Research Trend of Socioscientific Issues Based on Scopus Journal Database: A Bibliometric Study from 2011 to 2021

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Abstract: The implementation of socioscientific issues in science learning has increased recently. The purpose of this study is to highlight research trends over the previous ten years by examining the findings of bibliometric papers on socio-scientific issues. A total of 648 articles from the English-language Scopus database were analyzed using the VOS Viewer. The results of the analysis reveal that studies related to socio-scientific issues over the last ten years are still an increasing research trend. Keywords related to socio-scientific issues such as argumentation, decision making, scientific literacy, critical thinking, and climate change. The journal sources that were most cited were the international journal of science education, journal of research in science teaching, research in science education, international journal of science and mathematics education, science and education. Articles that are widely cited by other authors are Sadler T.D, Zeidler, D.L, Osborn, J, Eilks, I, Erduran, S, Lederman, N.G, Simon, S. Leading countries in the field of socio-scientific issues are the United States, Germany, Sweden, Taiwan, Australia, Turkey, United Kingdom, Canada, Spain, Indonesia. Further researchers can conduct scientific studies on socio-scientific issues by using educational technology in the form of digital media and other variables that have not been studied or are still little researched.

Keywords: Bibliometric; Research Trend; Scopus; Socioscientific Issues

Introduction

Science education has recently stressed the link between science and social concerns (Chen & Xiao, 2021). Science education is closely related to people's lives, thus, scientific issues that have a direct impact on society are an important part of the learning process (Hernández-Ramos et al., 2021). Social problems in society that are complex, controversial, ill-structured, contain ethical problems, and have a basis in science are called socio-scientific issues (Ke et al., 2020; Sadler et al., 2007). Discussions on socio-scientific issues recently have a very close relationship between science, technology, and society (Cebesoy & Rundgren, 2023). In addition, socio-scientific issues also link scientific knowledge and its use in social, political, and cultural life (Friedrichsen et al., 2016). Thus, it is important to study complex socio-scientific issues because they are closely related to everyday life in society.

In science learning, the use of socio-scientific issues had a positive impact on important skills for students' careers and futures. In previous research, various skills that have been documented include those related to scientific literacy (Anggereini et al., 2023; Ke et al., 2021; Permanasari et al., 2021; Saija et al., 2022; Tidemand & Nielsen, 2017), environmental citizenship (Ariza et al., 2021), conceptual understanding (Wahyuni et al., 2021), argumentation (Dewi et al., 2023; Herawati & Istiana, 2021), informal reasoning (Kalin & Bahadir, 2022), and critical thinking (Jariah & Aminatun, 2022).

The use of socio-scientific issues in current learning has also been combined with various learning strategies. Various learning models are used such as physical dynamic models (PDM) (Avsar Erumit & Yuksel, 2023), OE3C learning strategy (Orientation, Exploration,

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Explanation, Ethical Discussion, and Consolidation) (Saija et al., 2022). In addition, learning socio-scientific issues uses various educational technologies such as mobile augmented reality (Chang et al., 2020), and interactive computer simulations (Krüger et al., 2022). The use of immersive media such as augmented reality, virtual reality, and simulation, allows students and instructors to connect with each other's content across time and space boundaries in science teaching (Deta et al., 2021; Kong et al., 2022).

The purpose of this study is to examine the evolution of research on socio-scientific topics during the last ten years (2011-2021). This analysis will contribute to future researchers in the field of socio-scientific issues. This article aims to supplement other significant components of the socio-scientific issues study map to achieve a more thorough mapping.

The following problem formulation serves as the foundation for this research Q1: How is the trend of publication of socio-scientific issues in 2011 and 2021? Q2: From 2011 to 2021, which journal produced the most work on socio-scientific issues? Q3: Which journals are cited the most? Q4: How is the distribution of the keywords that the author uses? Q4: Who is the author of the most cited articles on socio-scientific issues? Q5: Which country publishes the most articles on socio-scientific issues?

Method

This type of research is bibliometric research. Bibliometrics is a branch of information science and the library research that use a quantitative technique to analyze bibliographic data such as year of publication, author, and country of origin, among others (Merigó et al., 2018). The bibliometric study examines various factors, such as top publications, citation structure, prolific and prominent authors, contributing nations, and organizations (Zurita et al., 2020). The research stages in the bibliometric analysis consist of 4 stages as follows Figure 1.

The research was analyzed by using a bibliometric mapping sourced from the Scopus database (www.scopus.com). Scopus is the world's biggest collection of abstracts and citations from peer-reviewed journals, books, and conference proceedings (Martín-Martín et al., 2021). The Scopus database keeps pace with scientific developments, making it easy to track key research, and identify key opinions. Search for keywords in the Scopus database using the keywords TITLE-ABS-KEY ("socioscientific issues" OR "socio-scientific issues" OR "Socioscientific issue" OR "Socioscientific") AND PUBYEAR > 2010 AND PUBYEAR < 2022 AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-

TO (SRCTYPE , "j")) , conducted on June 19, 2022 for publication in journals from 2011 to 2021. The selection is limited to articles written in English, so that obtained as many as 648 articles. Furthermore, the search results are downloaded in .ris and .csv formats. The data obtained were then analyzed using VOS viewer software. VOS viewer is a tool designed for making and viewing bibliometric maps. (www.vosviewer.com).
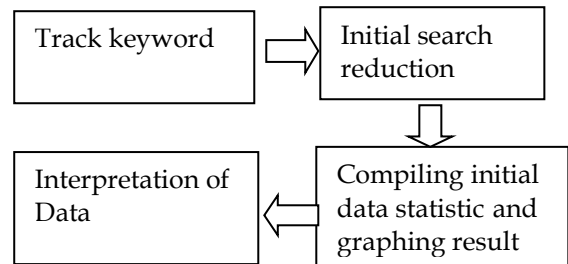

Figure 1. Stages of the Bibliometric Analysis Method

Result and Discussion

The trend of publication of socio-scientific issues based on Scopus journals database from 2011 to 2021 is presented in Figure 2.
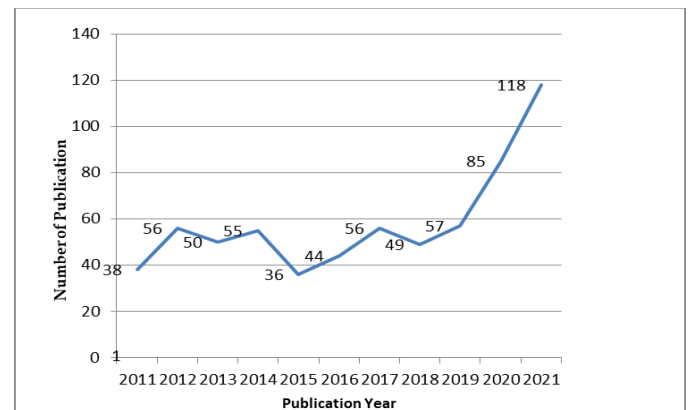

Figure 2. Trends in the publication of socio-scientific issues from 2011 to 2021

Based on Figure 2 it is known that there has been a growing tendency over the previous ten years, with a significant rise in the number of publications noticed after 2019-2021. It shows that the number of publications reach 118 in 2021. In this light, it is possible to infer that there is a growth in research interest in socio-scientific issues.

The journal that produces the most works on socio-scientific issues

The journal that produces the most works on socio-scientific issues presented in Table 1.

Table 1. Top ten journals that publish the most SSI articles

Source	Number of Document	Number of Citation	Total link
International journal of science education	91	1707	43318
Research in science education	47	766	26073
Cultural studies of science education	31	295	8457
Journal of research in science teaching	28	935	17071
Science and education	24	430	13194
Eurasia journal of mathematics, science, and technology education	19	195	11350
International journal of science and mathematics education	18	466	9123
Canadian journal of science, mathematics, and technology education	14	148	6224
Journal of biological education	14	116	3696
Journal of science teacher education	13	159	6908
Science education	12	330	9614

Based on Table 1, the journals that publish the most about socio-scientific issues are the international journal of science education (f= 91 documents), Research in science education (f= 47 documents), Cultural studies of science education (f=31 documents), Journal of research in science teaching (f= 28 documents), Science and Education (f=24 documents). The map is presented in Figure 3.
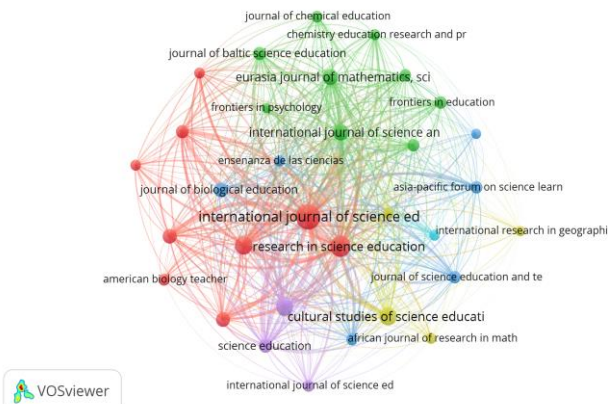

Figure 3. Journals that publish socio-scientific issues.

The Most cited journal

Based on Table 1, the most cited journals are the international journal of science education with 1707 citations, the Journal of research in science teaching with 935 citations, Research in science education with 766 citations, the international journal of science and mathematics education with 466 citations, Science, and education with 430 citations. Map based on density visualization is presented in Figure 4.
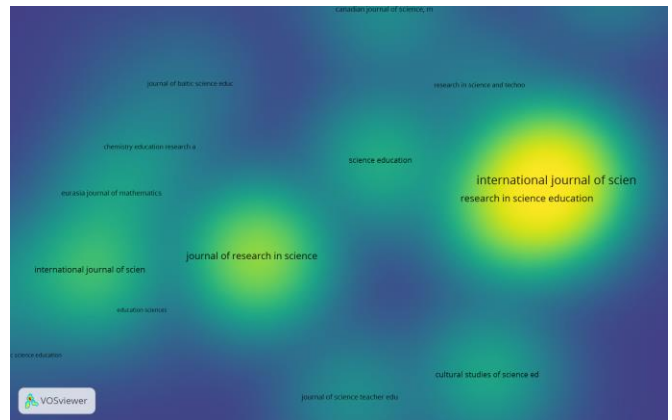

Figure 4. The most cited journals (citation analysis)

Based on Figure 4 above, the bright yellow color and large display depict the journals with the most citations, and so on, the more greenish yellow until the blue color shows the fewer citations in the journal.

The most used keywords in the article

The keyword research performed by the author is utilized to generate a data-driven map based on the most commonly used terms. Set the document's minimum number of keyword occurrences is two. Figure 5 depicts the completed map.
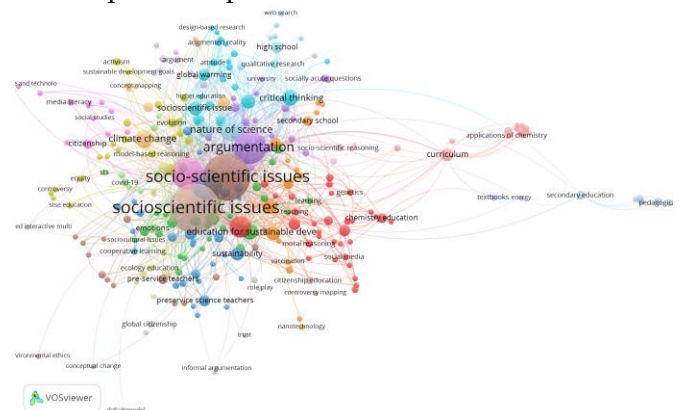

Figure 5. Most used words found in article

Based on Figure 5, describes the keywords that are often used by the author and the links between those words. Terms that appear near each other on the map are more likely to appear together in several publications. As a result, these concepts might be

regarded closely connected (Aktoprak & Hursen, 2022). The inclusion requirements in the data set are defined as having at least 2 occurrences. A total of 396 keywords meet the criteria. Based on the findings of the investigation, the keyword socio-scientific issues are the most widely used keyword (f = 156). In addition, it was revealed that 'socio-scientific issues' (f = 138), 'scientific literacy' (f = 64), 'argumentation' (f = 67) and 'science education' (f = 60), "nature of science" (f = 32), "decision making (f= 30), environment education (f= 23), climate change (f= 20), critical thinking (f= 17) were the most used keywords.

While the least used words are web search, global citizenship, and informal argumentation. These findings suggest that most of the articles focus on socio-scientific issues that discuss scientific literacy, argumentation, and decision-making. While the context focuses more on climate change in environmental education. In addition, critical thinking variables are still widely discussed related to socio-scientific issues. Meanwhile, based on keywords that are still little used, it provides information on opportunities for future research. Therefore, keywords can help researchers determine study trends.

The evolution of socio-scientific research can be seen from the emergence of keywords related to socio-scientific topics from 2011-2021. The distribution of keywords by year aids in finding current study subjects. Based on the distribution of the number of articles each year that use keywords (Figure 6), articles published in 2021 focus on covid 19, genetics, web search, gadget based interactive. Whereas ten years earlier, in 2011 in bibliographic analysis, the keywords that emerged were writing for learning. The distribution of keywords in articles by year is presented in Figure 6.
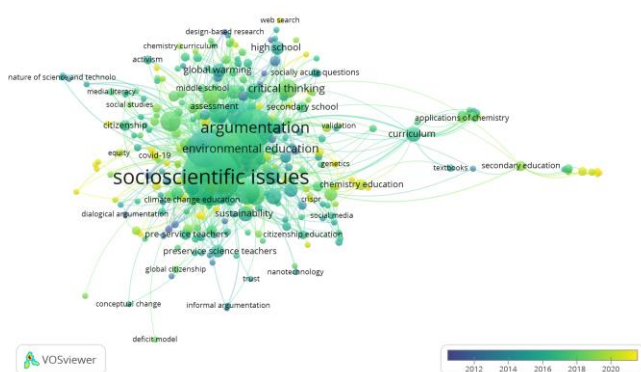

Figure 6. Visualization of the author's keyword co- occurrence analysis by year of publication.

The color difference in Figure 6 shows the progress of research on socio-scientific issues over time. The terms that appear in blue are publications in 2011, while the terms in yellow appear more recently, namely publications in 2021. This visualization explains the progress of research focusing on socio-scientific issues. Keywords that are blue in color represent keywords that are popular at the beginning of the period, while those that are yellow in color represent keywords that are more popular in 2021. Based on the emergence of keywords, it also reveals that keywords such as web search, gadget based interactive have become popular. Since the covid 19 pandemic, learning is done based on technology and digital. In addition, in particular, the influence of the concepts of sustainable development and global governance has had an impact on the broad discussion of socio-scientific Issues (SSI), thus impacting the teaching of SSI using media technology (Kong et al., 2022).

Authors most used in articles on socio-scientific issues (citation and co-citation)

Citation and author data are used to create a map of the most cited authors. Citation networks are used to find intellectual structures and to find study subjects or subdisciplines within a discipline (Hsiao & Chen, 2020). The minimum number of documents by a particular author is set to 4 and the minimum number of author citations is set to 10. The map created is shown in Figure 7.
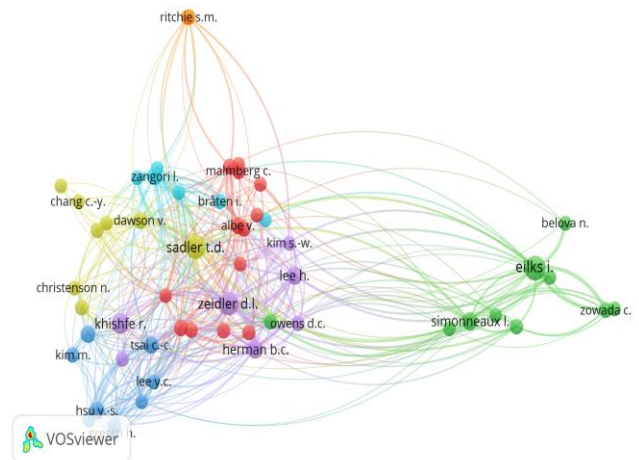

Figure 7. Most cited authors (citation analysis)

Figure 7 shows that Zeidler D.L (655 citations), Sadler T.D (442 citations), Eilks, I (415 citations), and Herman B.C (303 citations) are the most cited authors in the field of socio-scientific issues. The co-citation analysis for cited authors determined that the minimum number of citations for an author was set at 4, and the number of authors to be selected was set at 10. The map created is presented in Figure 8.
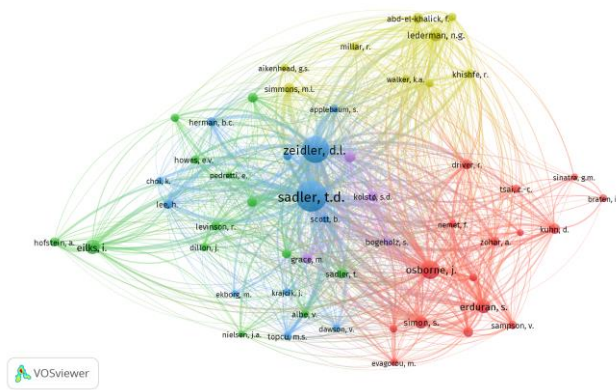
Figure 8. Most cited authors (co-citation analysis)

Based on the co-citation analysis in Figure 8 shows that Sadler T.D (1949; 52223), Zeidler, D.L (1468; 43453), Osborn, J (695; 20753), Eilks, I (430; 8015), Erduran, S (386; 12742), Lederman, N.G (337; 11702), Simon, S (328;10927) (citation; total link strength) are the most cited authors (co-quotes) in the field of socio-scientific issues.

Countries that produce the most publications on socio-scientific issues

To detect similarities between studies by country, bibliographic coupling analysis was used. Each item in the bibliographic mapping represents a country, and each color represents a cluster. The purpose of using bibliographic coupling analysis of socio-scientific issues is to identify countries with the strongest bibliographic coupling and describe the intellectual structure of these countries in socio-scientific issues. The bibliographic coupling analysis is presented in Figure 9.
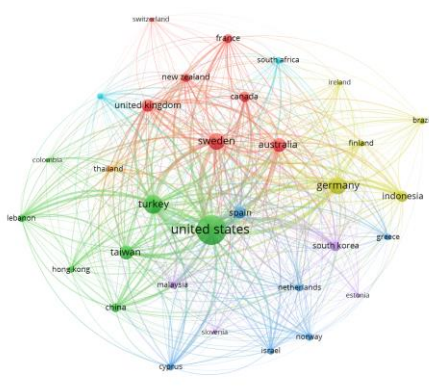

Figure 9. Bibliographic Coupling of Countries

Based on Figure 9 above, the countries that publish the most documents on socio-scientific issues are the United States (179; 3269; 62), Turkey (70; 485; 30), Germany (61; 915; 34), Sweden (55; 709;22), Taiwan (40; 703; 12), Australia (39;557; 23), United Kingdom (31; 452;

26), Spain (29;240; 19), Indonesia (25; 97; 14) , Canada (24; 270; 19) (The first number reflects the total number of publications, the second represents the total number of citations, and the third represents the total link strength).

The same color indicates the same group that is connected to each other into a single cluster. The countries included are Sweden, Australia, Canada, United Kingdom, New Zealand, France, and Switzerland, which are the first cluster countries (shown in red). United States, Turkey, Taiwan, Hong Kong, China, and Lebanon are countries with the same cluster (shown in green). Furthermore, Cyprus, Greece, Israel, Netherland, Norway, and Spain are the third cluster (shown in blue). The fourth cluster consists of Brazil, Finland, Germany, Indonesia, and Ireland (shown in yellow). The countries of Estonia, Malaysia, Slovenia, and South Korea are in the fifth cluster (marked in purple). The sixth cluster consists of Denmark, and South Africa (marked in blue). Thailand is the last cluster (marked in orange).

The results of the coupling bibliography by country provide information that the United States is the country with the highest and most influential number of documents (based on total link strength). Other countries that have influence after the United States are Germany, Sweden, Taiwan, Australia, Turkey, the United Kingdom, Canada, Spain, and Indonesia. Meanwhile, countries such as Thailand have minimal contribution to the literature related to socio-scientific issues.

The country of Indonesia is included in the tenth order country that is influential in research on socio-scientific issues. The United States is the most influential country and published the most documents on socio-scientific issues, this is closely related to science education policies and is closely related to the development of scientific literacy (DeHart Hurd, 1998; National Research Council, 1996).

Conclusion

Bibliometric studies enable researchers to identify research gaps in socioscientific issues by presenting the general structure of the literature. Studies related to socio-scientific issues have involved variables such as argumentation, decision making, scientific literacy, critical thinking, and climate change which make useful contributions to the study of socio-scientific issues in the literature. This bibliometric study also informs readers about contributing journal sources such as the international journal of science education, Journal of research in science teaching, Research in science education, international journal of science and mathematics education, science and education. Articles

are written that contribute to research on socio-scientific issues that can be included in the basic reading list related to socio-scientific issues such as articles that are widely cited by other authors, namely Sadler T.D, Zeidler, D.L, Osborn, J, Eilks, I, Erduran, S, Lederman, N.G, Simon, S. The results reveal that the leading countries in the field of socio-scientific issues are the United States, Germany, Sweden, Taiwan, Australia, Turkey, United Kingdom, Canada, Spain, Indonesia. Studies can be carried out in many other countries, for example in Asian countries. It is suggested that researchers engage in scientific studies on socio-scientific issues employing educational technology in the form of digital media and other variables that have not been investigated or received minimal attention.

Author Contributions
The main author, Yokhebed contributed to the research design, conducting the research, collecting and analyzing data, as well as writing the article. The second and third authors Sutarno and Mohammad Masykuri were also involved in the research design and article writing. The fourth authors, Baskoro Adi Paryitno contributed to the article writing.

Conflicts of Interest
The authors declare no conflict of interest.

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