



Exploring Scientific Identity in Teacher Education: A 20-Year Bibliometric Analysis

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Abstrak

Menyelidiki identitas sains dalam pendidikan guru sangat penting karena guru sangat berperan dalam kemajuan pendidikan dan proses pembelajaran. Dampaknya sangat penting bagi keberhasilan siswa, terutama dalam lingkungan sekolah yang terstruktur. Studi bibliometrik yang bertujuan menganalisis identitas sains dalam pendidikan guru selama 20 tahun terakhir. Dengan menggunakan VOSviewer, para penulis memetakan 541 artikel yang relevan (7880 kutipan) dari Scopus, yang diterbitkan antara tahun 2004 dan 2024. Metode analisis kualitatif menunjukkan peningkatan publikasi secara keseluruhan, tetapi terjadi penurunan dari tahun 2020 hingga 2024. Studi ini menekankan pentingnya identitas sains dalam pendidikan guru, menyoroti perannya dalam membentuk sikap, meningkatkan literasi sains, dan memfasilitasi pembelajaran. Temuan ini menunjukkan bahwa penelitian di masa depan harus mengintegrasikan identitas sains ke dalam kurikulum untuk mengatasi tantangan keberlanjutan global. Pergeseran paradigma dalam pendidikan sains pada tahun 2010-an berfokus pada pengetahuan dan keterampilan sains yang lebih luas, yang mengharuskan guru memiliki identitas yang jelas dan stabil dalam mengajar sains.

Kata kunci: Analisis Bibliometrik, Identitas Sains, Pendidikan Guru, VOSviewer

Abstract

Investigating scientific identity in teacher education is essential, as teachers play a pivotal role in advancing education and facilitating the learning process. Their impact is critical to student success, particularly within structured school environments. This bibliometric study aims to analyze the scientific identity in teacher education over the past two decades. Utilizing VOSviewer, the authors mapped 541 relevant articles (7,880 citations) indexed in Scopus, published between 2004 and 2024. Qualitative analysis methods revealed an overall increase in publications, though a decline was observed from 2020 to 2024. This study highlights the significance of scientific identity in teacher education, emphasizing its role in shaping attitudes, enhancing science literacy, and facilitating effective learning. The findings suggest that future research should integrate scientific identity into curricula to address global sustainability challenges. The paradigm shift in science education during the 2010s, which emphasized broader scientific knowledge and skills, necessitates that teachers develop a clear and stable scientific identity in teaching science.

Keywords: Bibliometric Analysis, Science Identity, Teacher Education, VOSviewer

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1. INTRODUCTION

Conversations about scientific inequality, intersectionality, and identity have been at the center of many scientific and social discussions over the past few years (Avraamidou, 2020; Gonzalves & Danielsson, 2020). Scientific identity is the result of interactions between individuals and their environment, where self-perception as a scientist is shaped by personal experiences, responsibilities, values, social context, and norms in science education, and recognised by the scientific community (Finnerty et al., 2024; Sandrone, 2022). Science identity is a description of how someone sees themselves and relates to the world of science. With science identity, we can find out how much individuals are motivated to study and contribute to the field of science, how they view themselves as scientists or aspiring scientists, and how they are recognised by others as individuals who have a science identity and engage with science as critical consumers and decision-makers in their daily live (Glass, 2019; Shein et al., 2019).

Research related to science identity in teacher education is very important. This is due to the important role played by teachers. Teachers also play a major role in educational development, especially those organised formally in schools. They have a huge influence on the learning process, one of which is the success of student learning. To achieve student learning success, teachers must act as facilitators and motivators (Hidayat, 2022; Pada et al., 2022). Teachers should transcend traditional roles and become facilitators who create positive and supportive learning environments. By doing so, they can help learners engage authentically, develop confidence, and gain recognition. This approach not only fosters essential skills for future success but also strengthens students' science identities, ultimately enhancing their motivation and participation in science education (Aghekyan, 2019; Belova et al., 2024; Listiandi et al., 2023).

Science identity also contributes to improving teachers' science literacy, which is important for teachers to develop students' ability to solve problems creatively and think critically. This is reinforced by the PISA 2025 science framework, which defines scientific competence as the key outcomes students should achieve in science education, including engaging with science issues and ideas and using them for decision-making (Deta et al., 2024; Lin & Shih, 2016). Teachers who have a strong science identity are better able to model positive science practices and behaviors, as described in the science literacy analysis literature review of prospective science teachers. This emphasis on a science identity in teaching helps prepare students who possess critical thinking and creative problem-solving skills. Furthermore, supportive educational settings play a crucial role in helping students feel competent and valued in the scientific community, thereby reinforcing the positive impact of teachers' strong science identities on student learning outcomes (Listiandi et al., 2023; Zhai et al., 2024). Thus, science identity is essential in teacher education as it shapes attitudes and practices, improves science literacy, facilitates science learning, develops scientific competence, and assists in developing of teacher competence.

Based on various bibliometric studies, science identity in teacher education has been a growing focus of research over the past few years, and deserves further scrutiny to understand the evolution of research in the discipline (Dwiputra et al., 2024; Kisworo et al., 2023). However, the studies that researchers have conducted show that the application of science identity in teacher education has not been fully analysed, including emerging trends, relationships between articles, research evolution, and related hot topics. Therefore, this study is presented with these reasons in mind and fills the gap of previous research. Through bibliometric analysis, this study aims to provide a literature review that analyses the literature related to the topic of science identity in teacher education. The results of this study include providing opportunities and challenges in applying science identity in chemistry education. This research is expected to contribute to the presentation of quantitative data and qualitative analyses for the evolution and recent development of applying science identity in teacher education as a reference for future research.

2. METHODS

The method used in this research is bibliometric analysis (Fitria et al., 2022). The articles used in this study are articles published on Scopus. We chose Scopus in this study due to several significant advantages. Scopus monitors more than 24,000 scientific journals from various fields, allowing for a more comprehensive and accurate analysis. In addition, Scopus' reputation as a trusted source of scientific data and the international standards applied in article indexation are also advantages. The open access provided by Scopus allows researchers and other users to access data freely and without restrictions, thus facilitating the

analysis and research process. The Publish or Perish (PoP) reference processing application was also used in this study. The stages of this research can be seen in Figure 1.

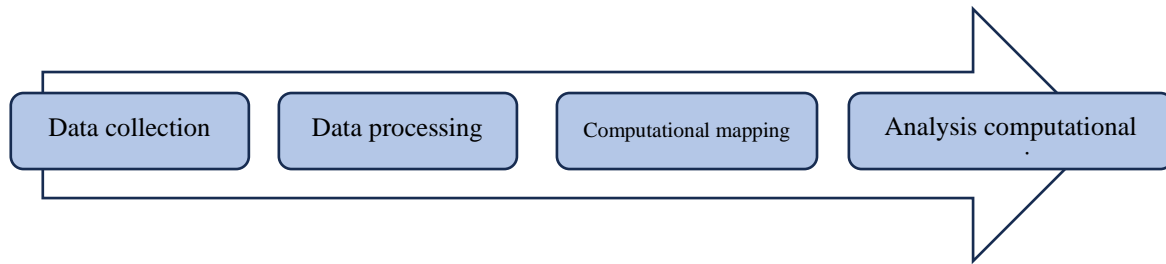


Figure 1. Structure of Research Stages

Data were collected from Scopus by specializing in "articles" and "conference articles" with the keywords "Science Identity" in "Teacher Education" and limited to 2004 to 2024. The data was then processed using Publish or Perish to categories the articles obtained. Data collection also included inclusion and exclusion criteria, as seen in Figure 2.

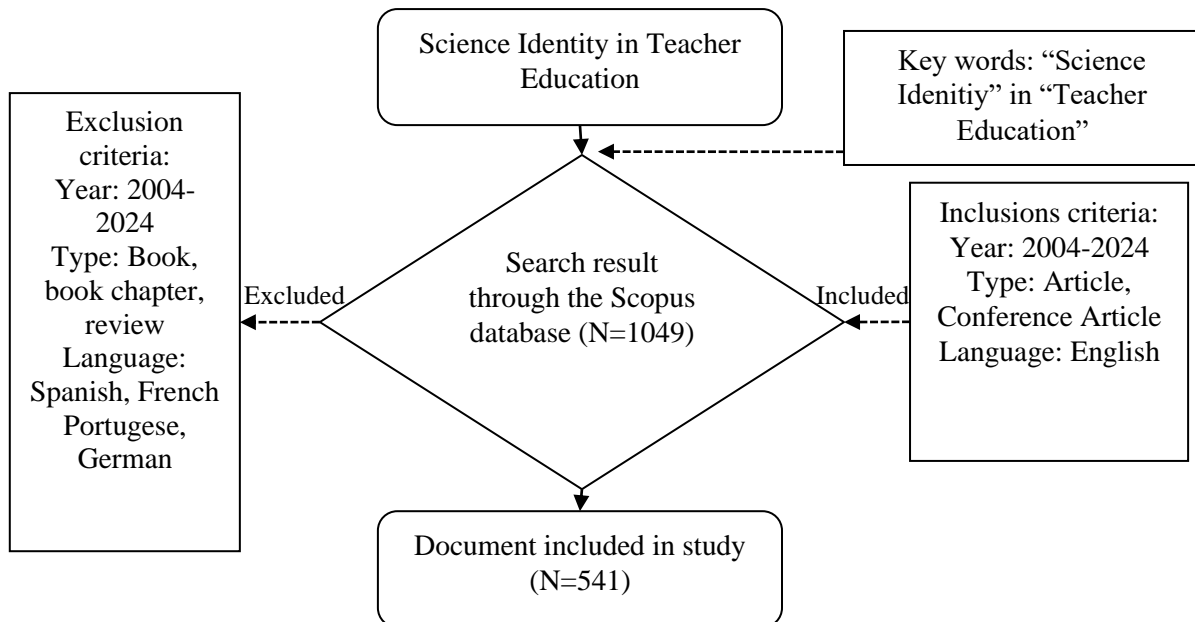


Figure 2. Literature Data Collection

A search for articles using the keyword "Science Identity" in "Teacher Education" yielded 1049 articles. The 2004-2024 criteria were applied to articles and conference articles to obtain more specific results. After collecting the data, 541 articles were received that met the requirements and were ready to be processed. Thus, further analysis can be done to understand the concept of Science Identity in the context of teacher education. Furthermore, the organization process was carried out with Publish or Perish (PoP) and obtained csv format followed by Microsoft Excel software to group based on author name, article title, year of publication, journal portal and number of citations.

VOSviewer was used to conduct a computational mapping analysis of publication data. It is effective at managing big data and offers a variety of visualisation options, such as network, overlay, and density visualisation, which helps in complex data analysis. VOSviewer can also be used to visualise and evaluate trends using bibliometric maps. Article data from the source database was then mapped. VOSviewer was used to create three

variations of publication mapping: network visualization, density visualization, and network-based overlay visualization (co-citation) among existing ones. When making the bibliometric maps, the keyword frequency parameter was set to be found at least three times. As a result, 160 terms met the threshold.

3. RESULTS AND DISCUSSION

Results

Data on science identity articles in teacher education were collected from Scopus and then exported in RIS and CSV formats and entered into Publish or Peris and Microsoft Excel for further analysis with VOSviewer. Before being refined according to the criteria, the search results obtained as much as 1049 data through Scopus. After refining according to the criteria, 541 relevant data were obtained for the keywords "Science Identity" and "Teacher Education" in the 2004-2024 types of articles and conference papers. The number of citations of all articles is 7880. We used a targeted sorting strategy, concentrating on articles most relevant to science identity and teacher education. This entailed identifying and selecting articles that thoroughly examined the application of science identity in teacher education and had the highest number of citations. The top 20 articles, selected based on their number of citations, have been presented in [Table 1](#).

Table 1. Science Identity in Teacher Education Publications Data

No.	Authors	Title	Year	Cites	Journal	Refs
1	A.L. Luehmann	Identity development as a lens to science teacher preparation	2007	247	Science Education	(Luehmann & Tinelli, 2008)
2	D.M. Levin, D. Hammer, J.E. Coffey	Novice teachers' attention to student thinking	2009	235	Journal of Teacher Education	(Levin et al., 2009)
3	A. Oleson, M.T. Hora	Teaching the way they were taught? Revisiting the sources of teaching knowledge and the role of prior experience in shaping faculty teaching practices	2014	196	Higher Education	(Oleson & Hora, 2014)
4	A.C. Barton, E. Tan, D. Greenberg	The makerspace movement: Sites of possibilities for equitable opportunities to engage underrepresented youth in STEM	2017	185	Teachers College Record	(Barton et al., 2017)
5	J.C.-K. Lee, H.-B. Yin	Teachers' emotions and professional identity in curriculum reform: A Chinese perspective	2011	137	Journal of Educational Change	(Lee & Yin, 2011)
6	J. Settlage, S.A. Southerland, L.K. Smith, R. Ceglie	Constructing a doubt-free teaching self: Self-efficacy, teacher identity, and science instruction within diverse settings	2009	135	Journal of Research in Science Teaching	(Settlage et al., 2009)
7	L. Avraamidou	Studying science teacher identity: current insights and future research directions	2014	125	Studies in Science Education	(Avraamidou, 2014)

No.	Authors	Title	Year	Cites	Journal	Refs
8	S.D. Snapp, H. Burdge, A.C. Licona, R.L. Moody, S.T. Russell	Students' Perspectives on LGBTQ-Inclusive Curriculum	2015	106	Equity and Excellence in Education	(Snapp et al., 2015)
9	S.L. Nichols, P.A. Schutz, K. Rodgers, K. Bilica	Early career teachers' emotion and emerging teacher identities	2017	97	Teachers and Teaching: Theory and Practice	(Nichols et al., 2017)
10	P. Prokop, G. Tuncer, J. Chudá	Slovakian students' attitudes toward biology	2007	85	Eurasia Journal of Mathematics, Science and Technology Education	(Prokop et al., 2007)
11	B.A. Brown, P. Boda, C. Lemmi, X. Monroe	Moving Culturally Relevant Pedagogy From Theory to Practice: Exploring Teachers' Application of Culturally Relevant Education in Science and Mathematics	2019	81	Urban Education	(Brown et al., 2018)
12	D. Tsybulsky, Y. Muchnik-Rozanov	The development of student-teachers' professional identity while team-teaching science classes using a project-based learning approach: A multi-level analysis	2019	77	Teaching and Teacher Education	(Tsybulsky & Muchnik-Rozanov, 2019)
13	J. Sjöström	Towards Bildung-Oriented Chemistry Education	2013	75	Science and Education	(Sjöström, 2013)
14	L. Sutherland, L. Markauskaite	Examining the role of authenticity in supporting the development of professional identity: An example from teacher education	2012	75	Higher Education	(Sutherland & Markauskaite, 2012)
15	L. Black, J. Williams, P. Hernandez-Martinez, P. Davis, M. Pampaka, G. Wake	Developing a 'leading identity': The relationship between students' mathematical identities and their career and higher education aspirations	2010	75	Educational Studies in Mathematics	(Black et al., 2010)
16	A.L. Luehmann, L. Tinelli	Teacher professional identity development with social networking technologies: Learning reform through blogging	2008	75	Educational Media International	(Luehmann & Tinelli, 2008)
17	A.L. Luehmann	Using blogging in support of teacher professional identity development: A case study	2008	73	Journal of the Learning Sciences	(Luehmann, 2008)
18	A. Holliday	The role of culture in English language education: Key challenges	2009	70	Language and Intercultural Communication	(Holliday, 2009)

No.	Authors	Title	Year	Cites	Journal	Refs
19	M.F. Mortensen, K. Smart	Free-choice worksheets increase students' exposure to curriculum during museum visits	2007	68	Journal of Research in Science Teaching	(Mortensen & Smart, 2007)
20	D. Block, B. Moncada-Comas	English-medium instruction in higher education and the ELT gaze: STEM lecturers' self-positioning as NOT English language teachers	2022	64	International Journal of Bilingual Education and Bilingualism	(Block & Moncada-Comas, 2022)

The overall 541 developments of research articles on science identity in teacher education can be seen in [Figure 3](#).

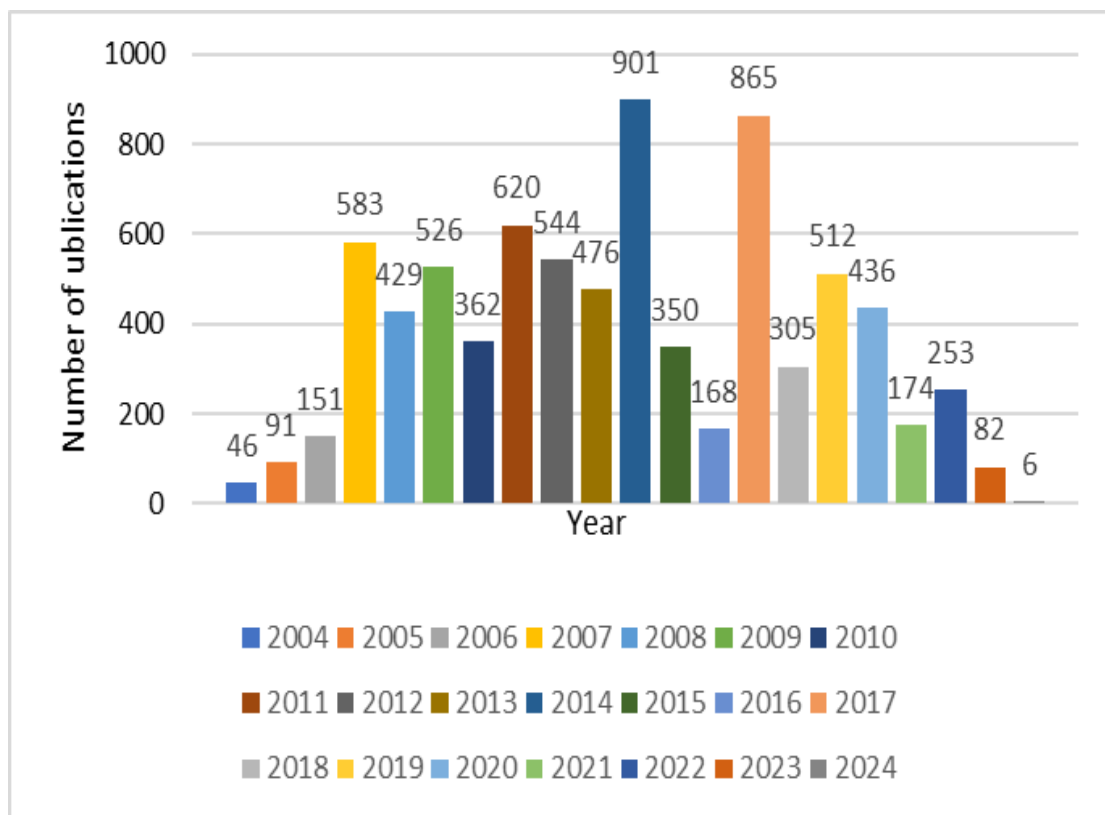


Figure 3. Number of Article Citations Over 20 Years

Base on [Figure 3](#), data from year-to-year research on science identity in teacher education experiences fluctuating dynamics. However, it has started to rise in the 2010s. In the 2010s, there was a paradigm shift in science education, focusing on developing students' and teachers' abilities to build broader science knowledge and skills. This requires teachers to have a clearer and more stable identity in teaching science, thus increasing research interest in science teacher identity. There was a drastic increase from 2013 to 2014, which can be seen from the number of publications in 2014 of, 476 and 2013 of 901. In 2013-2014, research on science teacher identity began to use more diverse qualitative and quantitative methods. This allowed researchers to collect more extensive and accurate data and better understand the complexities of science teacher identity. This mapping consists of several interrelated components, including network visualisation in [Figure 4](#).

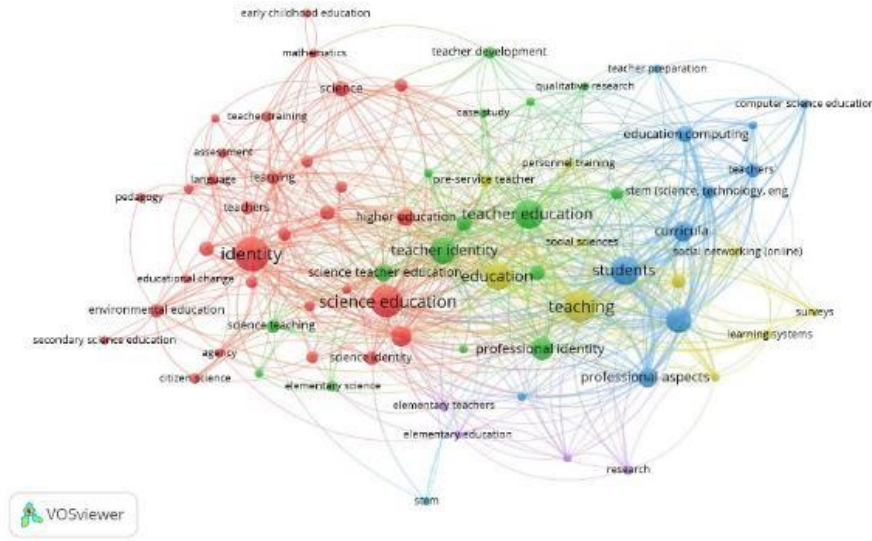


Figure 4. Network Visualization of Science Identity in Teacher Education Keyword

Base on Figure 4, mapping for publication data was conducted using the VOSviewer application. The mapping results show that 73 words related to science identity in the field of teacher education are divided into 6 clusters. Overlay visualisation, and density visualisation presented in Figures 5 and Figure 6.

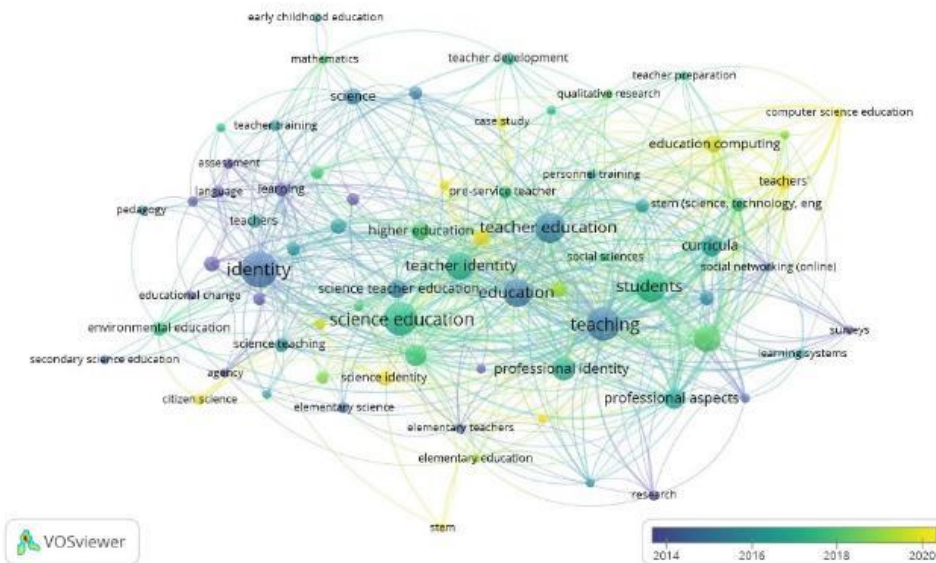


Figure 5. Overlay Visualization of Science Identity in Teacher Education Keyword

Based on Figure 5, it is clear that research related to the term "science identity" has a relatively small circle diameter and faded colour, indicating that research on science identity is still relatively low. In contrast, research on teacher education and chemistry education has a larger circle diameter and a greenish-yellow colour, indicating that research on chemistry education is quite high. The term "science identity" has appeared in teacher education, implying that research on science identity in teacher education has been conducted.

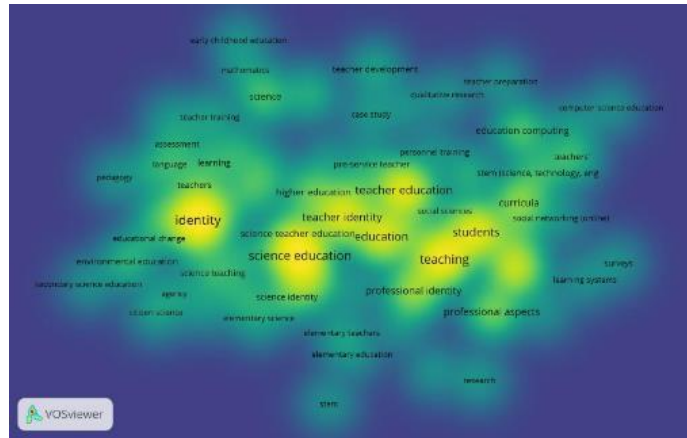


Figure 6. Density Visualization of Science Identity in Teacher Education Keyword

Figure 6 above displays a density visualization showing the relationship between term labels' colour and circle size. The lighter the yellow colour and the larger the diameter of the term label circle, the more frequently the term appears in the text. This indicates that the term has been the focus of significant research, with many studies having been conducted and published. Conversely, if the colour of the term fades closer to the background colour, then the amount of research on the term is relatively small and has received less attention.

The network visualizations for the keywords "Science identity" and "Teacher education" are presented in Figures 7 and Figure 8 respectively.

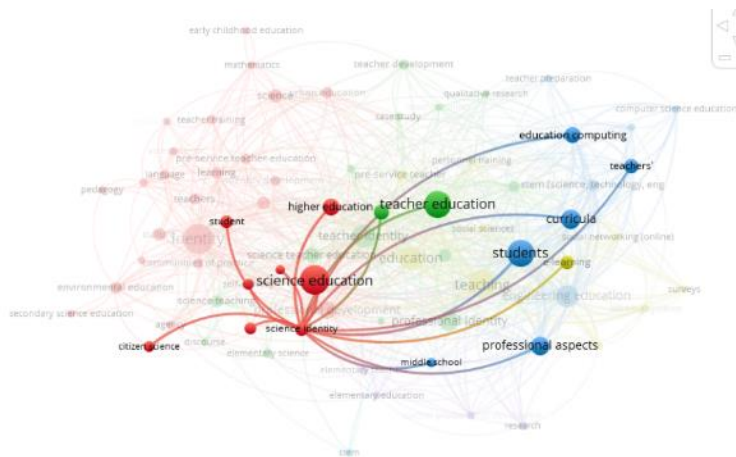


Figure 7. Networking Science Identity

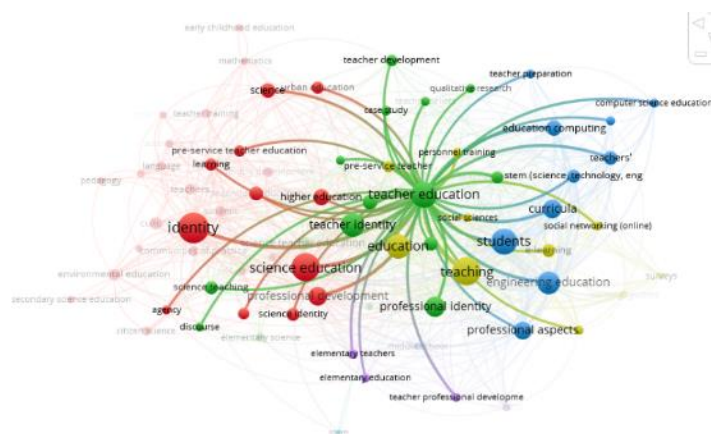


Figure 8. Networking Teacher Education

Based on [Figures 7](#) and [Figure 8](#), for networking visualization, the keywords "Science Identity" and "Teacher Education" are related. When looking at each keyword, specifically, "science identity" is in cluster 1, which includes 16 links, 20 link strengths, and 11 occurrences. Similarly, "Teacher education" is in cluster 2, which consists of 45 links, 104 link strengths, and 50 occurrences. To see how the overlay visualization on the keyword "Science Identity" is presented in [Figure 9](#).

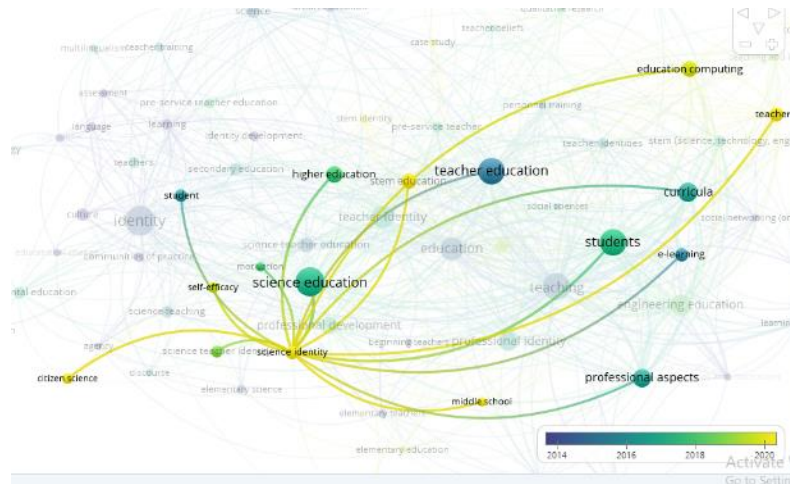


Figure 9. Overlay Visualization Science Identity

[Figure 9](#) shows that most of the research on science identity in teacher education was conducted from the beginning of 2014 to 2020. The popularity of science identity and teacher education in research has been around for a long time.

Discussion

The clusters are (1) cluster 1, which consists of 31 items marked in red, including agency, assessment, citizen science, communities of practice, culture, curriculum, early childhood education, educational change, environmental education, higher education, identity, identity development language, mathematics, motivation, multilingualism, pedagogy, pre-service teacher education, professional development, science, science education, science identity, science teacher identity, secondary education, secondary teacher education, self-efficacy, students, teacher training, teachers, urban education ([Block & Moncada-Comas, 2022](#); [Holliday, 2009](#); [Mortensen & Smart, 2007](#)). (2) cluster 2, marked in green, consists of 16 items, including novice teacher, case study, discourse, basic science, professional identity, qualitative research, science teacher education, science teacher, science teaching, basic education, basic identity, teacher beliefs, teacher development, teacher education, teacher identity, teacher identity ([Herdhiyani et al., 2024](#); [Veith & Bitzenbauer, 2022](#); [Zhai et al., 2024](#)). (3) cluster 3, marked in yellow, consists of 11 items, including computer science education, curriculum, computing education, technical education, secondary school, professional aspects, stem (science, technology, engineering, meta-mathematics), students, teacher preparation, teachers, teaching and learning. (4) cluster 4, marked with color, consists of 10 items, including e-learning, education, learning systems, personnel training, pre-service teachers, social networking, social science, society and institutions, surveys, and teaching ([Avraamidou, 2014](#); [Zhai et al., 2024](#)). (5) cluster 5, marked in purple, consists of 4 items: basic education, primary school teachers, research, and teacher professional development. (6) and cluster 6 marked in yellow consists of 1 item, namely stem.

Therefore, we can easily create new research on science identity in teacher education. Previous research shows that in the last two decades, there has been an increase in research on science teacher identity, involving empirical research published in leading science journals (Zhai et al., 2024). Research on science identity within the context of teacher education has been a significant focus of science education for some time, and the findings indicate that greater efforts are needed to integrate the concept of sustainability alongside science identity in teacher education programs. This involves incorporating knowledge of scientific content, scientific context, distinctiveness, and methodological characteristics of science into the curriculum to prepare students for the challenges of sustainable development (Avraamidou, 2014; Herdhiyani et al., 2024).

Based on the mapping results, the application of science identity in teacher education is still very minimal to learn. The research results contribute significantly to the scientific field of teacher education by highlighting the minimal application of science identity in Indonesian teacher education, which currently focuses primarily on the analysis and synthesis of science concepts without adequately training teachers to understand and develop students' science identities for human, social, and environmental welfare (Setyawan et al., 2021; Siti et al., 2021). This causes teachers to have weaknesses in understanding students' science learning outcomes. Future science education challenges are related to global sustainability, which requires attention to authentic interdisciplinary contexts to teach students about the complexity of global issues, including social, economic and environmental components.

Therefore, more efforts are needed to introduce the concept of sustainability with a science identity in teacher education to address current and future issues. One of the efforts to introduce it to students is to incorporate aspects of science identity into the science curriculum so that knowledge of scientific content, scientific context, distinctiveness, and methodological characteristics of science can answer the challenges of education for sustainable development.

4. CONCLUSION

This study was conducted to analyse bibliometric data from research articles related to "Scientific Identity in Teacher Education." The data from Scopus included titles and abstracts. The results showed that from 2004-2024, there were 541 relevant articles. That research on scientific identity and teacher education decreased from 2020-2024. However, these results show that there is a great opportunity to conduct research on scientific identity in teacher education, which is related to other terms that emerged from the data mapping results.

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