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The Role of Interactive E-Books in Enhancing Science Literacy: A Review of Studies from 2015 to 2024

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Abstract: This study explores the role of interactive e-books in supporting science literacy through bibliometric analysis using Publish or Perish, VOS viewer, and Dimensions tools. By utilizing overlay, density, and network visualizations, this study identifies key research trends, relationships between concepts, and term frequency densities in the literature related to interactive e-books. The results of the analysis show that publications related to interactive e-books in science literacy have increased significantly during the COVID-19 pandemic, with articles and book chapters being the most dominant forms of publication. These findings suggest that interactive e-books not only support more flexible science learning but also enable the integration of digital technologies to improve critical thinking skills and understanding of scientific concepts across a range of subject areas, including health and agricultural sciences.

Keywords: Bibliometrics; Dimensions; Educational technology; Interactive e-books; Science literacy; VOS viewer

Introduction

The development of digital technology has brought about major changes in the world of education, including in the way students learn science. One innovation that supports the science learning process is interactive e-books, which allow the integration of various digital features such as simulations, videos, and quizzes that can actively attract students' interest in the learning process (Boma et al., 2024; Doshi et al., 2024; Firdausy et al., 2020; Keedle et al., 2024; Stolpe et al., 2024). this interactive feature helps increase students' learning motivation because they feel more involved in the learning process (Falloon, 2019; Lim et al., 2021; Udompong et al., 2014; Yang et al., 2022). In addition, the use of mobile devices in science teaching also enables deeper learning through interactive and contextual activities (Skaraki et al., 2018).

Scientific literacy, which includes the ability to understand and apply scientific concepts in everyday life, is becoming increasingly important in facing global challenges. Scientific literacy not only helps students understand scientific phenomena but also prepares them to think critically and make decisions based on scientific evidence (Charzyński et al., 2022; Kumar et al., 2024; Oliver et al., 2020; Susilowibowo et al., 2024). Scientific literacy enables individuals to make informed decisions regarding environmental issues, while science education raises global awareness of issues such as pollution and deforestation (Cottafava et al., 2022; Filho et al., 2024). STEM-based e-books allow students to explore science concepts through an interactive and fun approach. The use of interactive e-books can increase student engagement in learning and allow them to connect theory with practical applications. Interactive e-books with simulation features and interactive quizzes help students visualize abstract concepts in science in a concrete and relevant way, and improve their problem-solving skills in a concrete way (Alsalhi et al., 2020; Asrizal et al., 2023; Hong et al., 2012; McCowan, 2023; Suja et al., 2022)

In this digital era, interactive e-books also enable personalization of learning, where students can learn at their own pace according to their needs and interests.

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Febrianti et al. (2022) showed that the use of e-books designed according to the local curriculum can increase the relevance and appeal of learning materials for students. This personalization of learning is very important because it allows students to have a learning experience that is tailored to their individual needs, which ultimately supports deeper understanding and improvement in their learning outcomes (Khofifah et al., 2023; Kusumawati et al., 2020).

In addition, interactive e-books also support the development of 21st century skills such as digital literacy and critical thinking. Pratiwi et al. (2022) emphasized that the ability to use digital technology such as interactive e-books is an important skill for students to be able to participate in an ever-evolving global society. Maričić et al. (2024) noted that interactive e-books allow students to learn through digital exploration and experimentation, which strengthens their critical skills in a more creative way. Thus, interactive e-books not only help improve science literacy but also prepare students to become knowledgeable global citizens who are adaptive to technological changes.

Hardiansyah et al. (2024) found that interactive e-books help build an early foundation in science literacy for elementary school students. They found that students who used interactive e-books were more motivated to learn and had a better understanding of basic science concepts compared to students who used traditional learning media. This suggests that interactive e-books can be an effective tool in supporting science learning, especially at the elementary school level (Asrowi et al., 2019).

To further understand the impact and research trends related to interactive e-books, analytical tools such as VOSviewer and Dimensions provide important insights. Suprapto et al. (2022) suggested that bibliometric analysis using this tool helps map research trends and relationships between key concepts frequently discussed in the literature. Putri et al. (2022) also found that by utilizing data from this tool, research related to interactive e-books can identify cross-disciplinary collaboration trends that drive innovation in the development of e-books for science education. Through these tools, this study seeks to explore the role of interactive e-books in the context of science literacy, identify patterns of collaboration between researchers, and understand how trends in the use of interactive e-books have evolved over time.

Method

This study uses review and bibliometric analysis methods to analyze data from Publish or Perish, VOSviewer, and Dimensions. Visualizations generated from VOSviewer include overlay, density, and network visualizations to map research trends and relationships between key concepts. This approach helps in understanding how interactive e-books impact science literacy and shows the development of research on this topic over time.

Result and Discussion

To understand research trends and the impact of interactive e-books in the context of scientific literacy, bibliometric analysis is used to map the development of this topic through various visualizations. Through tools such as Publih or Parish visualized by VOSviewer (overlay, density, and network visualization) and Dimensions provide an overview of key terms, relationships between concepts, and the density of term frequency in research related to interactive e-books. This analysis allows us to see how various elements in scientific literacy are interconnected and play a role in learning.

Publih or Parish Visualized by Vosviewer

A measuring tool is an instrument used to measure an object or event (Yanarti et al., 2023). The expansion of an object can be measured using an expansion measuring tool. The expansion measuring tool used to investigate the linear expansion of an object.

Overlay Visualization

Overlay visualization shows the time development of key terms in the literature. Based on the visualization results, terms such as "e-book," "student," and "literacy" are the center of more recent research. This is in line with the findings of Firdausy et al. (2020) who stated that interactive features in e-books allow students to more easily understand science material and increase their engagement in the learning process. In addition, Wang (2020) suggested that interactive features such as simulations can help students master complex scientific concepts, and terms such as "interactive features" that are more explicit in overlay visualizations indicate an increased focus on these elements in recent research. The resulting overlay visualization image for the Role of Interactive E-Books in Improving Science Literacy can be seen in Figure 1.

Density Visualization

Density visualization provides an overview of the frequency and density of terms in the literature. Terms with high density, such as "learning" and "science," indicate the main focus of research related to interactive e-books in the context of science literacy. Asrizal et al. (2023) noted that interactive e-books enable a richer learning experience, with simulations and quizzes that

enhance understanding of scientific concepts. Areas with high density indicate that research is more focused on how interactive e-books can support science learning and increase student engagement. Putri et al. (2022) also highlighted that the density of the term "science literacy" in literature shows how important it is to develop science literacy among students through the use of interactive media.

The visualization results of density for the Role of Interactive E-Books in Improving Science Literacy can be seen in Figure 2.

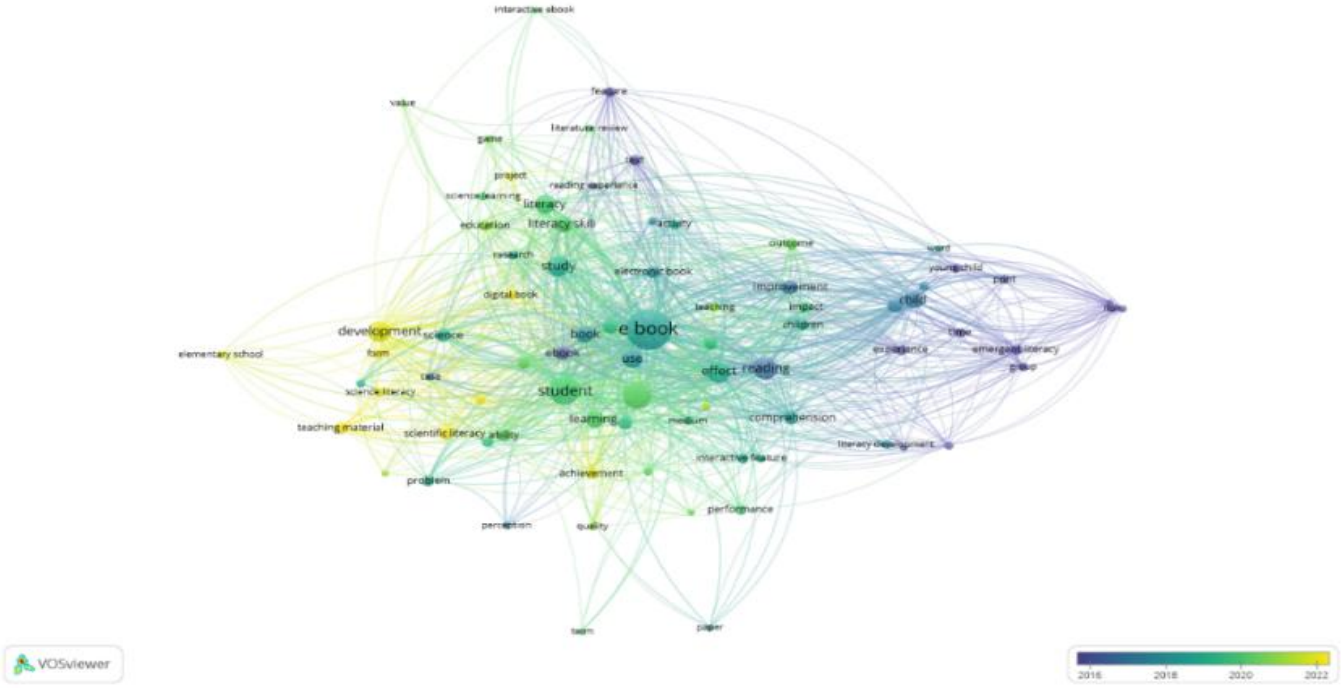

Figure 1. Overlay visualization for the role of interactive e-books in improving science literacy

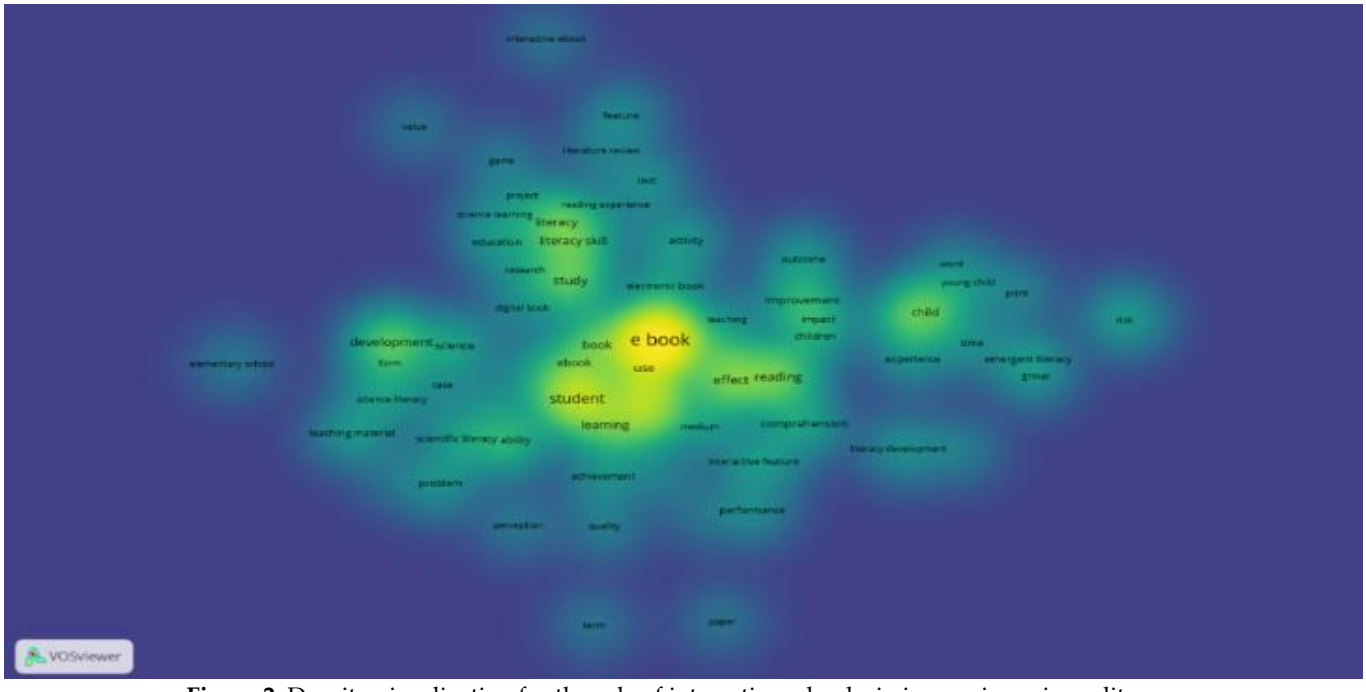

Figure 2. Density visualization for the role of interactive e-books in improving science literacy

Network Visualization

Network visualization shows the relationships between key concepts in the literature and identifies several key clusters. These clusters provide insight into how different aspects of interactive e-books and science literacy are related:

Green Cluster: Focusing on the terms "learning" and "comprehension," shows that interactive e-books are used to enhance students' understanding. Choo et al. (2018) stated that interactive e-books allow students to explore scientific concepts through a more practical learning approach, which can ultimately enrich their learning experience. Simulations and visual illustrations in e-books make it easier for students to understand natural phenomena and scientific processes (Grøver et al., 2023).

Yellow Cluster: Depicting the relationship between "development" and "science literacy," highlights the role of e-books in developing students' science literacy. Sukma et al. (2023) and Susilowibowo et al. (2024), emphasized that the use of e-books with a STEM approach can improve scientific literacy through the presentation of contextual and relevant content to everyday life and train students' thinking skills.

Blue and Purple Clusters: Leading to the topics of "child" and "emergent literacy," highlighting the use of interactive e-books in early childhood education. López-Escribano et al. (2021) found that interactive e-books help children develop basic literacy in a fun and interactive way, which can lay an important foundation for later science understanding.

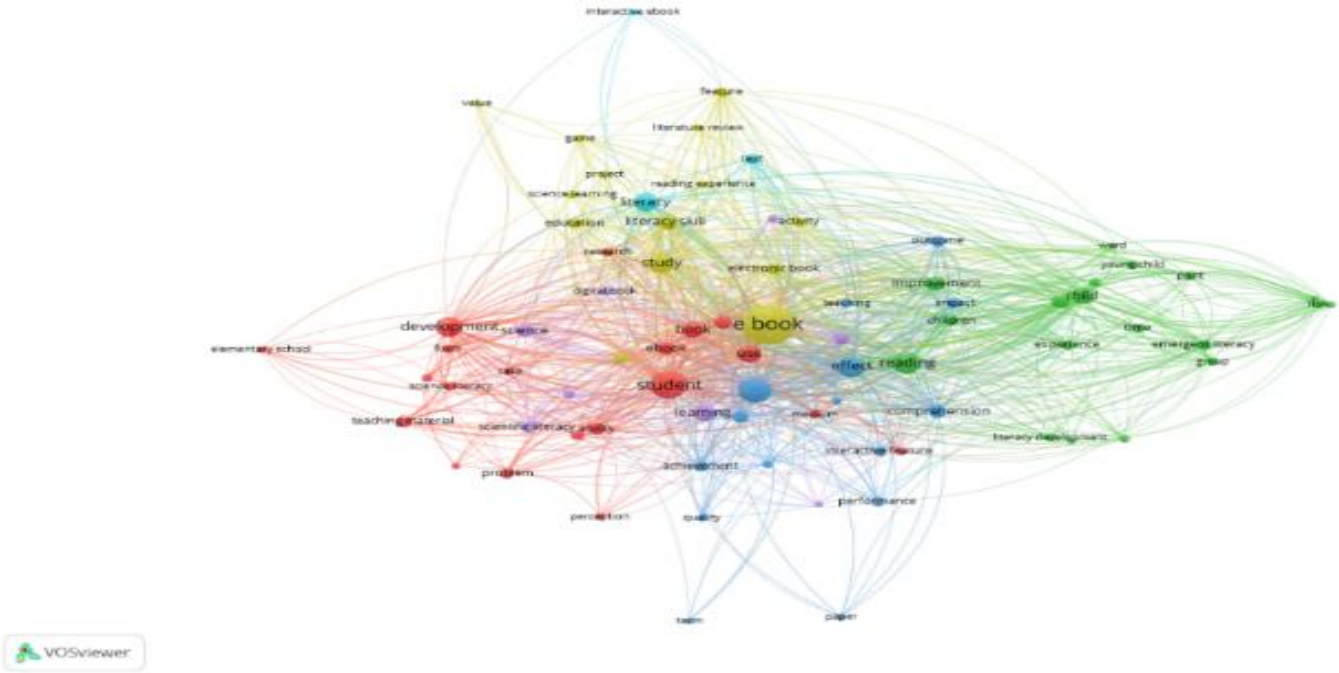

Figure 3. Network visualization for the role of interactive e-books in improving science literacy

Dimensions Analysis

In addition to the visualization from VOSviewer, data from Dimensions shows the annual publication trend related to this topic. This graph allows us to see the increase in the number of studies focusing on interactive e-books and science literacy. Data from Dimensions is used to map the annual publication trend related to the topic of using interactive e-books in science literacy. Based on the annual publication graph, since 2015, the number of publications focusing on interactive e-books and science literacy has increased significantly. This spike in publications peaked in 2020 and 2021, a period when the COVID-19 pandemic required learning to be shifted online, so that many educators and educational institutions turned to digital resources, including interactive e-books (Hardiansyah et al., 2024).

The increase in publications in 2020-2021 indicates that interactive e-books are considered an effective solution in supporting distance learning. However, in 2022, the number of publications decreased slightly, although interest in this topic remained high. This decline could be due to several factors. One is the shift of most institutions back to face-to-face learning, which reduces the immediate need for digital learning solutions. In addition, this trend may reflect a shift in research focus towards other learning technologies, such as augmented reality and virtual reality, which are also rapidly emerging in science education. Wang (2020) noted that these technologies can complement and enrich interactive e-books, offering a more immersive learning experience.

Despite the decline in the number of publications, academic interest in interactive e-books in science education remains relevant. Rokhayati et al. (2022) argued that interactive e-books not only serve as alternative learning media during the pandemic, but also become an integral part of long-term learning strategies, especially in developing scientific literacy in

the digital era. In addition, interactive e-books allow for content customization to suit local curricula and students' specific needs, making them an effective tool for a variety of educational contexts.

This Dimensions graph not only reflects short-term interest during the pandemic but also shows an increased awareness of the importance of digital literacy in education. The continuation of this trend shows that interactive e-books have the potential to continue to grow and be applied in various disciplines, especially science, where literacy skills are needed to understand complex and real-world concepts (Susilowibowo et al., 2024). Overall, the analysis of this Dimensions graph indicates that although interactive e-books were first seen as a support tool during the crisis, their potential to support ongoing science literacy has been recognized by the academic community. This is reflected in the increasing number of publications before, during, and after the pandemic, indicating that this topic will remain a major focus in the education and educational technology literature.

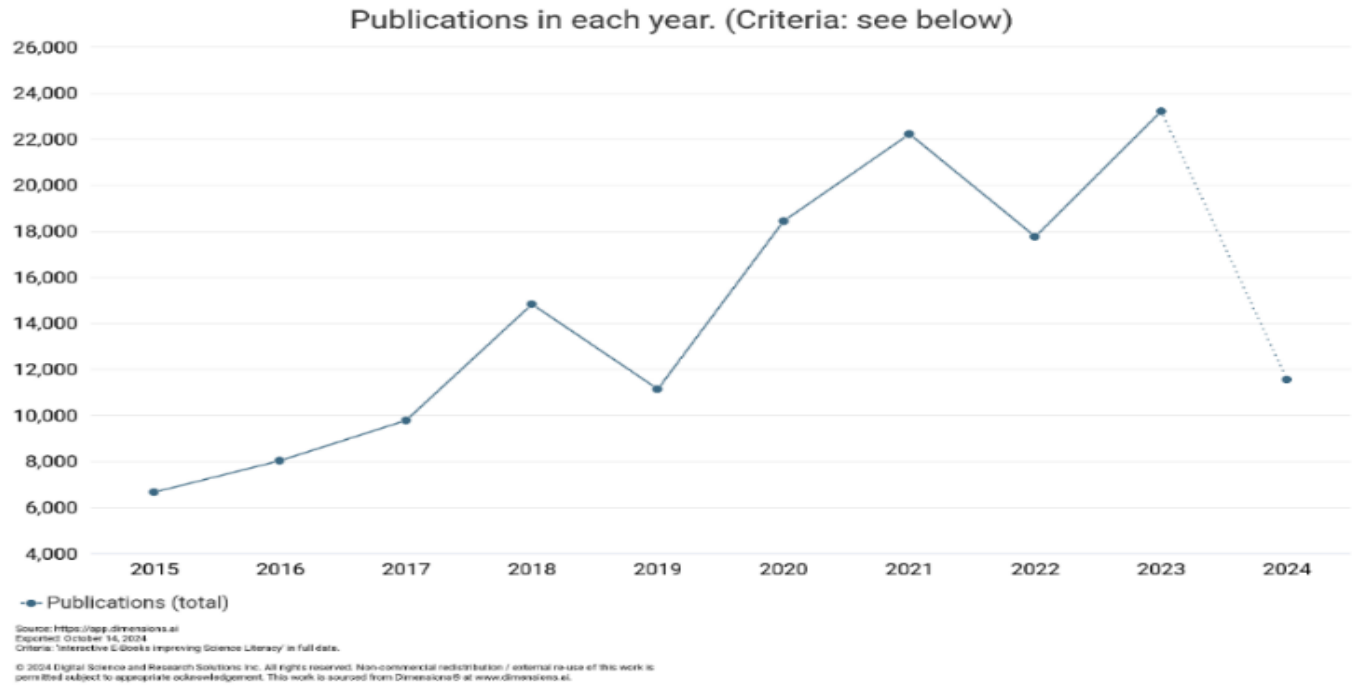

Figure 4. Dimensions graph for the role of interactive e-books in improving science literacy

Publication Type

In the Publication Type category, the most dominant publication type is Chapter with 92,024 publications, followed by Article with 58,878 publications. This publication form highlights the tendency of academics to utilize faster and more accessible formats when documenting findings related to interactive e-books. Publications in the form of Chapters often appear in books that focus on a specific topic, indicating that interactive e-books are seen as an integral part of the broader discussion on educational technology and innovation in science learning (Firdausy et al., 2020). The use of Chapters as a medium allows authors to explore the topic of e-books in a more comprehensive and cross-disciplinary context, providing insight into how interactive e-books can support various aspects of education and the development of science literacy. Based on the dimension data, the following is the publication type data used to present the findings related to the role of interactive e-books in improving science literacy.

Table 1. Types of Publications Used to Present the Findings Related to the Role of Interactive E-books in Improving Science Literacy

Publication Type	Published
Chapter	92,024
Article	58,878
Edited book	40,926
Monograph	32,143
Proceeding	5,433
Preprint	2,473

Articles, which are the second largest publication format, are often chosen for their ability to be distributed quickly, especially in situations where the need for the latest research is high, such as during the COVID-19 pandemic. According to Asrizal et al. (2023), the article format allows research on interactive e-books to be shared quickly with the scientific and educational communities, helping educators find new methods to

integrate digital technologies into their curricula during the distance learning period. These articles often highlight empirical results on the impact of interactive e-books on science literacy, student engagement, and critical thinking skills, all of which are important components of effective science education. The dominance of publications in the Chapter and Article formats reflects the flexibility of interactive e-books that can be adapted to various educational contexts. This suggests that interactive e-books not only support science literacy at the elementary level but can also be applied at various educational levels and across disciplines. For example, interactive e-books have been found useful in higher education for complex science courses, where interactive features can help visualize abstract scientific concepts (Putri et al., 2022). This shows that interactive e-books have become an important component in a broader spectrum of educational technologies that enable more flexible and student-focused learning.

Source Title

In the Source Title category, some of the main sources of publications are Lecture Notes in Computer Science, Encyclopedia of the UN Sustainable Development, and SSRN Electronic Journal, with 2,002, 1,577, and 1,358 publications, respectively. Publications in Lecture Notes in Computer Science show that research on interactive e-books is often integrated with studies related to computer science, especially in the fields of interactive application development and e-book supporting technologies. Interactive e-books in scientific literacy often utilize advanced technologies such as augmented reality and digital simulations, which help students visualize difficult concepts in science more effectively (Wang, 2020). The use of these technologies also helps students develop critical thinking and problem-solving skills, which are becoming increasingly important in science and technology education.

Table 2. Types of Publishers Used to Present the Findings Regarding the Role of Interactive E-books in Improving Scientific Literacy

publisher	Publications	Citation	Mean Citation
Lecture Notes in Computer Science	2,002	11,573	5.78
Encyclopedia of the UN Sustainable Development Goals	1,577	1,607	1.02
SSRN Electronic Journal	1,359	7,120	5.24
Epidemiology	1,138	763	0.67
Tobacco Induced Diseases	957	396	0.41
HortScience	948	319	0.34

The Encyclopedia of the UN Sustainable Development highlights the sustainable development aspect of interactive e-books, underlining their role in supporting scientific literacy relevant to global challenges. Interactive e-books help students understand complex issues such as climate change and sustainability through features designed to engage and deepen their understanding of the world around them (Susilowibowo et al., 2024). This suggests that interactive e-books are not only useful in science education, but can also be an effective tool for introducing students to broader global concepts, which is in line with the 21st century education goal of producing environmentally and socially conscious students. Furthermore, the presence of resources such as Tobacco Induced Diseases and HortScience suggests that interactive e-books are also being applied in specific fields, including public health and agriculture. For example, in health education, interactive e-books can be used to educate students about the risks of tobacco-related diseases, while in agriculture, interactive e-books can help teach sustainable agricultural practices (Hardiansyah et al., 2024). This demonstrates the flexibility of interactive e-books as a cross-disciplinary learning tool, allowing for the integration of a range of real-world relevant topics and issues. As such, these resources demonstrate the potential of interactive e-books to support education that is relevant to the needs of industry and wider society.

Conclusion

Based on the overall results of the analysis, it shows that interactive e-books play a key role in supporting science literacy with features that can increase student engagement and deepen their understanding of the subject matter. The surge in publications during the COVID-19 pandemic underscores the continued relevance and potential of interactive e-books as a digital learning tool, which is not limited to science education but can also be adapted across a range of other fields. With data from VOS viewer and Dimensions, as well as the types of publications and primary sources supporting them, interactive e-books show potential to be an integral component of long-term educational strategies focused on developing holistic digital and science literacy skills. These findings provide a foundation for content developers, educators, and policymakers to continue exploring and leveraging interactive e-books as an essential tool in education in the digital age.

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Conflicts of Interest
All authors declare that they have no conflict of interest.

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