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Short Review

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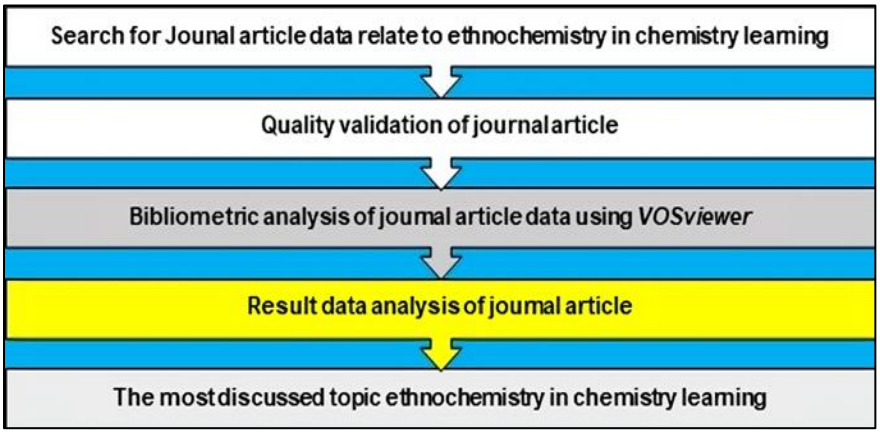
Bibliometric analysis: most discussed topics ethnochemistry in chemistry learning

Resty **Utami**[1+], Trining Puji **Astutik**[2]

Abstract

Ethnochemistry, integrating local culture with chemistry education, enhances students' comprehension by relating lessons to everyday life. This study utilizes bibliometric analysis to identify prevalent topics in ethnochemistry research within chemistry learning from February 2018 to January 2023. Using Publish or Perish (PoP) software, Google Scholar, and the VOSviewer application, 31 journal articles were analyzed to reveal key themes and trends. The findings indicate a strong association of ethnochemistry with terms like "guidelines," "development," "implementation," "local wisdom," "ability achieved," and "learning process". Ethnochemistry has shown significant potential to make chemistry learning more engaging and relevant by linking abstract concepts to cultural and everyday contexts. However, the integration of ethnochemistry into curricula is still limited, and practical applications in modern education remain underexplored. This study highlights the importance of developing strategies to incorporate ethnochemistry into teaching and research, fostering critical thinking, scientific literacy, and cultural appreciation among students. The findings offer a framework for future studies, encouraging innovative approaches that bridge science education with cultural heritage to create more meaningful learning experiences.



CONTENTS

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Highlights

- Bibliometric analysis is to map and identify research trends in ethnochemistry.
- Ethnochemistry integrates local culture with chemistry education.
- This enhances students' understanding and makes learning contextual and meaningful.
- VOSviewer visualizes data relationships, revealing key points in ethnochemistry.
- These are important in chemistry learning and their evolution between 2018-2023.

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[1]Yogyakarta State University, Faculty of Mathematics and Natural Sciences, Yogyakarta, Indonesia. [2]Antasari State Islamic University Banjarmasin, Faculty of Tarbiyah and Teacher Training, Banjarmasin, Indonesia. **+Corresponding author:** Resty Utami, **Phone:** +62822-1926-1482, **Email address:** restyutami.2023@student.uny.ac.id

1. Introduction

Ethnoscience is an interdisciplinary field that connects cultural anthropology with scientific study. It focuses on understanding scientific knowledge by exploring the local knowledge embedded in the culture of a society or ethnic group (Dewi *et al.*, 2019; 2021). According to Sutrisno *et al.* (2020, p. 7833) "ethno refers to group members in cultural environments identified by cultural traditions, codes, symbols, and myths to consider and conclude concepts". Authentic scientific knowledge encompasses the facts and understandings within a society. This knowledge is passed down through generations, often in an informal, unstructured, and non-systematic manner, reflecting people's perceptions of natural phenomena (Dewi *et al.*, 2019).

Ethnochemistry is part of ethnoscience and views a culture based on a chemistry perspective involving cross-disciplines of social sciences and humanities. Ethnochemistry studies chemical materials from a local cultural perspective (Rahmawati *et al.*, 2018a), both chemistry shapes culture and culture contribute to chemistry and its changes (Gani *et al.*, 2022) and ethnochemistry can be applied to the learning process (Seprianto and Hasibuan, 2021). Implementation of ethnochemistry in the learning process either from strategies, models, learning resources or scientific investigations can develop critical thinking skills, scientific attitudes, and scientific processes and improve students' cognitive, affective and psychomotor abilities (Wahyudiati and Qurniati, 2023). Students would prefer learning if the topics studied were related to everyday life (Zidny and Eilks, 2020; Abumchukwu *et al.*, 2021), have conducted research in the Onitsha Education Zone, Anambra State University in Nigeria, and received the data showing implementation of ethnochemical learning methodologies can considerably boost students' understanding of concepts and learning outcomes.

Irawati and Sofianto (2019) explained that the application of ethnochemistry in learning is carried out through the utilization of local cultural or traditional products through the learning process or included in learning resources. The application of ethnochemistry in learning is carried out through the integration stage, and students' understanding of chemical concepts becomes more meaningful. Wahyudiati (2022a) explained that the application of ethnochemistry in learning can help students formulate research problems and prove hypotheses so that chemistry learning objectives can be achieved optimally. Azizah and Premono (2021) stated that the integration in question is a reciprocal relationship between culture and chemistry so that learning becomes more contextual.

Heliawati *et al.* (2022) and Wahyudiati (2022a; 2022b) show that the implementation of ethnochemistry in the learning process can improve students' understanding of chemical concepts. Despite its potential, there are still significant gaps in this field. Ehnochemistry has not been widely integrated into the learning process, and there is a lack of comprehensive studies that analyze research trends, popular topics, and their practical relevance to modern education. Additionally, few studies have explored effective ways to incorporate ethnochemistry into chemistry curricula to make learning more meaningful and connected to real-life contexts. Addressing these gaps is essential to fully realizing ethnochemistry's potential to improve chemistry education. Attempts at the relevance of ethnochemistry in the chemistry learning process are still not widely carried out to increase the relevance it is necessary to analyze the development of literature related to ethnochemistry in chemistry learning. Increasing relevance will result in new ways of overcoming the problem of conveying chemistry concepts in future learning (Fadli, 2019; Sutrisno *et al.*, 2020). Literature analysis can help researchers in the field of ethnochemistry find research topics that have been widely researched in the last 5 years as an effort to improve the quality of learning.

Bibliometric analysis research is a measurement using a mathematical and statistical approach to analyze certain literature to help VOSviewer application (Nandiyanto and Husaeni, 2021). The VOSviewer application was chosen because it can display network data mapping visualizations, interesting analysis and investigations (Widiawati *et al.*, 2022). Article data searches can be carried out with the help of Publish or Perish (PoP) software because PoP can reach various metadata such as Google Scholar, Scopus, Web of Science, and others.

Ethnochemistry and *etnokimia* are the main keywords in the literature search (journal article data). Journal articles with ethnochemical topics in chemistry learning used in the analysis were selected based on several criteria, namely: **(1)** Literature in the form of journal articles where the contents include title, author, year, journal, keywords, abstract, and bibliography; **(2)** The publication deadline is at least the last 5 years with a timeframe from February 2018 – January 2023; **(3)** The literature discusses ethnochemistry/*etnokimia* in chemistry learning; **(4)** Literature is presented in easy-to-understand Indonesian and/or English grammar. Journal article data is relevant to the research topic and can be used if it meets all the specified criteria. Researchers can identify research mapping based on keywords (co-occurrence) to find out topics that are often discussed in research. Previous research on bibliometric analysis was carried out by Kamdem *et al.*, (2019) and Wati *et al.* (2021) to find out the trend of a study on the Scopus and Google Scholar databases.

Based on the description above, the importance of learning chemistry with local culture makes it easier for students to understand the concept of the material being taught. Efforts to make ethnochemistry relevant in the learning process have not been widely carried out, and analysis of literature development is needed to determine research opportunities and topics. Bibliometric analysis is a measurement with a mathematical and statistical approach to analyzing literature carried out with the help of the VOSviewer application, because it can display data mapping visualizations, interesting analysis and investigations. The purpose of this study is to analyze scientific articles that examine ethnochemistry that have been published from February 2018 – January 2023 on reputable scientific platforms.

2. Research methodology

This research uses descriptive qualitative research with a bibliometric approach to convey the results of review of journal articles. The data search method was carried out using PoP software with the main Google Scholar database and analyzed using the VOSviewer application (Rahayu *et al.*, 2022). This research was adapted from (Hudha *et al.*, 2020) through 5 stages (**Fig. 1**):

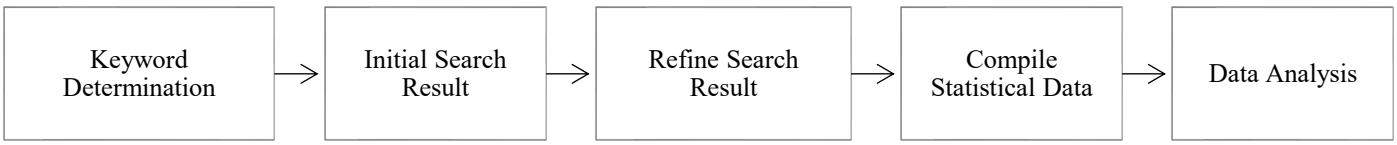

Figure 1. Research Stages.
Source: Adapted by the author using data from Hudha *et al.* (2020).

A systematic literature review on ethnochemistry was conducted in January 2023 using the keywords "ethnochemistry" and "*etnokimia*". The process involved five key stages. First, keyword determination was carried out using Google Scholar, supported by PoP software, to search for journal articles published between February 2018 and January 2023, yielding 43 articles stored in RIS format, containing essential bibliographic information. Second, the initial search results were refined by filtering data based on study topics and ensuring only journal articles were included, which were then transferred to Mendeley for enhancement. Third, a thorough validation process was conducted to check the completeness and quality of the articles, ensuring the inclusion of relevant and high-quality literature, resulting in a final dataset of 31 articles. Fourth, statistical data compilation was performed in Mendeley to ensure all bibliographic details, such as publication year, volume, and page numbers, were complete and accurate. Finally, bibliometric network analysis and visualization were conducted using VOSviewer software, enabling the creation of network maps that revealed literature clusters, historical connections, and potential research opportunities within the field. This structured approach ensured a focused and reliable analysis of the topic.

Data collection used a purposive method; the data were selected based on the special characteristics determined by the researcher Faizah *et al.* (2021) so that data relevant to the research topic was obtained. Research object data can be seen in **Fig. 2**. The process of data analysis for bibliometric analysis in research uses co-occurrence analysis as a description of the conceptual structure or knowledge from the literature and analysis based on keywords to see the development of research and the development of visualized data. Briefly, bibliometric data analysis techniques can be seen in the following flowchart in **Fig. 3**.

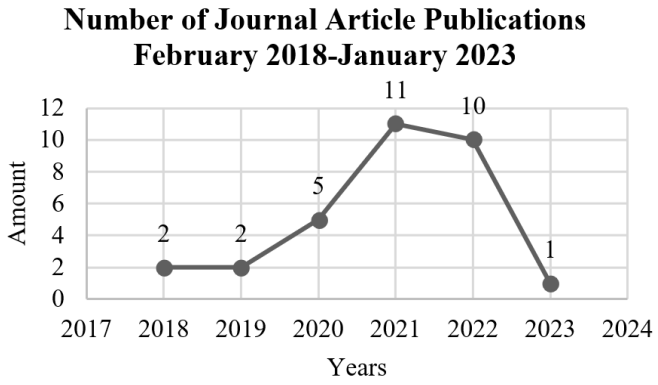

Figure 2. Journal article publication data February 2018 – January 2023.
Source: Elaborated by the authors.

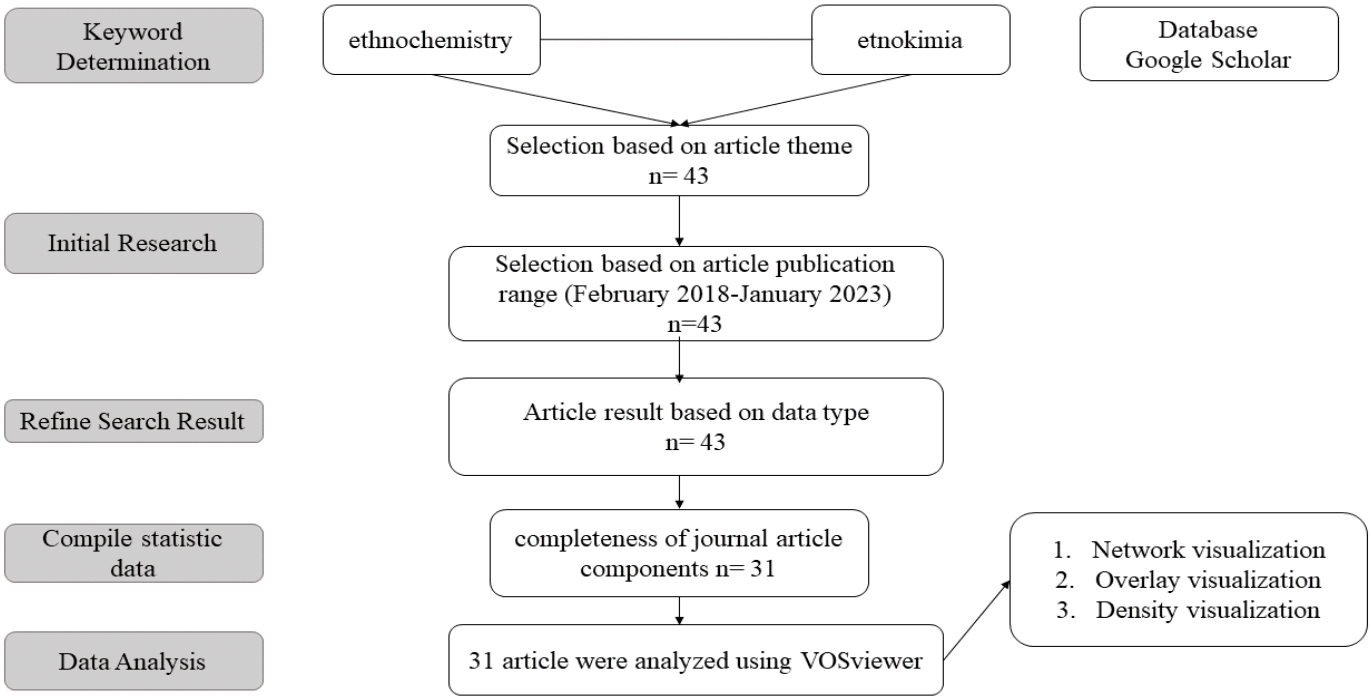

Figure 3. Data analysis technique.
Source: Elaborated by the authors.

3. Results and discussion

3.1. General information and growth trends

Using Publish or Perish to search for journal articles from the Google Scholar database, 43 relevant articles were initially identified. These articles were then processed using the Mendeley application to complete missing information and undergo quality validation, resulting in 31 articles deemed useful and relevant to the research topic (Table 1). Validity was ensured by applying predefined inclusion and exclusion criteria, with articles classified by two chemistry educators. Overlay visualization was used to show the frequency of topics mentioned in research over a specific period, represented by color gradients.

So, it is known that the development of ethnochemistry research trends from 2018 to 2023 is developing well, where publications increased quite significantly in 2021 by 11 articles. There was a decrease in 2022 to 10 articles. As for the publication in 2023 of at least 1 article, this is due to limited data collection in January. Based on these data, it shows that research on ethnochemistry has become a popular topic among chemistry education researchers despite fluctuations in interest over the past 5 years and must be further developed through continuous research and publication.

Table 1. An article relevant to the research topic.

No	Reference	Source	Citations
1	Asmaningrum *et al.* (2018)	Jurnal Tadris Kimiya	17
2	Rahmawati *et al.* (2019)	Journal Of Physics: Conference Series	1
3	Rahmawati *et al.* (2018b)	International Conference of Chemistry	9
4	Jofrishal and Seprianto (2020)	Jurnal IPA dan Pembelajaran IPA	4
5	Hidayatussani *et al.* (2020)	Chemistry Education Practice	5
6	Ugwu (2018)	Journal of the Nigerian Academy of Education	2
7	Zidny and Eilks (2020)	Sustainable Chemistry and Pharmacy	28
8	Sutrisno *et al.* (2020)	Universal Journal of Educational Research	26
9	Riza *et al.* (2020)	Jurnal Pendidikan IPA Veteran	6
10	Zidny and Eilks (2021)	International Joint Conference on Science and Engineering	0
11	Seprianto *et al.* (2021)	Antlantis Press	0
12	Azizah and Premono (2021)	Journal of Tropical Chemistry Research and Education	7
13	Robo *et al.* (2021)	Jurnal Ilmiah Wahana Pendidikan	1
14	Arif *et al.* (2021)	Jurnal Ilmiah Wahana Pendidikan	1
15	Wahyudiati (2021a)	Jurnal Pendidikan Kimia Indonesia	10
16	Wahyudiati (2021b)	SPIN Jurnal Kimia & Pendidikan Kimia	4
17	Abumchukwu *et al.* (2021)	African Journal of Science, Technology & Mathematics	1
18	Seprianto and Hasibuan (2021)	Budapest International Research and Critics Institute	1
19	Asmaningrum *et al.* (2021)	Atlantis Press	2
20	Konyefa and Okigbo (2021)	International Journal of Education and Evaluation	2
21	Zahro *et al.* (2022)	International Conference on Science, Education and Technology	0
22	Wahyudiati (2022a)	Journal of Xi'an Shiyou University, Natural Science Edition	2
23	Heliawati *et al.* (2022)	Jurnal Pendidikan IPA Indonesia	2
24	Wahyudiati (2022b)	Jurnal Pendididkan Kimia Indonesia	0
25	Wahyudiati (2022c)	Jurnal Tarbiyatuna	6
26	Irfandi (2022)	Proceeding of International Conference on Science and Technology	0
27	Wahyudiati (2022d)	Journal of Xi'an Shiyou University, Natural Science Edition	0
28	Mudau and Tawanda (2022)	International e-Journal of Education Studies	0

Source: Elaborated by the authors.

3.2. Keywords and terms analysis

Journal article data was then analyzed using the VOSviewer application to be able to visualize and map bibliometric network data. The results of data analysis are in the form of a network visualization map display (Fig. 4a), an overlay visualization map display (Fig. 4b) and a density visualization map display (Fig. 4c). The data analyzed using VOSviewer generated an overlay visualization map (Fig. 4b) with 12 clusters, 111 links and 45 items (topics/terms). Ethnochemistry is the topic with the most links, namely 39.

Overlay visualization can represent the level of frequency of a topic mentioned in research throughout a specific period based on color levels. Ethnochemistry as the main topic has as many as 39 related links with the highest total link strength of 52 with an occurrence of 21. The brighter the color of the map area (yellow) the fewer items/topics are studied. Ethnochemistry is related to other keywords (Fig. 4d). According to Afandi *et al.* (2022) research in mapping research trends, "the brighter the color of the node, the more recent the topic is studied in research".

Figure 4b shows that old topics that are often discussed in a study are based on bibliometric analysis using VOSviewer. For example, in Fig. 5a, you can see the relationship between the topics of 'ethnochemistry' and 'guide' with purple nodes, which is one of the most discussed topic combinations in 2018. Figure 5b 'ethnochemistry' and 'development' with dark blue nodes because it is one of the most discussed topic combinations around 2019. Figure 5c 'ethnochemistry' and 'chemistry' with blue to dark green nodes because it is one of the most discussed topic combinations around 2020. Figure 5d 'ethnochemistry' with 'local wisdom' with nodes green because it is one of the most discussed topic combinations around 2021. Figure 5e 'ethnochemistry' with 'gender' with the node color light green because it is one of the most discussed topic combinations around 2022. Figure 5f 'ethnochemistry' with 'chemistry learning' with node yellow color because it is one of the most discussed topic combinations in around 2023.

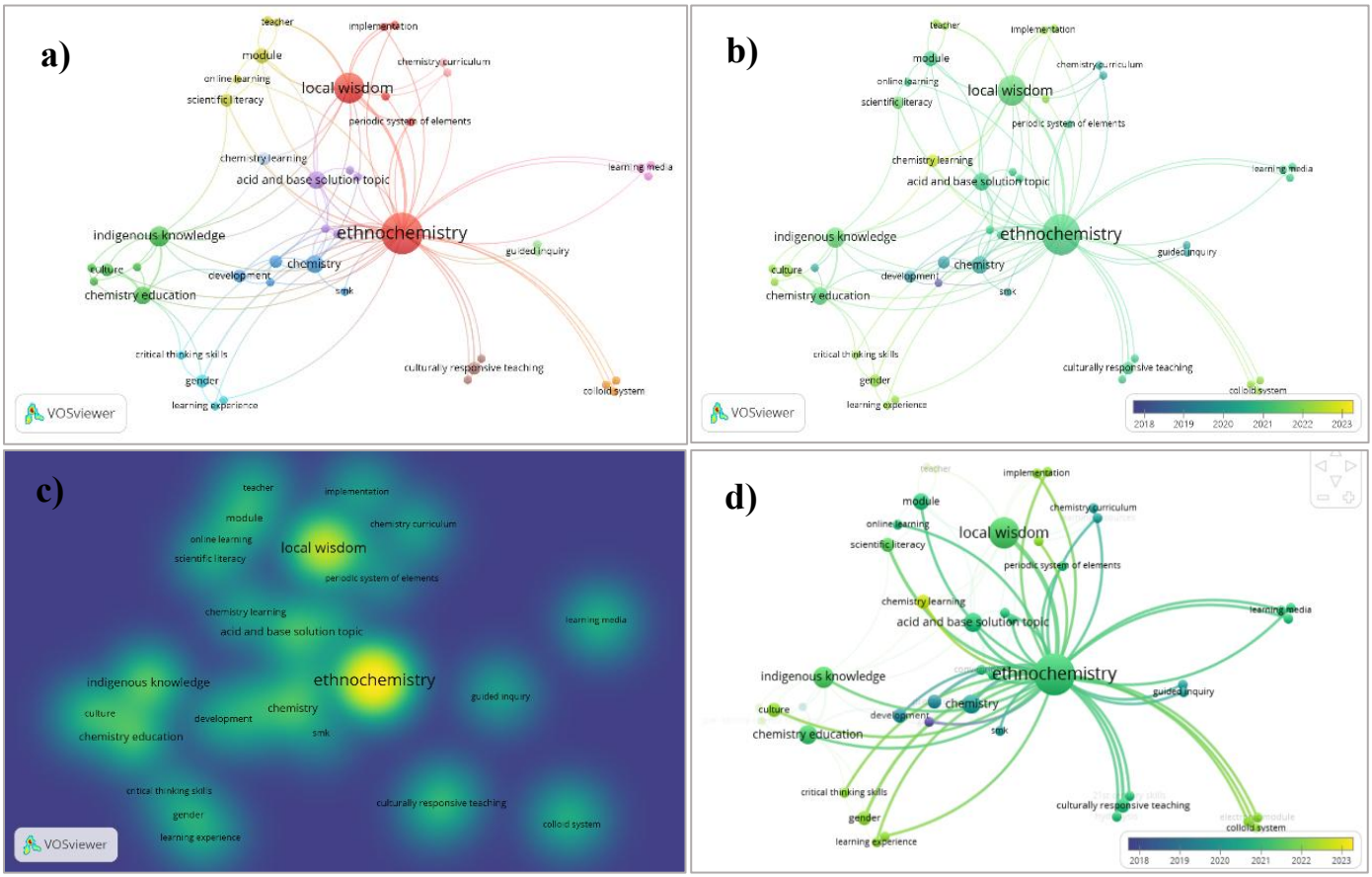

Figure 4. VOSviewer Data result. **(a)** Network visualization; **(b)** Overlay visualization; **(c)** Density visualization and **(d)** Topic related to ethnochemistry.
Source: Elaborated by the author using data from VOSviewer application (2023).

The latest topics that are often discussed in a study based on bibliometric analysis using VOSviewer are contained in color items light green and yellow: *student scientific attitudes, learning experience, gender, critical thinking skills, pre-service science teachers, chemistry metacognition, culture, training, teacher, implementation, islamic education concept, problem-solving, electronic module, colloid system, scientific literacy, teaching material* and *chemistry learning* which are widely researched in 2022 to 2023.

Ethnochemistry is intrinsically linked to local wisdom and indigenous knowledge because it fundamentally involves studying chemical materials from a local cultural perspective. Local wisdom is built upon the traditional knowledge of communities within specific regions. Contextual chemistry content is easier to learn when an ethnochemistry approach is applied. Students are better able to construct knowledge when they have prior knowledge or experiences to build upon. Ethnochemistry helps students understand chemical concepts by integrating local cultural knowledge with chemical principles. For example, traditional remedies like *jamu brotowali*, *jamu kunyit asam*, and *bunga bougainville* can be used as acid-base indicators (Riza *et al.*, 2020). By connecting science with cultural contexts, ethnochemistry fosters a deeper understanding of chemistry and enhances students' critical thinking and problem-solving skills.

Ethnochemistry exploration in the community environment is carried out first to identify which cultures are related to the chemical material to be taught (Azizah and Premono, 2021; Irfandi, 2022). Through the exploration carried out, it can provide convenience for researchers and teachers who will include ethnochemical topics in the learning process. For instance, in creating batik, the dye dissolution process demonstrates the application of chemical bonding principles. The batik dye itself can serve as a natural acid-base indicator, while other related chemical concepts such as moles, redox reactions, and compound nomenclature are also involved (Azizah and Premono, 2021). Several studies have shown that ethnochemically integrated learning can develop 21st-century skills in students (Arif *et al.*, 2021; Robo *et al.*, 2021).

The implementation of ethnochemistry in the chemistry learning process can improve critical thinking skills, learning experience, chemistry metacognition, problem-solving and scientific literacy of students (Heliawati *et al.*, 2022; Wahyudiati, 2024; 2022d). Efforts to improve students' abilities are carried out with the help of learning media, some media developed are integrated with ethnochemistry in the form of Adobe Flash Learning Media (Heliawati *et al.*, 2022), modules (Jofrishal and Seprianto, 2020; Riza *et al.*, 2020; Sanova *et al.*, 2022; Seprianto *et al.*, 2021; Zahroh Asna *et al.*, 2024) or other media such as creating vlog designs as chemistry learning media (Asmaningrum *et al.*, 2021). In its implementation, ethnochemistry is often combined with learning models such as PjBL, Inquiry and others (Asmaningrum *et al.*, 2021; Hidayatussani *et al.*, 2020) and combined with a learning approach such as culturally responsive teaching (CRT) (Arif *et al.*, 2021; Robo *et al.*, 2021; Wardani *et al.*, 2023; 2024) and Culturally Responsive Transformative Teaching (CRTT) (Najid *et al.*, 2021; Rahmawati *et al.*, 2018, 2023) according to the learning topic.

The application of ethnochemistry-based chemistry education can be influenced by gender, as seen in the research conducted by Wahyudiati (2023; 2022a) which indicates that female students tend to have higher critical thinking skills and

more positive scientific attitudes compared to male students. This difference can be attributed to female students exhibiting greater motivation, perseverance, and self-confidence in their academic tasks, which directly enhances their critical thinking abilities. Furthermore, female students in the study were found to have a more positive attitude toward learning, especially in chemistry, when it is linked to real-life cultural contexts, such as the integration of ethnochemistry. These factors collectively contribute to their superior performance in critical thinking tasks compared to their male counterparts (the relationship between gender and ethnochemistry can be seen in Fig. 5e). Despite its potential, ethnochemistry is not widely integrated into current curricula, and there is a lack of comprehensive studies exploring its practical application in modern education. Addressing these gaps is crucial for leveraging ethnochemistry to improve chemistry learning outcomes. This study provides a new perspective on the development of ethnochemistry research, offering a foundation for future studies to explore effective methods for incorporating cultural contexts into chemistry education.

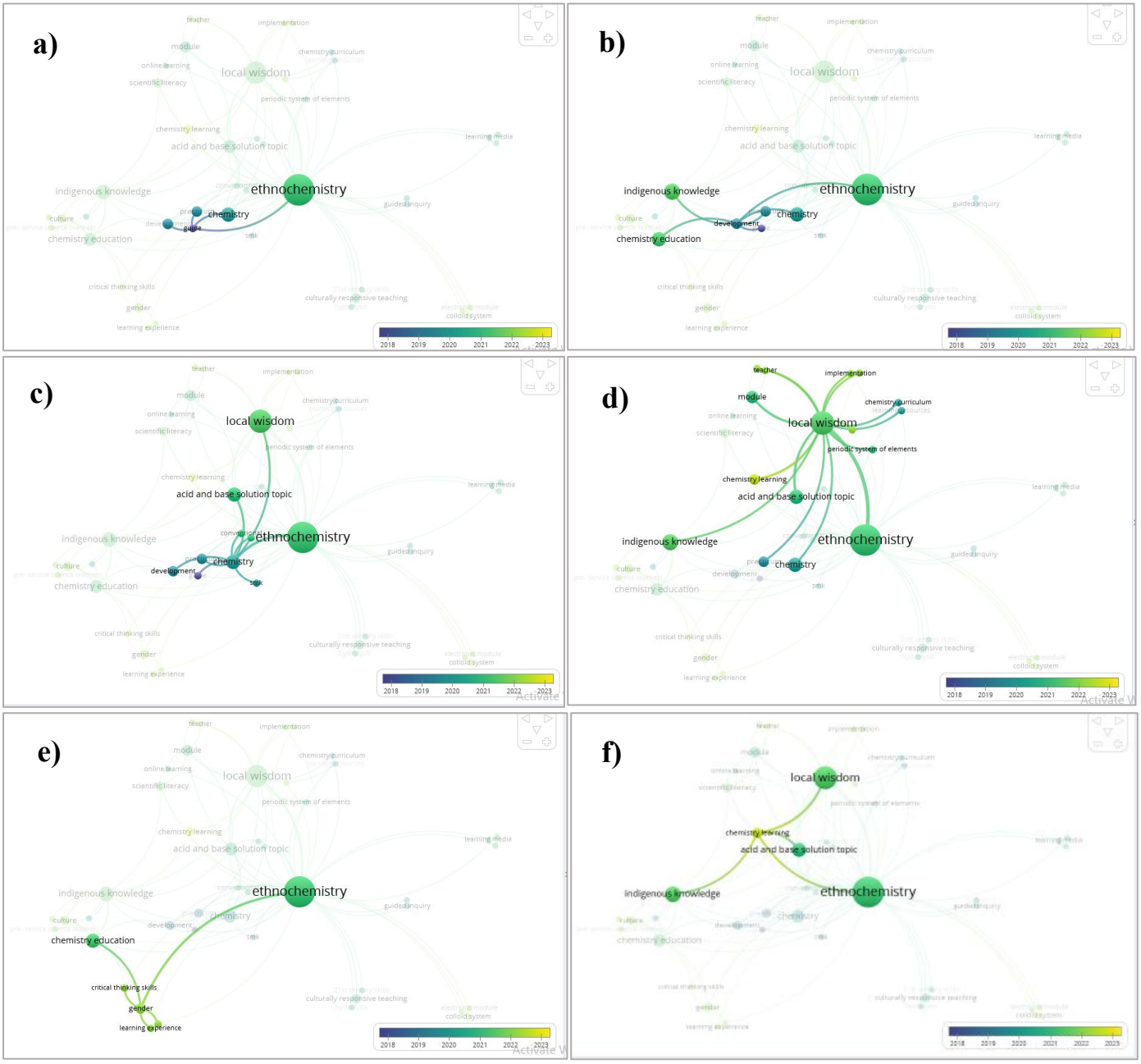

Figure 5. VOSviewer Data Result. **(a)** The Relationship Between Topic "Ethnochemistry" and "Guide"; **(b)** The Relationship Between Topic "Ethnochemistry" and "Development"; **(c)** The Relationship Between Topic "Ethnochemistry" and "Chemistry"; **(d)** The Relationship Between Topic "Ethnochemistry" and "Gender"; **(e)** The Relationship Between Topic "Ethnochemistry" and "Gender"; **(f)** The Relationship Between Topic "Ethnochemistry" and "Chemistry Learning".
Source: Elaborated by the author using data from VOSviewer application (2023).

5. Conclusions

The bibliometric analysis of 31 journal articles reveals that ethnochemistry is a frequently discussed topic within chemistry education. The research indicates that the integration of local culture into chemistry lessons significantly enhances students' understanding and engagement. Key terms associated with ethnochemistry in the article published from January 2018 to February 2023 include "guidelines", "development", "implementation", "local wisdom", "ability achieved," and "learning process". Despite its potential, ethnochemistry is not widely integrated into current curricula, and there is a lack of comprehensive studies exploring its practical application in modern education. Addressing these gaps is crucial for leveraging ethnochemistry to improve chemistry learning outcomes. By integrating local cultural contexts into chemistry learning, this approach enhances students' understanding of abstract concepts through relatable, everyday experiences. The bibliometric analysis highlights key research trends and identifies gaps, such as practical strategies for incorporating ethnochemistry into curricula. These findings contribute to teaching and research by offering innovative methods to make chemistry education more engaging and meaningful while promoting cultural preservation. This integration has the potential to improve critical thinking, scientific literacy, and 21st-century skills among students, fostering a more inclusive and contextually relevant approach to science education.

Supplementary material

Please visit **https://app.vosviewer.com/** and add the file from the link **https://revista.iq.unesp.br/ojs/index.php/ecletica/libraryFiles/downloadPublic/57** for visualization data from VOSviewer application

Authors' contribution

Conceptualization: Resty Utami; Trining Puji Astutik; **Data curation**: Trining Puji Astutik; Resty Utami; **Formal Analysis**: Resty Utami; Trining Puji Astutik; **Funding acquisition**: Not applicable; **Investigation**: Resty Utami; **Methodology**: Resty Utami; **Project administration**: Resty Utami; Trining Puji Astutik; **Resources**: Not applicable; **Software**: Resty Utami; **Supervision**: Trining Puji Astutik; **Validation**: Resty Utami; Trining Puji Astutik; **Visualization**: Resty Utami; **Writing – original draft**: Resty Utami; Trining Puji Astutik; **Writing – review & editing**: Resty Utami.

Data availability statement

The data will be available upon request.

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Conflict of interest

The authors declare that there is no conflict of interest.

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