Bibliometric Analysis of Socio Scientific Issues (SSI) in Physics (2019-2020)

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ABSTRACT

Socio-Scientific Issues (SSI) is a controversial topic that arises from advances in science and technology (IPTEK). In implementing Socio scientific issue as a learning context, it is necessary to study literature for investigating the selection of social-scientific issues. The aim of this research was to analyze the implementation of SSI in physics learning in terms of the distribution of bibliometric. Data was taken from Publish or Perish, sourced from Google Scholar with "Socio scientific issues in physics" as the keyword in 2019-2020. The data was mapping using VOS Viewer software. This research obtained on May 4, 2021, using bibliometric analysis as much as 982 data. Thus, from these results, we can be concluded that the most significant association with using socio-scientific issues as a context for science learning is the ability of argumentation, understanding, reasoning, scientific knowledge, scientific literacy and investigation. In addition, from this study, the SSI contextual learning model, learning inquiry model with a decision making, was the most widely used. The physics material taught is related to the nature of science and climate change.

Keywords: *Socio scientific issues, Bibliometrics, VOSViewer, Google scholar.*

1. INTRODUCTION

Education is a means for develop potential resources human power [1]. The advancement of technology and science always creates new relations between society and science, which results in often and complex controversial problems [2]. Many science teachers say that students' motivation and interest in science learning is still low. The internal factors that can increase motivation to carry out learning activities are interest in learning itself [3]. It is related with development of problem-solving skills that very important in higher education [4]. Therefore, it is necessary to provide a relevant context for science learning to fulfil the relationship between life problems and science knowledge. In context-based learning, the process emphasizes approaches so that students can learn science more meaningfully. One of the learning contexts that be in great demand in science education research is socio-scientific issues.

SSI is a controversial topic with an important and scientific foundation or fear to society [5]. Socio

Scientific Issues frequently debated in the media with scientific evidence and perspectives sometimes have a contradicting with non-scientific perspectives. Science that underlying SSI is often complex, multidisciplinary, and debated. Overall, SSI has emerged as a practical context for students to relating science learning in more complex political and social environment. In this case, climate change and global warming have been positioned and identified as SSI in science education as productive contexts for learning and teaching [6].

Several studies have examined the impact of introduction SSI in various scientific topics, including electromagnetic radiation [7], climate change [8,9] and air pollution [10], and the results of implementing socio-scientific issues into science in schools affect improving skills to decision making and argumentation, increasing understanding nature of science and other science content, increasing student self-efficacy and increasing motivation and interest to learn science. On the other hand, there are a study searching some literature from the EBSCO Host Library database (www.ebscohost.com) to identify the application of SSI

in science learning. Analysis of information content related to SSI implementation was mapped using ArcGIS 10.5 software and visualization of geospatial data. However, analysis using the bibliometric method has never been carried out, so this study was hold to examine the development of scientific study from 2019 to 2020 through bibliometric analysis method.

Analysis of bibliometric mapping results can be performed to triangulate and explain gaps in the literature. Bibliometrics is a bunch of tools that researchers can use to analyze published data and is a research field that applies mathematical and statistical techniques to study publishing patterns in the distribution of information [11]. Bibliometrics effectively provide datasets that policymakers can use, researchers and other stakeholders to improve the quality of research [12].

Based on the above background, the aims of this study is to analyse implementation of SSI in physics learning in terms of distribution bibliometric mapping on Google Scholar database using VOS viewer software. In addition, this research also aims to find out the top 5 best articles and top five authors from publish or perish software.

2. METHODS

This research is a literature study that analyzed using bibliometric analysis guidelines. Research sourced from google scholar database. Questing the data was carried out on April 22, 2021, through the Publish or Perish software, and then the sample articles were downloaded in .ris format. The data used comes from google scholar database with the keywords socio scientific issues in physics with the category of articles, titles and keywords in the period 2019-2020.

Based on the search results using Publish or Perish Software, data obtained are as many as 982 documents. Then the top five articles were determined related to SSI based on the number of citations. Trends in the development of research internationally on socio-scientific issues are analyzed using VOSviewer software with network visualization and density [13].

F**igure 1** Research steps with bibliometric analysis [13].

3. RESULTS AND DISCUSSION

The results were obtained as many as 980 documents for socio-scientific issue (SSI) research in physics in the google scholar database. Those published were starting in 2019 and until the latest the year 2020. The specific result can be explained in the Table 1.

From the number of article citations, questing results obtained the top five articles, there research conducted by Solli et al [14]; Lee and Yang [15]; Benez et al [16]. The top three article have the highest number of citations. It can be seen in the Table 2.

Table 1. The questing result from Publish or Perish

Years Publication	2019-2020
Years citation	2019-2020
Papers	982
Citations	15.511
Cites/year	7.755,50
Cites/paper	15,80
Author/paper	2.61
h-index	43
g-index	102
hA-index	32

From the results of Solli et al.'s (2019) research, students discursively manage the multimodality and multivocality inherent in SSI and the communicative competencies involved can be developed through education while engaging in public debate [14]. On the other hand, Lee and Yang's (2019) research states several problems faced by teachers in the classroom when implementing SSI [15]. Meanwhile, study from Beneze et al (2020) explains that epistemology and axiology make students have more critical and holistic in understand the conceptions in fields of technology and science [16]. Research of Wiyarsi and Calik (2019) examines the development of reliable and a valid scale that measures Indonesians' level of scientific way (SHOM) through SSI in a context where the SHOM scale can be improved or adapted or for SSI in different contexts [17]. Meanwhile, Amos et al.'s research explores applying a pedagogical approach to teaching through socially responsible inquiry embedded in SSI problems [18].

Figure 2. shows the top authors and their clusters in the study, which indicate the most productive authors in research on SSI in physics. From these results, it can also be seen that SSI research in Indonesia is quite popular. The most author is Archer, [19] that lead in cluster 1. Coloured circles on the visualization results

with VOSviewer indicate items or keywords and obtained as many as 67 items or keywords appear in the title and abstract. The size of the circle also indicates how often the research is related to the topic. If the size of the circle is getting bigger, the keywords that appear are also more frequent.

Table 2. Top five article from Google Scholar

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Navigating the Complexity of Socio-scientific Controversies—How Students Make Multiple Voices Present in Discourse	Anne Solli, Thomas Hillman & Åsa Mäkitalo	Research in science education	15
Science Teachers Taking their First Steps toward Teaching Socio-scientific Issues through Collaborative Action Research	Hyunju Lee & Jung-eun Yang	Research in Science Education	15
SAQ, SSI and STSE education: defending and extending "science-in-context"	Larry Bencze, Chantal Pouliot, Erminia Pedretti, Laurence Simonneaux, Jean Simonneaux & Dana Zeidler	Cultural studies of science education	15
Revisiting the scientific habits of mind scale for socio-scientific issues in the Indonesian context	Antuni Wiyarsi &Muammer Çalik	International Journal of Science Education	10
Socio-Scientific Inquiry-Based Learning: Possibilities and Challenges for Teacher Education	Ruth Amos, Marie-Christine dan KnippelsRalph Levinson	Science Teacher Education for Responsible Citizenship	9
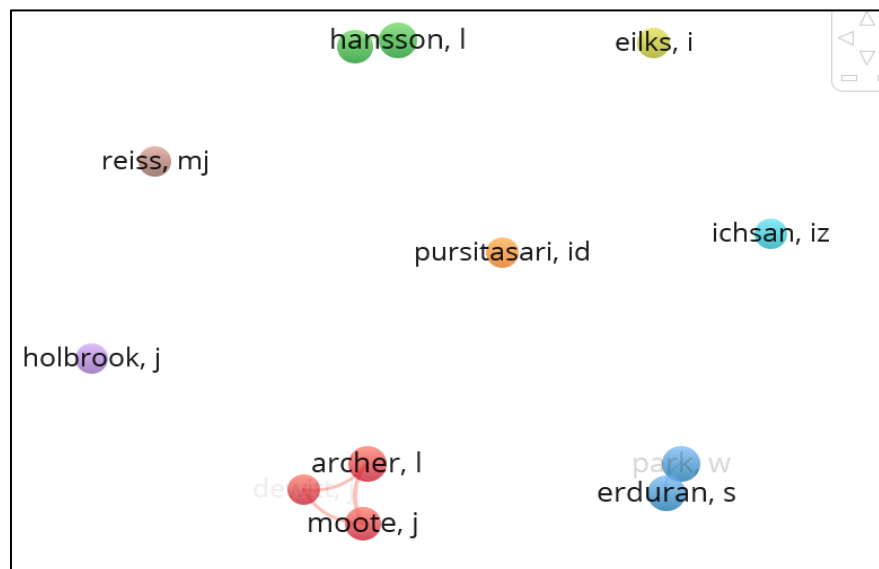
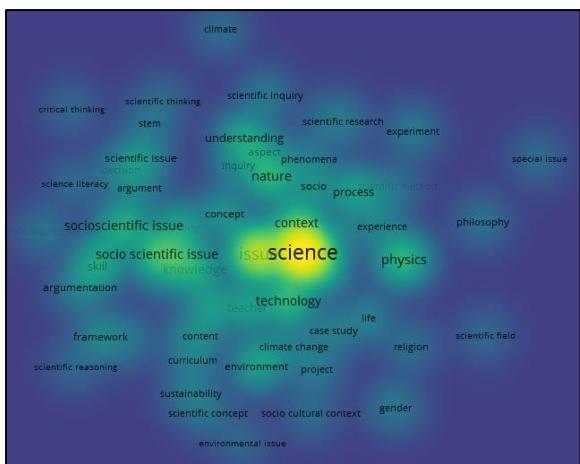**Figure 2** Top Authors in SSI research.
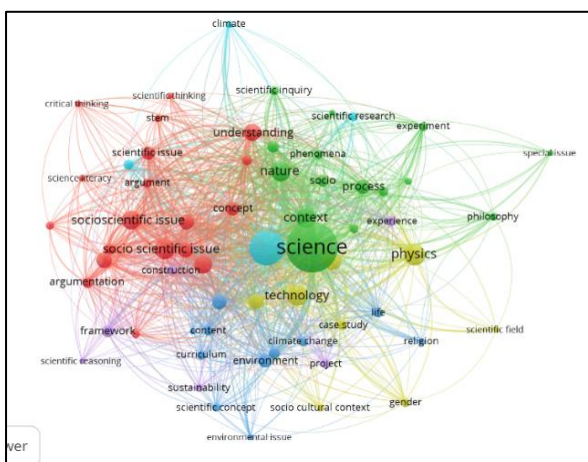
Figure 3 Density visualization with VOSviewer.

Figure 4 Network visualization with VOSviewer.

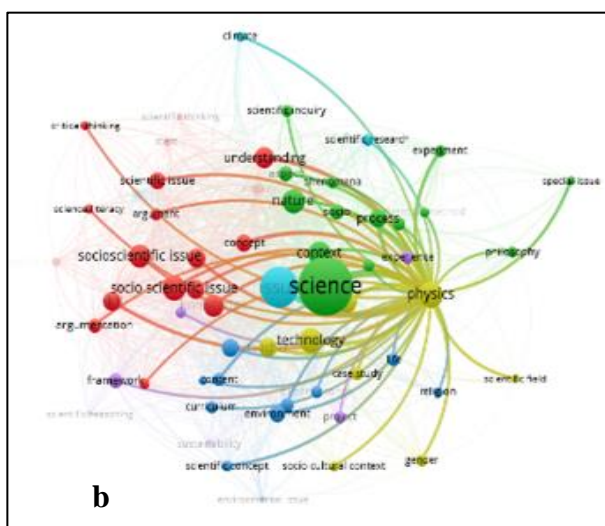Based on the search results, the keyword Science most often appears in several research articles, which is indicated by the appearance of the keyword in yellow, as well as for socio-scientific issues and physics in yellow opaque (Figure 3.), which means that the keywords socio-scientific issue and physics have appeared quite a lot in the title and abstract of several scientific articles. On the other hand, one of the keywords that do not appear often is natural science and decision making, which are still green in colour. After being analyzed using VOSviewer through network visualization, there are 6 clusters (red, green, blue, yellow, purple and light blue) that show a relationship between one topic and another. (Figure 4)

Cluster 1, shown in red, is a group closer to the word Science. Cluster 2, shown in green, is a group closer to the word Science. Cluster 3, shown in blue, is a group closer to the word environmental issue. Cluster 4 is shown in yellow, which is closer to the word physics. Cluster 5 is shown in purple, which is closer to the word framework. And for cluster 6, it is shown in light blue, which is closer to the word issue.

If we focus on mapping more specific relationships, we can find research trends. Figure 5a. shows that the content of SSI's research is more dominant in science and quite a bit for physics. Physics is one of the trends in SSI research issues in 2019-2020, especially related to climate change (Figure 5b). Climate change can be used as a topic for SSI in implementing it as a learning context.
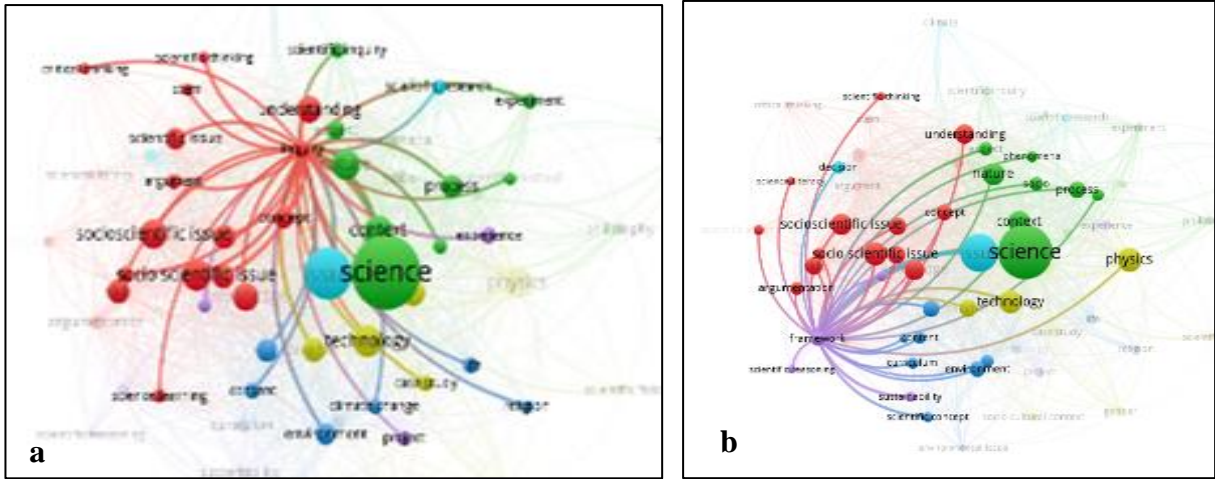

Figure 5 (a) SSI related to Physics and (b) SSI related to Physics.

Figure 6 (a) SSI related to inquiry and (b) SSI related to framework.

Figure 6a emphasizes teaching using the inquiry model that teachers do when implementing SSI as a learning context. The word inquiry is related to argumentation, critical thinking and reasoning, which means that SSI is learning with this inquiry model that impacts argumentation and reasoning abilities. This has been proven in Putri's research that students' scientific arguments and reasoning experience significant changes after learning by implementing the SSI-based Levels of Inquiry model on global warming material [20].

The socio-scientific issue keyword is in a cluster with the skill keyword (Figure 7.). This shows that the two keywords have a reasonably close relationship. SSI can be closely related to several skills such as argumentation, reasoning, scientific literacy, scientific processes, and understanding, as shown in the distribution of skill items. For example, SSI implemented in a learning context will influence the quality of argumentation, an escalate in students' scientific argumentation skills by using the SSI learning strategy. Also, the implementation of SSI in learning can improve students' understanding of climate change.
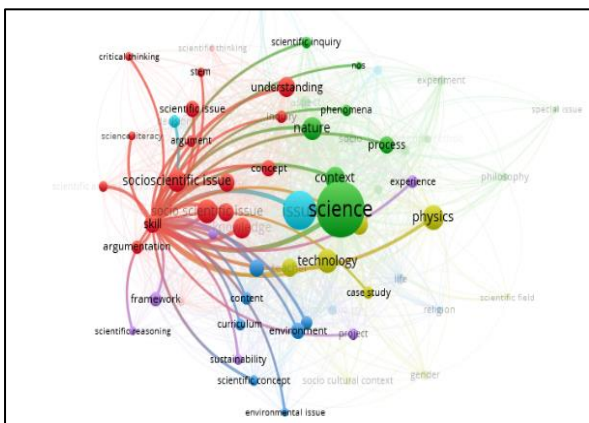

Figure 7 SSI related to skill.

Several studies that prove the relationship between science skills and SSI are as follows: From Izma et al, (2019) research, it can be shown that the use of teaching materials based on socio-scientific issues can improve the understanding in nature of science, especially on solar system material [21]; Dolan's research proves that the application of learning in the SSI context also affects students' reasoning abilities and the application of SSI in learning can make it easier for students to explain scientific phenomena [22]. Learning accompanied by the phenomenon of lunar eclipses increases students' understanding and knowledge [23].

Socio scientific issue topics can also be chosen as teaching materials to improve the quality of students' scientific arguments. From Deta's study, it can be seen that learning about the solar eclipse phenomenon through argumentation can improve students' understanding of concepts [24]. Other research also shows that learning design by integrating socio-scientific issues can also improve students' argumentation skills [25]. However, what is not yet known is whether gender differences affect students' argumentation skills, especially about SSI. One of the trending SSI is the phenomenon of La Nina and El Nino climate anomalies. The phenomenon is one symptom of climate change. Climate change is a social scientific problem because it is an actual global problem and a challenge for human life.

The research results are expected to be taken into consideration for teachers to be able to implement SSI in the context of learning or as teaching materials, especially in learning physics. Because the issues raised are very complex, current, global and need to be discussed, SSI, which is authentic and up-to-date, can encourage students to work with actual events reported in the media. Even SSI often involves global, regional and local dimensions, which can characterize

environmental problems. For example, the decision at the local level impacts global systems such as water and air systems? Because many issues involve ethical reasoning, decisions or opinions on issues reported in the media today are usually based on knowledge and values.

This research is only limited to analysing word items obtained based on titles and keywords from the Google Scholar database. Therefore, obtaining an estimate of the strength of the relationship can not be ascertained clearly. In addition, the extent to which SSI is implemented in Indonesia and various parts of the world is still unknown. Data search results can also make it easier to find novelty from research on socio-scientific issues. For example, research on socio-scientific issues has a reasonably significant relationship with students' argumentation skills. It is shown that the keyword socio-scientific issue is in the same cluster as the keyword argumentation. Because the search results contain gender terms or keywords but do not yet have a relationship with the keywords socio-scientific issue and argumentation, the term gender can also be considered for researchers to conduct further research related to argumentation and socio-scientific issues.

4. CONCLUSION

The implementation of socio-scientific issues in science learning, especially in physics, has an extensive relation. As evidence, the results of the VOS Viewer mapping show that there are many links (in one cluster) between the words socio-scientific issue and argumentation, understanding, reasoning, knowledge, scientific knowledge, and scientific literacy. So, from these results, it can be concluded that the relevance of the implementation of the socio-scientific issue as a science learning context is dominated by the ability. In addition, from this study, the most widely used SSI-context learning model is an inquiry with a decision-making-based framework. The physics material taught is related to the nature of science and climate change. SSI's research content is more dominant in science and physics, especially those related to climate change and the nature of science. The best article about SSI is from the research of Solli et al., which is related to the complexity of the SSI controversy. Meanwhile, the most prolific author is Archer, L.

AUTHORS' CONTRIBUTIONS

Arika: Data curation, data visualization, method and drafting manuscript; U A Deta: review and editing of manuscript, conceptualization; Suliyanah: review and editing of manuscript; S Admoko : review and

editing of manuscript; N Suprapto: review and editing of manuscript.

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