

Development of Mangrove Ecotourism Teaching Materials on Ecosystem Material to Improve Students' Science Literacy Skills: A Literature Review

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Abstract: This study aims to identify and analyze the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills. Using the systematic literature review method, this study collected and analyzed scientific articles published between 2015 and 2024 through the Google Scholar and Sinta databases. The focus of the study includes keywords such as "Learning Materials Development", "Mangrove", "Ecosystem", and "Science Literacy". The results of the review show that environmental-based teaching materials, especially those that link the concept of mangrove ecotourism, can significantly improve students' scientific literacy. Learning approaches such as project-based learning and the use of interactive media have proven effective in attracting students' interest. This study confirms that the development of teaching materials that are contextual and relevant to students' environment can encourage a better understanding of ecosystems and the environmental issues they face. It is hoped that through direct experience and interaction with the mangrove ecosystem, students will not only gain theoretical knowledge, but will also be able to apply it in their daily lives, thereby contributing to environmental conservation. Thus, the development of mangrove ecotourism teaching materials is expected to be an effective tool in science education and increase students' environmental awareness.

Keywords: Development of teaching materials; Ecosystem; Mangrove; Science literacy

Introduction

Science education at the secondary school level plays a very important role in shaping students' understanding of the environment and natural phenomena around them. One aspect that needs to be taught is the ecosystem, which includes scientific concepts and the reciprocal relationship between humans and nature. In this context, teaching about mangrove ecosystems, such as those in Bagek Kembar, becomes increasingly relevant considering the environmental conditions that require more attention.

Mangrove ecosystems not only function as environmental protectors, but also as resources that can be utilized through the development of sustainable ecotourism (Alfriza et al., 2018; Fadhilah et al., 2023).

Science subjects aim to enable students to understand and apply scientific concepts in everyday life. BSKAP Document 033 of 2022 states that one of the goals of science learning is to develop students' scientific literacy. Scientific literacy includes the ability to understand, evaluate, and apply scientific information, and to use that knowledge to solve problems in relevant contexts. Students who have good scientific literacy are expected to be able to explain these concepts in their own

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language and apply them in real situations, so that they can contribute to solving environmental issues faced by society (Ministry of National Education, 2022).

However, there are major challenges in achieving this goal. Data from international studies such as PISA (Programme for International Student Assessment) shows that Indonesian students' scientific literacy skills are still below standard. In PISA 2022, Indonesia ranked 72 out of 79 participating countries in terms of science skills. This shows that students' understanding of scientific concepts and their ability to apply them in everyday life still need to be improved. This low score reflects a gap in science education that needs to be addressed immediately.

Several factors that contribute to low scientific literacy among students include a lack of interest in science lessons, non-contextual teaching methods, and minimal use of interesting media and teaching materials (Al Mubarak et al., 2024). In addition, according to Lekahena et al. (2024) the learning strategies applied by teachers are often monotonous and uninspiring, thus inhibiting students' active involvement in the learning process. Students who are not involved tend to have a poor understanding of the material and find it difficult when facing challenges in learning.

Previous studies have shown that developing relevant and contextual teaching materials can improve students' understanding. For example, research by Amelia et al. (2024) found that project-based learning can improve students' engagement and understanding of the material. Thus, developing mangrove ecotourism teaching materials in Bagek Kembar can be an innovative solution to overcome this challenge. Teaching materials based on real situations in students' environments are expected to increase their interest and understanding of ecosystems and existing environmental issues.

Through the development of contextual teaching materials, students will not only gain theoretical knowledge, but also practical experience that can deepen their understanding (Sari et al., 2024). Direct interaction with the mangrove environment, for example, can provide opportunities for students to observe and analyze ecosystems directly, as well as understand the importance of maintaining environmental sustainability. In this way, it is hoped that students can become agents of change who care about the environment and are able to apply their knowledge in everyday life.

This study aims to explore the development of mangrove ecotourism teaching materials on ecosystem material, with the hope of improving the science literacy skills of grade X high school students in West Lombok. Through a contextual and relevant approach, it is expected that students will not only understand scientific concepts but also be able to apply them in real contexts and contribute to the preservation of their

environment. Thus, this study is expected to provide a positive contribution to science learning and support efforts to preserve mangrove ecosystems in the region.

Method

The systematic literature review (SLR) method was used in this study to analyze and synthesize literature relevant to the topic being studied. SLR is a systematic way to identify, evaluate, and interpret all research results that are in accordance with the topic that is the focus of the study (Calderón et al., 2015). The articles reviewed are articles related to the title of this study from trusted online sources. From various literature reviews, they will be searched using the keywords: development of teaching materials, mangroves, ecosystems, and scientific literacy. To conduct this study, researchers collected articles from the Google Scholar and Sinta databases that were selected based on the required research keywords. Furthermore, researchers conducted an in-depth review and identified the selected articles sequentially, according to the steps set out in the systematic literature review method (Marzi et al., 2025).

The next step, the author analyzed the abstract and context that discussed the trend of developing mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills. The criteria used to search for related articles are: (1) The article is the result of research from science education articles; (2) Articles published in the period 2019-2024 with the keywords development of teaching materials, mangroves, ecosystems, scientific literacy.

Next, the researcher will conduct a literature review by selecting a number of articles that are closely related to the keywords used. Important data from the articles, such as the name of the author/researcher, year of publication, title, journal name, results, and type of approach or learning model that will be classified and presented in the table provided. Next, the researcher will analyze the contents of the articles in depth, especially in the discussion and conclusion sections, using the content analysis method with a specific coding scheme to draw inferences related to communication in the text (Maer-Matei et al., 2019). Through this literature study, the researcher hopes to collect references that are relevant to the formulation of the research problem. The expectation of the output in this study is the availability of certain approaches and learning models that can improve students' scientific literacy skills.

Result and Discussion

In several literature studies related to the keywords of this problem about the trend of teaching material development, mangroves, ecosystems, and scientific literacy, researchers found a number of relevant study

results from the articles that have been collected. The research data in this article is a summary and analysis of various empirical studies that have been published, in accordance with the keywords that are the focus of research conducted from 2015 to 2024. Research documents on the trend of research on the development of mangrove ecotourism teaching materials on

ecosystem material to improve students' scientific literacy skills are taken from Google Scholar documents. The following is Figure 1 regarding the trend of research on the development of teaching materialsteach mangrove ecotourism on ecosystem material to improve students' scientific literacy skills.

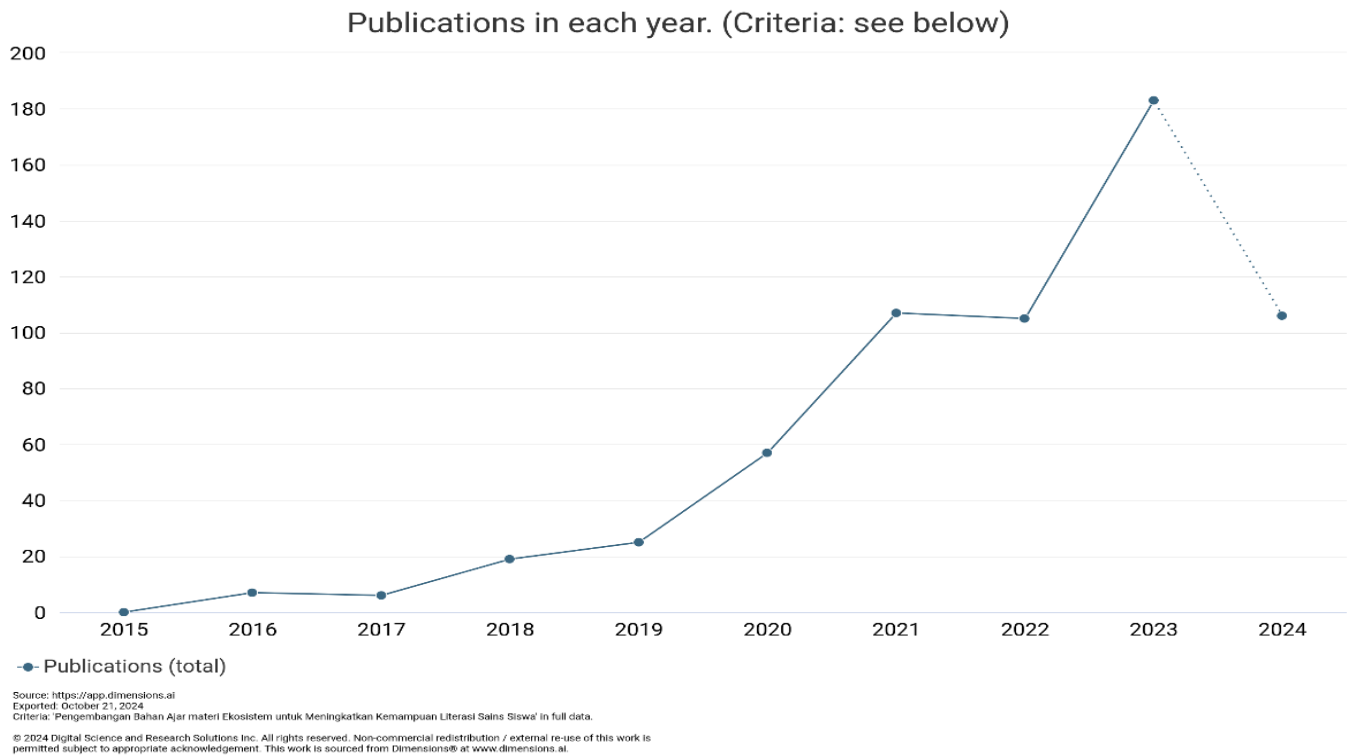


Figure 1.Research trends in the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills

Figure 1 shows that the research trend on the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills from 2015 to 2024 shows that in 2015, the number of publications recorded was only around 10. However, this number then increased gradually from year to year, indicating increasing interest and research activity in this field. A significant increase occurred in 2021, where the number of publications peaked at around 175. Although there was a decline after 2021, the number of publications was still much higher than before 2021, and is expected to return to close to 100 in 2024. Overall, Figure 1 indicates a fairly rapid upward trend related to research on the development of mangrove ecotourism teaching materials, as an effort to improve scientific literacy among students.

Based on Table 1, it is known that the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills from 2015 to 2024, there are 3 types of

publications. In the form of articles there are 245 documents, Edited Book form as many as 2 documents and Proceedings as many as 1 document. The research trend in the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills for the most types of publications compared to other types of publications is in the form of articles. Research conducted by La Placa et al. (2024) states that an article is a written work that presents research results in a particular field that aims to convey ideas and facts that can convince a person who reads it.

Table 1. Trends in Developing Mangrove Ecotourism Teaching Materials on Ecosystem Material to Improve Students' Scientific Literacy Skills

Publication Type	Publication
Article	245
Edited Book	2
Proceeding	1

Table 2. Top 10 Categorical Sources Related to the Trend of Developing Mangrove Ecotourism Teaching Materials on Ecosystem Material to Improve Students' Science Literacy Skills in 2015-2024

Name	Publications	Citations	Citations Meaning
Education	248	688	2.77
Curriculum and Pedagogy	248	688	2.77
Education Systems	84	169	2.01
Language, Communication and Culture	16	28	1.75
Information and Computing Sciences	15	26	1.73
Engineering	5	10	2.00
Philosophy and Religious Studies	5	17	3.40
Creative Arts and Writing	4	2	0.50
Human Society	4	4	1.00
Social Work	4	4	1.00

Table 2 presents the top 10 category sources related to the trend of developing mangrove ecotourism teaching materials on ecosystem materials to improve students' science literacy skills from 2015 to 2024. The categories "Education" and Curriculum and Pedagogy" each had 248 publications and 688 citations, with an average citation of 2.77, indicating high interest. The category "Education Systems" had 84 publications and 169 citations, with an average citation of 2.01. Meanwhile, "Language, Communication and Culture" recorded 16 publications and 28 citations, with an average of 1.75. The category "Information and Computing Sciences" had 15 publications and 26 citations, with an average of 1.73. The categories

"Engineering," "Philosophy and Religious Studies," "Creative Arts and Writing," "Human Society," and "Social Work" showed a lower number of publications, with "Philosophy and Religious Studies" has the highest average citation at 3.40 despite having only 5 publications. Overall, this table illustrates the variation in the number of publications and citations in various fields related to the development of ecotourism teaching materials. Table 3 presents the trend of the top ten article titles in research on the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills, which are often cited by other researchers on this matter.

Table 3. Top 10 Quotes on Trends in Developing Mangrove Ecotourism Teaching Materials on Ecosystem Materials to Improve Students' Science Literacy Skills in 2015-2024

Mean	Year	Author	Title
1.48	2024	Abdul Syukur	Advances in Social Science, Education and Humanities Research
3.23	2023	Asrizal	Berkala Ilmiah Pendidikan Biologi (BioEdu)
2.67	2022	Bambang Supriatno	Jurnal Basicedu
1.47	2021	I Gede Margunayasa	Jurnal Penelitian Pendidikan IPA
2.15	2020	Muhammad Zaini	Edukatif Jurnal Ilmu Pendidikan
3.42	2019	Fida Rachmadiarti	Jurnal Pendidikan Teori Penelitian dan Pengembangan
1.00	2018	Riandi Riandi Riandi	Jurnal Ilmiah Profesi Pendidikan
30.56	2017	I Gusti Ayu Tri Agustiana	Jurnal Inovasi Pendidikan IPA
5.78	2016	Lufri Lufri	Jurnal Pijar MIPA
0.56	2015	Relsas Yogica Relsas Yogica	Bioscientist Jurnal Ilmiah Biologi

Table 3 shows that research on the development of mangrove ecotourism teaching materials on ecosystem material to improve students' science literacy skills from 2015 to 2024. From the data listed, the highest citation came from Agustiana in 2017 with an average citation of 30.56, followed by Rachmadiarti in 2019 with 3.42. Several other publications, such as Asrizal (2023) with 3.23 and Supriatno (2022) with 2.67, show significant relevance and influence in this field. Although there is variation in the number of citations, many works have received academic attention, with several publications from previous years, such as Lufri (2016) and Yogica (2015), also receiving attention although with a lower average citation. Thus, this table shows that research and publications on the development of mangrove ecotourism teaching materials have produced several

significant and influential works, especially in 2017, which was the peak of citations. This reflects the importance of this topic in the context of science education and literacy, as well as the potential for continued development in the future.

Figure 2 displays a network visualization that illustrates the complexity and interconnectedness of various concepts related to the development of ecotourism teaching materials for mangrove ecosystems, with the aim of improving students' scientific literacy skills. The central concept is "ecotourism", which is connected to various other elements such as "mangrove forest", "mangrove area", "mangrove conservation", "community", and "resource". Clusters of interrelated concepts are also visible, such as those related to "mangrove conservation" and

"environmental education", as well as those related to "tourism" and "awareness". The size of the nodes and the thickness of the lines indicate the relative importance and strength of the relationships between concepts. This visualization provides a comprehensive overview of the complexity of the research topic, helping to identify key themes and relationships between various aspects that

are relevant in the development of mangrove ecotourism teaching materials to improve students' scientific literacy. The following also presents keywords regarding the research on the development of bird watching ebooks to improve ecological, conservation, and ecotourism literacy in the form of an overlay visualization in Figure 3.

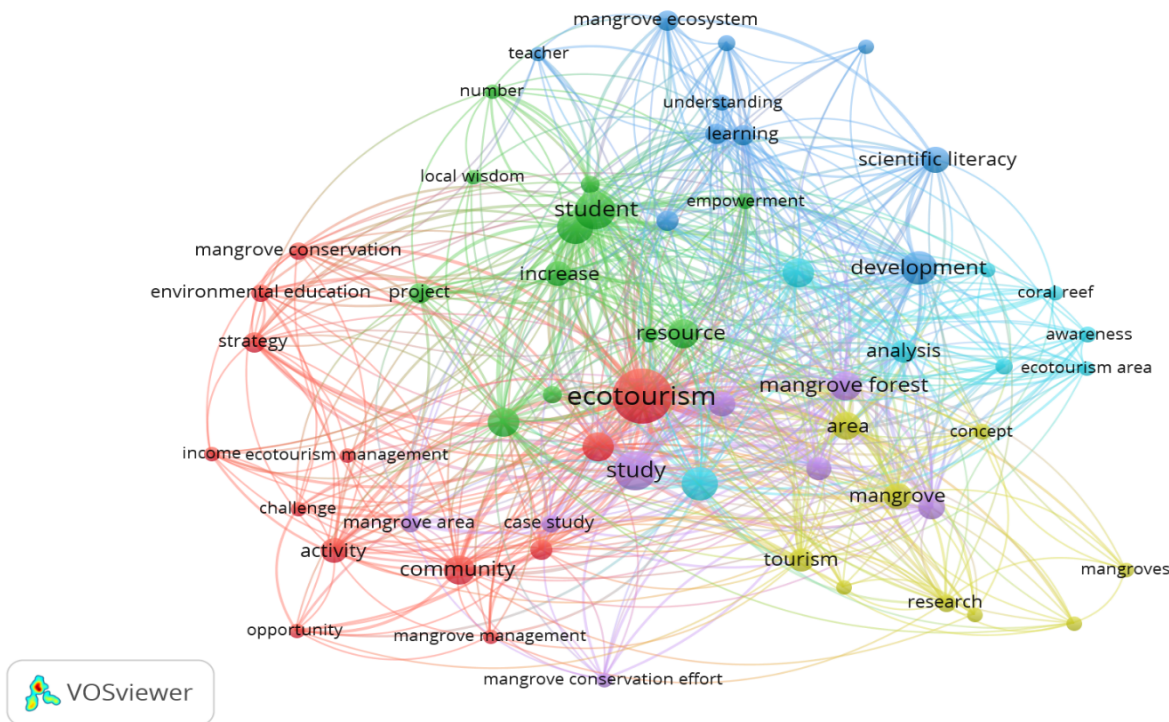


Figure 2. Network visualization in the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills

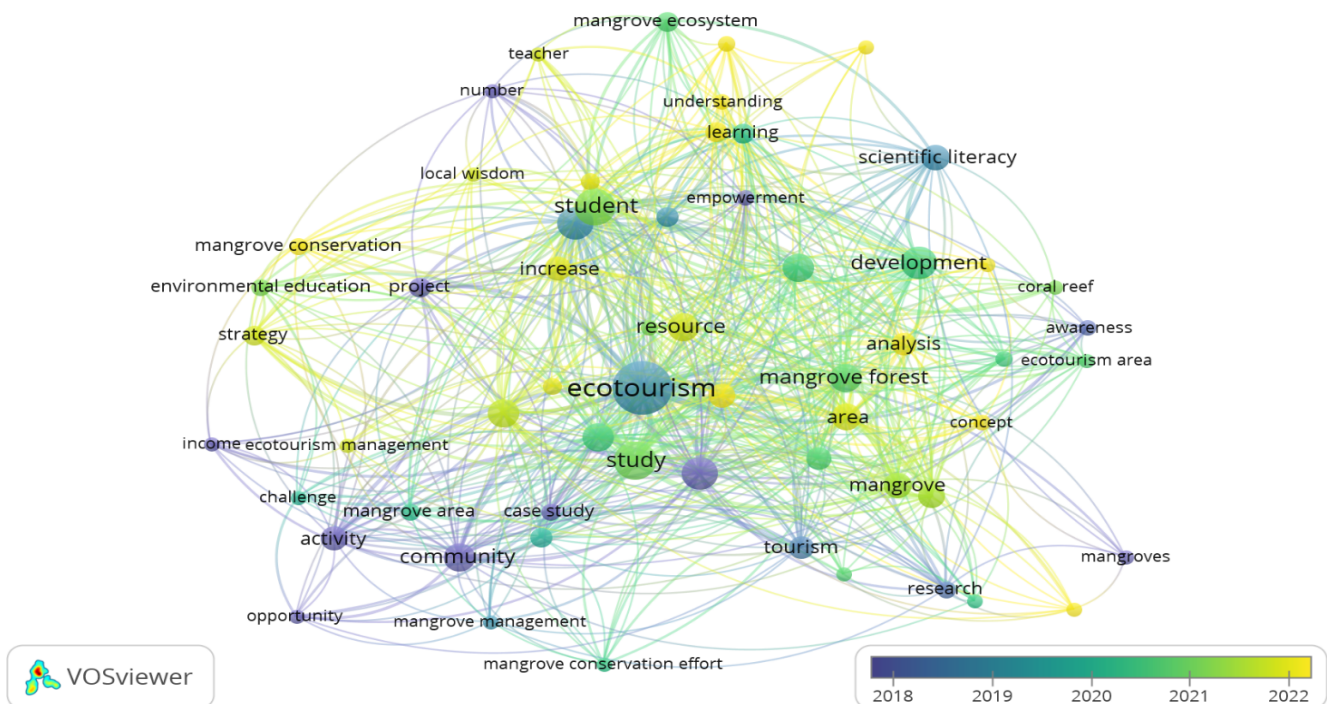


Figure 3. Overlay visualization on development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills

Figure 3 presents a visualization depicting the trend of research publications related to the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills, from 2018 to 2022. At the top, the graph shows a significant increase in the number of publications, reaching a peak in 2021, although it then tends to decline but is still higher than before. At the bottom, the network visualization illustrates the complexity and interconnectedness of related concepts, with "ecotourism" as the main focus connected to other elements such as "mangrove forest", "mangrove conservation", "community", and "resource". Clusters of interrelated concepts are also identified, such as those related to "mangrove conservation" and "environmental education", as well as "tourism" and "awareness". The size of the nodes and the thickness of the lines reflect the level of importance and strength of the relationship between concepts. Overall, this figure presents a holistic picture of the trends and characteristics of research in the field of developing mangrove ecotourism teaching materials to improve students' scientific literacy.

Figure 4 presents a density visualization that illustrates the conceptual structure and hierarchy in the

research on the development of mangrove ecotourism teaching materials to improve students' science literacy skills. The concept of "ecotourism" is seen as the center of the visualization, with the brightest yellow-white area, indicating a very high level of concentration and interconnectedness. Surrounding this core concept are clusters of other closely related concepts, such as "mangrove forest", "mangrove area", "mangrove conservation", "resource", "study", and "community", marked by darker green-blue areas. Meanwhile, concepts that have a lower level of connection and interconnectedness, such as "teacher", "number", "local wisdom", are seen in the light purple-blue area. The color gradation from yellow-white to green-blue and light purple-blue illustrates the level of density and interconnectedness between concepts, where lighter areas indicate higher concentration. Overall, this visualization provides a clear picture of the conceptual structure centered on "ecotourism" as the main focus of this research topic. The following Figure 4 relates to the visualization of density in the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills, namely as follows:

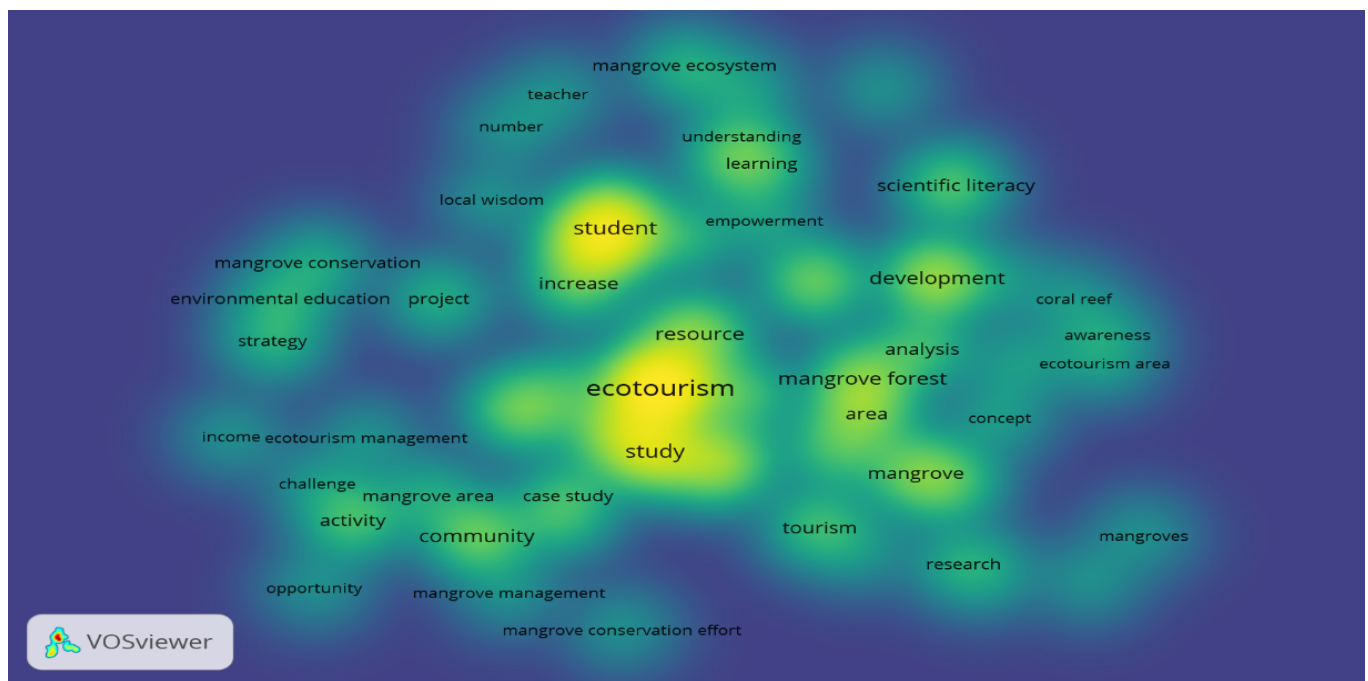


Figure 4. Density visualization in the development of mangrove ecotourism teaching materials on ecosystem material to improve students' science literacy skills

Overall, research related to the development of mangrove ecotourism teaching materials on ecosystem material to improve students' scientific literacy skills shows that the complex relationship between the concept of "ecotourism" and related elements such as "mangrove forest", "mangrove conservation", and "community" is very important in improving students' scientific literacy. The network visualization illustrates

the research trend showing a significant increase in publications related to mangrove ecotourism from 2018 to 2022, with a peak in 2021, reflecting the growing interest in this field. In addition, the conceptual structure displayed highlights the importance of integrating various elements in science education. With a contextual approach and direct experience in the mangrove ecosystem, it is hoped that students will not only

understand scientific concepts but also become agents of change who care about the environment, making this teaching material an effective tool in science education in the future.

Conclusion

This study shows that the development of mangrove ecotourism teaching materials has great potential in improving students' scientific literacy skills. The relationship between the concept of "ecotourism" and related elements such as "mangrove forest", "mangrove conservation", and "community" is very important in creating a holistic understanding. Research trends show a significant increase in interest in this topic, especially in 2021, reflecting the relevance and urgency of integrating environmental issues into education. With a context-based approach and direct experience, students are expected to become agents of change who are responsive to environmental challenges, so that the development of this teaching material is not only academically beneficial but also supports the sustainability of the mangrove ecosystem.

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Conflicts of Interest

No conflict interest.

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