucial for students in the era of globalization.[20,21] They not only learn about differences but also how to coexist, practice tolerance, and build better relationships with people from diverse backgrounds, regardless of location.[22] In the professional world, cultural awareness is essential, as companies seek individuals who can adapt to multicultural work environments.[23,24] Those with strong cultural awareness are more capable of collaborating effectively within diverse teams. Beyond professional benefits, cultural awareness fosters empathy and respect for differences.[25,26] Ultimately, cultural awareness is not just an academic skill—it is a fundamental life competency for the future.

To increase students' cultural awareness, research can focus on developing and evaluating educational models that integrate local traditions, languages, and belief systems into classroom learning.[21] One promising idea is designing interdisciplinary project-based learning that involves students investigating cultural practices related to environmental sustainability, traditional medicine, or local art forms. Another approach could explore the impact of virtual exchange programs or collaborations with students from different cultural backgrounds to promote global understanding. Researchers can also examine how storytelling, oral history, and the inclusion of Indigenous perspectives in science or social studies curricula influence students' attitudes toward cultural diversity. Additionally, studies could assess the role of teacher training in delivering culturally responsive pedagogy and how it affects students' engagement and cultural empathy. These research directions offer valuable insights into practical strategies for nurturing inclusive, culturally aware learning environments.[26]

Gap in the Topic of Ethnobiology

Based on keyword analysis, ethnobiology-related keywords appear infrequently. Terms such as ethnobotany, ethnozoology, ethnoecology, local wisdom, and traditional knowledge are rarely found, despite their direct relevance to culture and traditions that can enhance students' cultural awareness. This gap highlights an underutilization of ethnobiology's potential. Ethnobiology should not only focus on the conservation of local wisdom but also contribute to fostering students' cultural awareness. Integrating ethnobiological perspectives into biology education could bridge this gap and provide a more holistic understanding of the relationship between science and culture.

The most frequently appearing keyword is evolution. If research on cultural awareness focuses predominantly on the rejection of the theory of evolution, it may lead to an imbalanced understanding of the relationship between culture and science. An excessive emphasis on this rejection could reinforce negative stereotypes or create polarization between communities holding traditional beliefs and the scientific community, hindering constructive dialogue and mutual respect. Moreover, this focus risks overlooking the positive aspects of cultural awareness, such as the appreciation of diverse local knowledge and cultural practices that can enrich education and scientific research. Therefore, studies that highlight only the rejection of evolution without considering the broader cultural context may limit opportunities to develop inclusive and culturally sensitive educational approaches, ultimately restricting students' understanding of how science and culture can complement each other.

Indonesia's Role in Promoting Cultural Awareness in Biology Education

Indonesia should be one of the most productive countries in promoting cultural awareness in biology education. As a country with rich biodiversity[27] and a vast repository of local wisdom passed down through generations,[28] Indonesia has great potential for integrating ethnobiology into education. Ethnobiology education is crucial for Indonesia, as it plays a vital role in preserving both biodiversity and cultural heritage. It can also serve as a platform for fostering students' cultural awareness. However, the reality shows otherwise—Indonesia has contributed only one scientific publication on this topic from 2003 to March 2025. This indicates that biology education in Indonesia has yet to fully integrate cultural awareness into its curriculum. Further studies are needed to identify the underlying causes of this gap and to develop effective solutions for enhancing cultural awareness in Indonesian biology education.

The Role of Ethnobiology in Enhancing Cultural Awareness

Ethnobiology plays a crucial role in fostering students' cultural awareness by connecting them to the values of local wisdom.[29] Through learning experiences that explore the use of traditional medicinal plants, ritual plants, and other local knowledge practices, students develop a sense of pride in their cultural identity while also appreciating the diversity around them.[30] By understanding the harmonious relationship between humans

and nature as practiced by their ancestors, students perceive their learning not merely as theoretical knowledge but as an integral part of a meaningful life.[8]

Proposed Solutions

To bridge this gap, solutions must be implemented to make biology education more prominent in promoting students' cultural awareness. The ethnobiology education approach should be expanded beyond an ecological intradisciplinary focus to incorporate a social interdisciplinary perspective. Additionally, the scope of ethnobiology should be broadened from an ethno-cultural focus to a global-cultural perspective. This shift ensures that ethnobiology education is not exclusive to a particular ethnic group but is instead designed to be multicultural and inclusive. By integrating this approach, biology education can effectively promote all 21st-century skills essential for students, including cultural awareness, collaboration, critical thinking, and adaptability in diverse environments.

Research limitations

The limitation of this analysis is similar to the common weaknesses found in bibliometric research, namely the reliance on a single database (Scopus), which may lead to bias as not all scientific publications are covered, particularly non-English works or local journals that are not yet indexed.

CONCLUSIONS

As of March 2025, the trend in scientific publications related to cultural awareness in biology education remains stagnant, averaging only two documents per year. Another significant gap is the lack of research on ethnobiology, which should play a crucial role in promoting students' cultural awareness but remains largely unexplored. To address this gap, the ethnobiology education approach must be expanded beyond an ecological intradisciplinary focus to include a social interdisciplinary perspective. This broader approach will ensure a more holistic integration of cultural awareness in biology education, making it more relevant and impactful for students.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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