Use of bibliometric software to explore the relationship between scientific literacy and socio-scientific issues

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Abstract. This article aims to provide a bibliometric analysis of relevant literature to explore the relationship between scientific culture and social science issues in research trends or publications indexed by the Scopus database. This analysis can reveal the extent of the relationship between scientific literacy and socio-scientific issues. The study methodology used was the Preferred Reporting Items for Systematic Reviews and Meta-Analyses explained in a four-step usage flow diagram including identification, selection, eligibility and inclusion, which will then be applied when carrying out the review process to assist reporting authors. This search examined all journal articles related to scientific literacy and socio-scientific issues. All data were collected in the Scopus database from 106 articles published between 2014 and 2022. Much research has been conducted on issues of scientific knowledge and social sciences in a variety of fields. However, research that specifically addresses scientific literacy and socio-scientific issues remains rare. This is clearly shown through the analysis results performed using VOSviewer software. This article uses bibliometric analysis to identify the main subject areas of each of the studies undertaken and to explore the relationship between scientific literacy and socio-scientific issues in the fields.

1 Introduction

The development of human civilization has now entered the 21st-century, where there have been very significant developments in various fields, including developments in information, industry, technology, education, to needs that refer to human resource skills [1]. The various demands of the 21st-century require every individual to be able to survive and compete with other individuals in the wider community [2]. 21st-century skills are the key skills that each individual must master to face the challenges of the future [3]. In 21st-century skills, it is explained that humans must be ready to become lifelong learners. When someone is ready to become an independent lifelong learner,

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each individual needs awareness to maximize themselves in developing abilities according to their field.

Applying skills in daily work is a key requirement for acquiring basic knowledge, including literacy, numeracy, technological literacy, financial literacy, cultural literacy, as well as civic and scientific literacy. Scientific literacy is considered a skill that students need to acquire in the 21st-century [4], [5], in which scientific literacy skills require understanding and applying knowledge. knowledge to solve problems related to science and technology in everyday life [6]. On the other hand, scientific literacy is also necessary in the ability to make decisions [7] and participate in the socio-cultural environment, so that students can promote an active role in social life from an early age.

Rychen and Salganik [8] write that scientific knowledge is about understanding how to change the way one interacts with the world so that it can be used to achieve broader goals. On the other hand, scientific literacy can enable someone to use the knowledge they have to identify problems, obtain new knowledge, explain scientific phenomena, and draw conclusions based on evidence relating to scientific issues [9]. So that students who are familiar with scientific literacy skills can make scientifically sound decisions [10–12].

Even though the results of the research conducted [13] show that reasoning and argumentation skills can explain scientific phenomena and can be stimulated and trained through the argumentation process in debates on social scientific issues, unfortunately not all educators are motivated to get used to presenting real problems that are close to their daily lives to discuss together with his students.

This article aims to provide a bibliometric analysis of relevant literature to explore the relationship between scientific literacy and socio-scientific issues. As well as research or publication trends indexed by the Scopus database. This analysis can reveal the extent of the relationship between scientific literacy and socio-scientific issues.

2 Research methods

The PRISMA statement [14], [15] is contained in a flow diagram using four phases consisting of identification, screening, eligibility, and inclusion *which* are then adopted when carrying out the review process to help authors report systematic reviews more effectively. The research method used is prism.

2.1 Eligibility criteria

All original studies investigated the relationship between scientific literacy and socio-scientific problems. Studies were identified by searching for relevant papers between 2014 and 2022 via the Scopus electronic database. All articles covering the topic are written in English and are empirical studies. Articles published in scientific peer-reviewed journals. The following are some examples of research journal names used: Educational Psychology Review, Chemistry Education Research and Practice, Education Sciences, Journal of Education and Learning, Journal of Technology and Science Education, International Journal of Instruction, International Journal of Science Education, Journal of Social Sciences Kasetsart, etc.

2.2 Search procedure

The search process uses keywords such as "Scientific Literacy" AND "Socio-scientific Issues"; and "Scientific Literacy" OR "Socio-scientific Issues". This process is carried out using the Scopus electronic database. The reason why the focus is on papers published in Scopus journals is based on the assumption that papers go through strict screening procedures and the results are more objective.

2.3 Study selection and data collection process

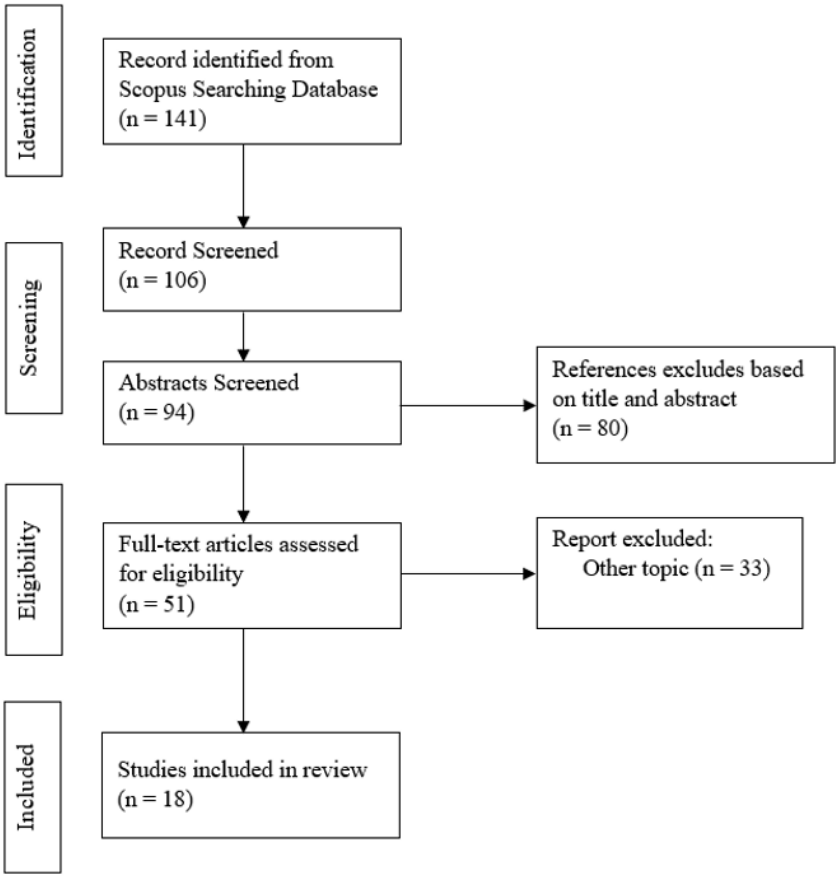

Fig. 1. PRISMA Flow Diagram of Study Selection Process

2.4 Data items

The data extracted from each study includes: background to research problems, the concept of scientific literacy, examples of social scientific problems, and the relationship between social scientific problems and scientific literacy. Data mining, mapping and grouping of articles taken from the database were carried out using VOSviewer software.

3 Results and discussion

3.1 Performance analysis

The results of the bibliometric analysis of this study are referred to [16]. There are two types of analytics, which are performance analytics in the form of the number of publications per year, most cited articles, journal with the most articles, journal ranking and country with most articles; and scientific map in the form: Circle Network Visualization, Frame Overlay Visualization, and Density Visualization.

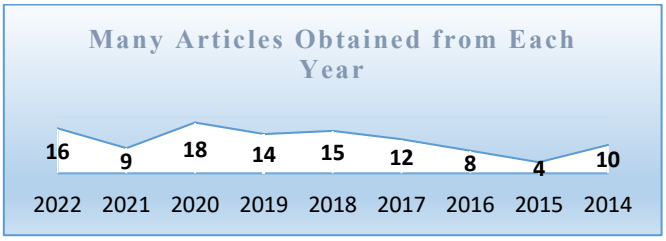

Fig. 2. Number of article publications obtained from 2014 to 2022 according to keywords

Articles in Scopus-indexed journals are often used as reference material in other research. The greater the number of citations or citations for an article, means that the research results can be used as a reference in other research. The search results for these articles show a total of 820 citations from 106 articles in 2014-2022.

Table 1. Top Writer

No	Number of Quotes	Authors	Article Title	Year	Journal Name
1	137	Sadler	Exploring Undergraduates' Breadth of Socio-scientific Reasoning Through Domains of Knowledge; Developing and Using Multiple Models to Promote Scientific Literacy in the Context of Socio-Scientific Issues; Students' perceptions of socio-scientific issue-based learning and their appropriation of epistemic tools for systems thinking; Student development of model-based reasoning about carbon cycling and climate change in a socio-scientific issues unit; Assessment of scientific literacy: Development and validation of the Quantitative Assessment of Socio-Scientific Reasoning (QuASSR); Thai pre-service science teachers' struggle in using Socio-scientific Issues (SSIs) during practicum.	2022; 2021; 2020; 2017; 2017; 2016	Research in Science Education; Science and Education: International Journal of Science Education; Journal of Research in Science Teaching; Asia-Pacific Forum on Science Learning and Teaching
2	85	Zangori	Developing and Using Multiple Models to Promote Scientific Literacy in the Context of Socio-Scientific Issues; Students' perceptions of socio-scientific issue-based learning and their appropriation of epistemic tools for systems thinking; Student development of model-based reasoning about carbon cycling and climate change in a socio-scientific issues unit.	2021; 2021; 2017	Science and Education; International Journal of Science Education; Journal of Research in Science Teaching
3	13	Forbes	Exploring Undergraduates' Breadth of Socio-scientific Reasoning Through Domains of Knowledge; Cultivating water literacy in stem education: Undergraduates' socio-scientific reasoning about socio-hydrologic issues; Application of construal level and value-belief norm theories to undergraduate decision-making on a wildlife socio-scientific issue.	2022; 2020; 2018	Research in Science Education; Water (Switzerland); International Journal of Science Education

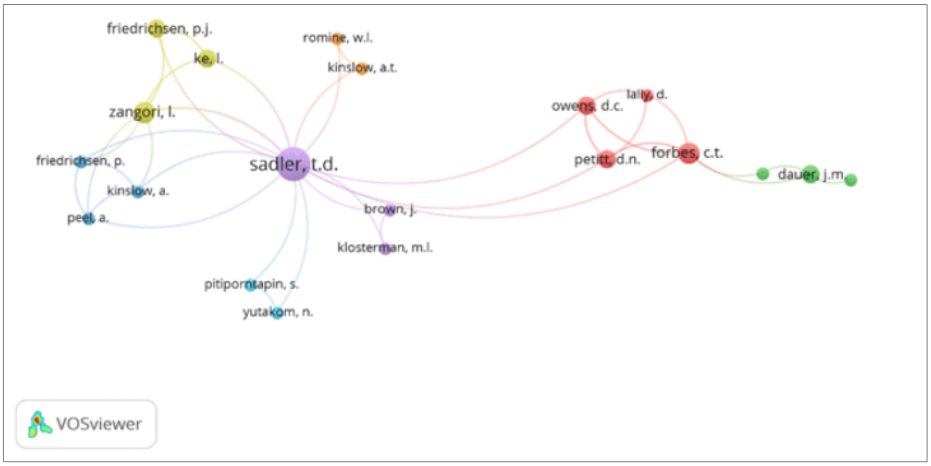

Fig. 3. Visualization of the network of top writers related to scientific literacy and socio-scientific issues

It appears that Sadler is in first place for top writer, the reason is that apart from having the highest number of citations, it turns out that Salder is an active writer every year. However, it turns out that Salder was not always and never even the first author, but rather he was the second, third, and even fifth author. So, this data shows that a person's

existence may not always be first, but writing regularly and consistently maintaining the quality of writing can increase public trust so that a person's citations will increase.

Zangori came in second as best author, showing that his research with Sadler in 2017 titled Developing Students' Model-Based Reasoning on the Carbon Cycle and Climate Change in the social issues unit whose scientists received the most citations, specifically 46 citations and Zangori's. The study is his first on the topic of social science issues. The next writer who ranks third in the top is Forbest. Forbest may be a little different from Zangori, if Zangori started out as the first writer with Sadler, while Forbest in his final year started writing with Sadler so it appears in the visualization that his chain network is longer than Zangori's.

3.2 Scientific literacy topic areas and socio-scientific issues using vosviewer

In bibliometric research, thematic mapping is essential [17]. All thematic areas related to the keyword's scientific literacy and social scientific issues can be viewed in Figure 4. In bibliometric analysis, VOSviewer can display three images of different map visualizations, which are Figure 4. related to the visualization network, Figure 5. related to overlay visualization, and Figure 6. related to density visualization. The minimum number of relationships between subjects is limited to two events or conditions.

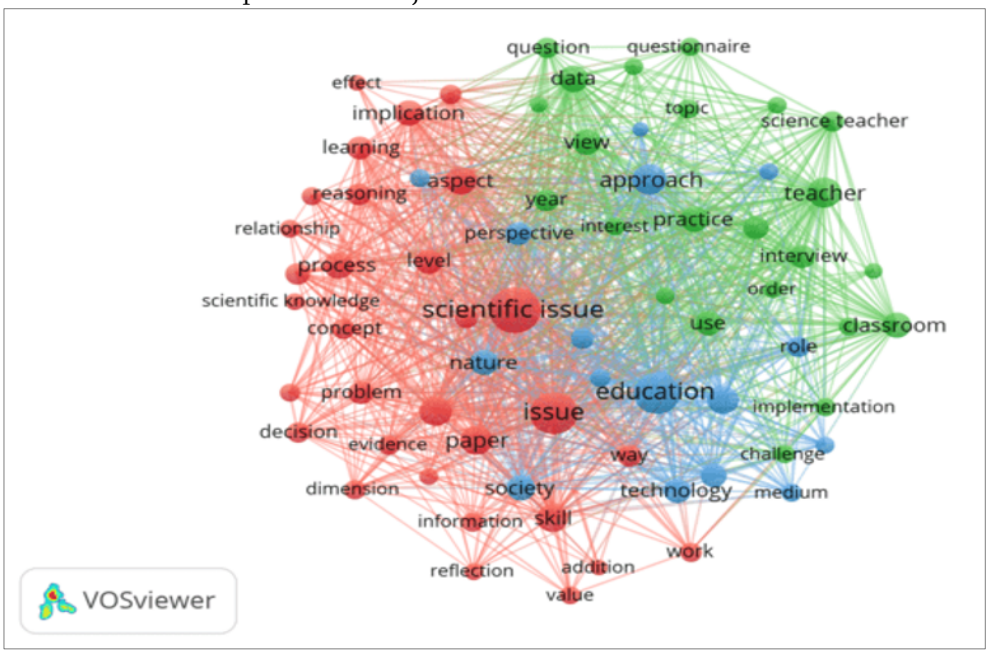

Fig. 4. Network visualization of scientific literacy topics and socio-scientific issues

After analysis with VOSviewer software, three clusters were obtained in the mapping of all topics. The color that appears in each cluster has a meaning, whereas red means that the data in the research is empirical or the research in this cluster has a strong empirical basis. Research in the red cluster bases findings on empirical data collected directly from observations or experiments, so the cluster in red indicates that research results tend to

be more reliable and trustworthy because they are supported by strong empirical data. Furthermore, the green color indicates that research in this cluster encourages more in-depth analysis or interpretation of data. This means that research in this cluster tends to focus on an in-depth understanding of existing data and may produce deeper insights or understanding related to the topic discussed. Lastly, the blue color indicates that this cluster has a lower impact or relevance compared to other clusters because perhaps the number of publications or the number of citations is lower. In addition, the blue cluster provides an indication that research in this cluster may receive less attention or be considered less significant in the context of bibliometric research.

The thickness of the connecting lines indicates the strength of the topic area or keyword pair. In addition to groups and rows, the size of the circle indicates the frequency of a keyword or topic. In addition, buttons or keywords that have no network with other keywords and appear to be buttons but do not display information will also have the potential to become new research topics in the future.

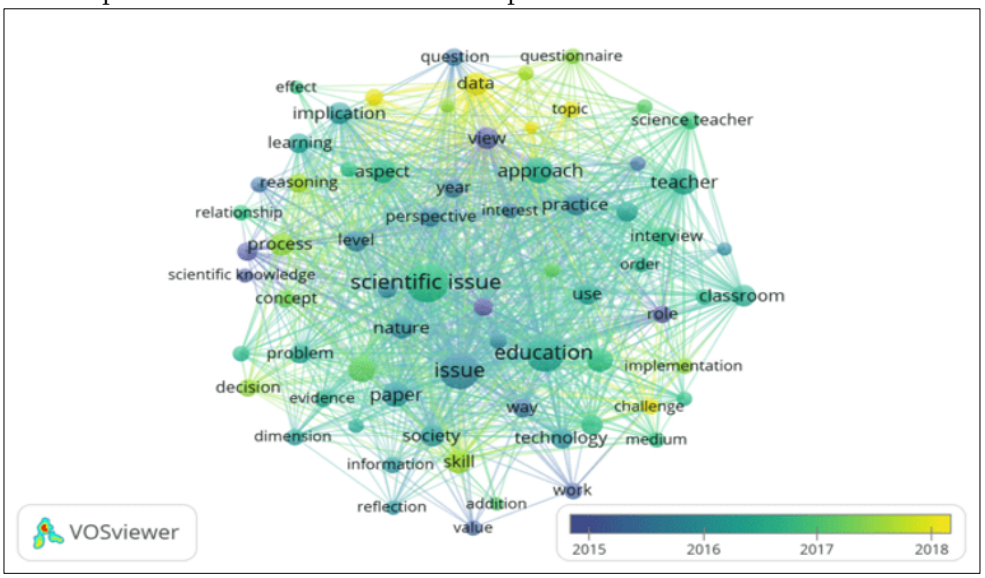

Fig. 5. Overlay visualization of scientific literacy topics and socio-scientific issues

Figure 5 above shows year-over-year trends related to search areas or keywords. The color in the keyword indicates the search period. The brighter the color seen, the more recent the year the research was conducted. It can be seen that the oldest year is 2015 in purplish blue and the maximum year obtained is 2018 which is marked in yellow. Even though the Scopus database was obtained from 2014 to 2022.

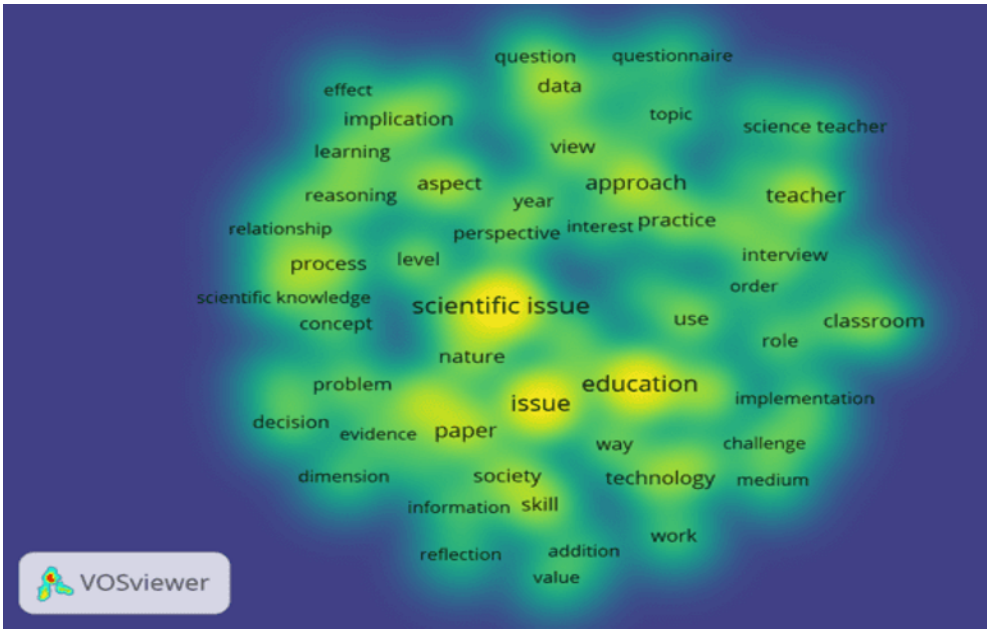

Fig. 6. Visualization of the density of scientific literacy topics and cosio scientific issues

In research related to the field of scientific literacy and socio-scientific issues, this can be seen in Figure 6. The lighter the color, the more researchers are conducting research related to this field and conversely, the more color is seen. dark. Fewer people conduct research. From Figures 4, 5, and 6 (topic network visualization, overlay visualization, and density visualization), no major topics or keywords are shown. Therefore, the researcher reduced the keywords to focus on the relationship between scientific culture and social science issues. The topic area is narrowed because the buttons are visible but the information is not yet available. Therefore, the researcher believes that this topic to be a potential new research topic in the future.

3.3 Scientific literacy topic areas and socio-scientific issues

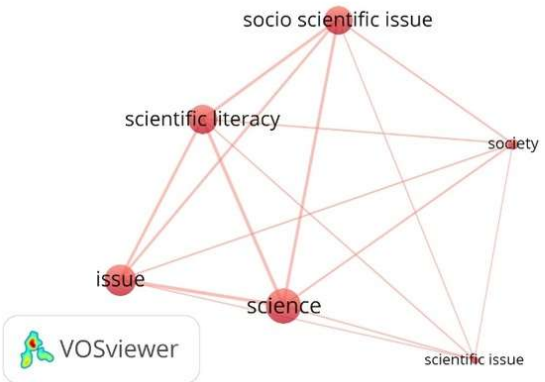

Fig. 7. Overlay network of the narrowing of socio-scientific issues topic areas and scientific literacy

Based on the results of keyword reduction focus on the relationship between scientific culture and social science issues. Figure 7 presents a comprehensive visualization of the narrowing of thematic areas of scientific literacy and socio-scientific issues. We see that there is a close relationship between scientific culture and socio-scientific issues, as evidenced by the thickness of this line and the fact that this line is the shortest among the others.

The results of this analysis show that the relationship between scientific literacy and social science issues is congruent, which is indicated by an upright prism-shaped shape. The points that make up the shape also appear strong as evidenced by the very significant area of the points. This congruence shows parallelism, congruence, and the same forces that influence each other.

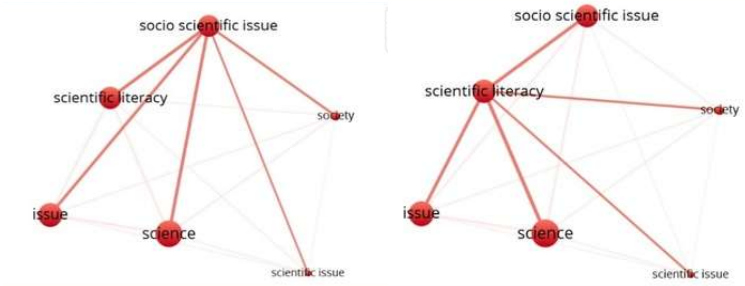

Fig. 8. Overlay visualization of congruent topics of scientific literacy and socio-scientific issues

Scientific literacy is one of the most important skills to prepare the next generation, and using scientific knowledge and information helps meet life's challenges [18–20]. Therefore, due to the importance of scientific knowledge, the amount of research on this topic must increase. This is a research opportunity for future researchers looking for related keywords. Keywords that do not have a strong network with other keywords can become new research topic opportunities. Figure 8 shows that social science issues, scientific culture, issues, and science have an important connection, but science and social issues are related to each other, although not very strongly, so this could be an opportunity for research as research related to this area is still very new.

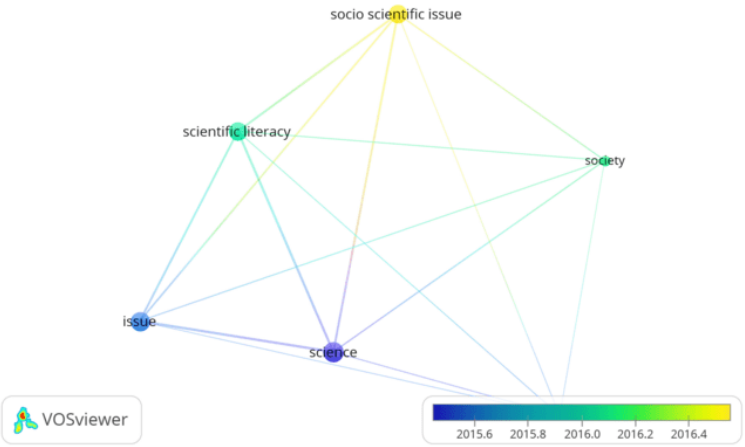

Fig. 9. Overlay visualization of the narrowing of socio-scientific issues topic areas and scientific literacy

Figure 9. shows an overlay visualization of the narrowing of the topic areas for socio-scientific issues and scientific literacy. In the modern information age, solving social science problems is becoming increasingly important [21]. However, it should be understood that until mid-2016, the results of overlay visualization using VOS Viewer in the context of socio-scientific issues could not yet be realized. This discovery is an important step, marking a change in the way we approach the analysis of social science questions. With more advanced visualization capabilities, we can sometimes analyze complex data to get a clearer, more focused picture. This will not only increase public understanding of these issues but also provide a strong basis for making more informed and responsible decisions regarding issues that affect people's daily lives [22].

The density of visualization narrows the thematic areas of social science and scientific culture issues, expressed through bright colors, containing profound meanings. The bright colors in this visualization indicate a significant increase in attention and research on social science issues as well as a significant increase in scientific literacy [23]. The presence of this prominent color also reflects the growing effort and investment devoted to understanding and solving complex problems that combine scientific and social aspects [24]. Furthermore, it reflects a growing awareness of the importance of scientific literacy in society, as it equips individuals with the ability to make informed decisions when faced with challenges and important decisions in everyday life.

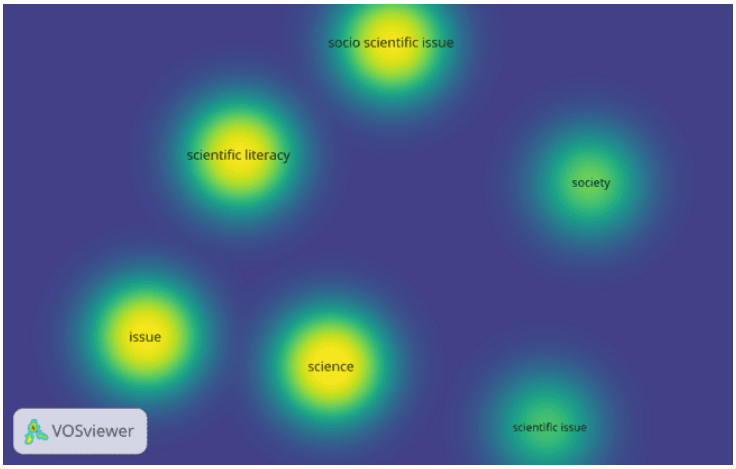

Fig. 10. Visualization density of the narrowing of socio-scientific issues topic areas and scientific literacy

As the density of visualizations shows increasing attention to socio-scientific issues and scientific knowledge in bright colors, there is a need to expand educational and research efforts in this area. This development shows that society is increasingly aware of the complexity of issues including scientific and social aspects, as well as the great importance of scientific culture [25]. Therefore, an important first step involves increasing public access to scientific information. Educational programs that prioritize scientific knowledge and socio-scientific issues need to be improved, both academically and through easily accessible online educational resources.

Through these steps, we ensure that the increased focus on socio-scientific issues and scientific literacy is not just a temporary trend. Rather, it is an inseparable part of education and knowledge of society as a whole. This will bring great benefits in forming a society that is more informed, critical and able to face the complex challenges of this modern era [26].

The rapid progress of scientific knowledge will make classical memorization of material increasingly meaningless, so it is necessary to present real-life problems or social scientific issues. Environmental problems, social problems, and other problems that are often encountered in everyday life, whether real, printed or digital, can be used as a study with students [27–29]. Problems that basically do not reflect good things should be studied together with students in learning so that from an early age students are inspired not to do the wrong thing, can make the right decisions, act according to norms, and are able to spread goodness through actions or invitations that are corrective in nature. which is not good.

This is in line with socio-scientific issues (SSI) based teaching which was chosen because it aims to invite students to be actively involved in learning [30], both inside and outside the classroom. This is related to the opinion [31] that the main aim of SSI-based learning is for students to develop a sense of having something to say truthfully about the problems they encounter so that students develop a sensitivity to care about the surrounding environment, both natural, and social.

4 Conclusion

In summary, this study conducted an in-depth analysis of 106 journal articles related to scientific culture and social sciences issues, all from the Scopus database. Although there is a wealth of research in various fields on these topics, there is a lack of research that focuses specifically on the connection between scientific knowledge and socio-scientific issues. This difference can be seen from the results of the analysis performed using VOSviewer. Through a bibliographic review, this article successfully describes the main thematic areas of each study, providing insight into the dynamic relationship between scientific culture and socio-scientific issues Associations in currently popular fields. We hope that this comprehensive review of current research will provide a valuable foundation for future research, providing updated perspectives and opportunities for further exploration in this important area.

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