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Research Trend of Socio Scientific Issues (SSI) in Physics Learning Through Bibliometric Analysis in 2011-2020 using Scopus Database and the Contribution of Indonesia

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Abstract: Socio-Scientific Issues (SSI) are controversial topics that have a scientific basis and important to society. This study aims to analyze the trends of SSI research publications from 2011-2020, visualize SSI research trends and how Indonesian researchers contribute to SSI research. This study was conducted on April 18, 2021, using bibliometric analysis. Data obtained is 225 data and taken by using Scopus database with "socio-scientific issues in physics" as the keyword from 2011 until 2020. After that, the data mapping was carried out using VOS Viewer software. Based on the result research, it can be concluded that the most topic in SSI research is related to scientific literacy, argumentation, and global warming. The visualization result shows that SSI has many effects on science learning, especially to improve argumentation skills. From 35 countries, Indonesia became the largest contribution research documents in SSI by placing two representative institutions: Universitas Pendidikan Indonesia and Universitas Negeri Yogyakarta. Indonesia also contributed the most prolific SSI writer, Widodo became the most prolific writer.

Keywords: Socio scientific Issues; Bibliometrics; VOS Viewer; Scopus

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Introduction

The development of technology and science (IPTEK), especially in the 21st century, cannot be avoided in education. Technology and science play a part in bringing superior generations to produce human resources who can communicate and collaborate in using technology. According to Murti (2015), innovative and learn skills, as well as applying information media and technology, being able to survive and work are very much needed. In order to continue for using life skills.

The 2013 curriculum emphasizes the existence of social scientific issues in learning activities (Rahayu, 2015). SSI are contemporary controversial issues that arise due to advances in technology and science (Ozden, 2015). Using SSI as a learning displays controversial social issues that related to science daily (Zeidler et al., 2005)

Research on SSI in physics, especially in physics learning, has been studied by several researchers. Among them, the research result which conducted by Izma et al. (2019) stated that SSI-based teaching materials affected in increasing student's understanding of the Nature of Science (NOS). The study is focused on the relevance content to each aspect of NOS. Meanwhile, Dawson and Charson (2018) conducted a study about the introduction of SSI arguments related to climate change, they are found

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that the implementation of SSI can improve argumentation skills.

Dawson (2015) also conducted a study about the application of SSI that can improve conceptual understanding. In his study, students provide accurate definitions of the greenhouse effect and climate change. Through scientific and social problems, students are taught to solve problems in society based on scientific knowledge (Hendri and Defianti, 2019). Unfortunately, the results of Deni's research (2018) prove that the quality of junior high school students' arguments in SSI is still deficient. They can only make claims and rebuttals but still difficult to make excuses (data, warrants, and backing). The difficulty of making excuses is based on the students' understanding of the concepts themselves.

The low quality of this argument cannot be separated from how teachers implement SSI in the context of learning. As a result, the application of SSI as a lesson study in several countries is still rarely carried out by teachers. Genisa et al. (2020) have researched and studied the implementation of SSI in teaching materials. The research method is carried out by reviewing and searching the literature. However, analysis by bibliometric method using the Scopus database has never been carried out, so this research was conducted to examine scientific research from 1986 to 2021 through the bibliometric analysis method by taking data from Scopus.

Based on the background description above, the purpose of this study is to analyses the implementation of Socio Scientific Issues as a physics learning context and research/publication trends (2010-2020) in the Scopus database using VOS viewer software. It is about the publication outputs, document sources and language sources of SSI from 2011-2020, the distribution of SSI research across countries and agencies, the top research authors of SSI in the world, the visualization of SSI research trends, Indonesia research contribute to SSI.

Method

The type's research of this study is descriptive research which was analyzed by using the bibliometric analysis method. The research was sourced from the Scopus database, which was taken from the Scopus web (www.scopus.com). Scopus was chosen because it is the largest academic database globally with citations that provide abstracts from various scientific and research literature that have been reviewed (Tupan et al., 2018). So, the Scopus database is effective for visualizing, tracking and analyzing research.

The data was carried out on April 18, 2021, with the keywords of the title and abstract is "socio", "scientific", "issue", and "in physics" from 2011 until 2020. The data obtained in the form of the publication numbers each year, authors, and journals that contain articles in physics. Furthermore, the search results in the form of data samples are downloaded in .ris and .csv formats. This research are analyzed using VOSviewer software from three types of mapping produced, namely network visualization, overlay visualization and density visualization.

Research subjects were analyzed by using Microsoft Excel 2013. Like the publication trends in SSI field and document's types number was processed by using Microsoft Excel, which was formed into a graph to make it easier for readers to understand this research. After the statistical results are obtained, the mapping data analysis is carried out using VOSViewer.

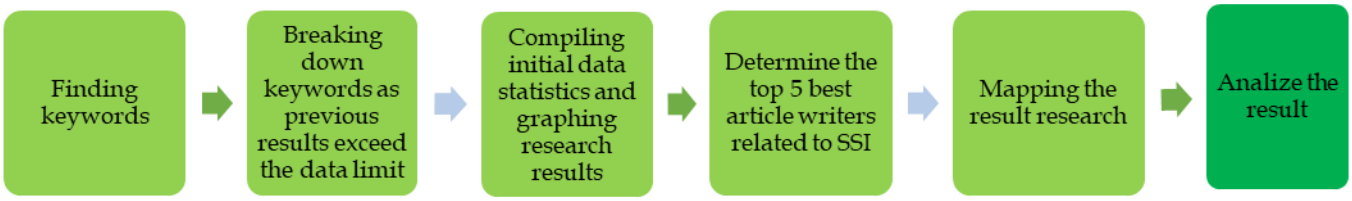

Figure 1. Steps to conduct research with bibliometric analysis

Result and Discussion

Publication Result, type of document and Language.

From the data search results there were 225 document. The distribution of articles each year is described in figure 2. There are seven document sources of Socio-scientific issue (SSI) research in physics from the Scopus database, including articles, conference papers, conference reviews, reviews, book chapters, books, and editorials. The published documents are starting in 2011 and until 2020. The publication number from 2011 to 2020 can be shown in Figure 2. From that graph, it can be seen that there are an enhancement in the document's number from 2011 to 2020. One of the authors who published research documents in 2011 was Soresen (2011) with his document that discusses about renewable energy. In the document, it is written that several solutions for

renewable energy become a sustainable system, and useful in daily life. The comprehensive documents decreased in 2016, while in 2019, there are a significant enhancement in the total documents from 18 to 46 documents. Furthermore, in 2020, the number of research documents did not decrease.

Figure 2. Graph of Number Publication Years 2011-2020

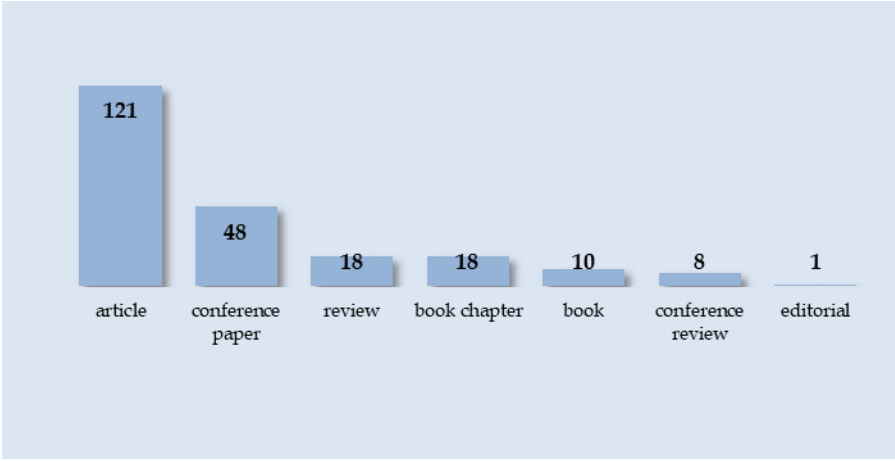

Figure 3. Graph of Document's type

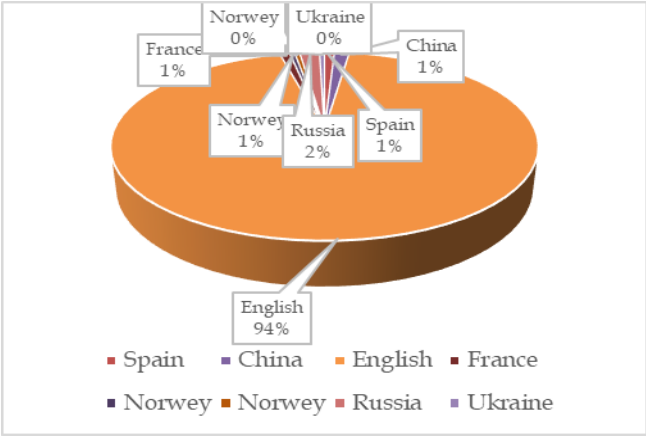

Figure 4. Graph of Language

The publication numbers based on the document's type shows that the article was dominant, which is 225 documents (figure 3). The editorial has the least publication numbers. Tytler R. (2012) wrote the type of editorial about socio-scientific Issues, science education and sustainability. This paper describes the perspective of SSI and sustainability related to science education. The most of documents used English, which as much 211 documents or 94%. This data can indicate that most of the publications on SSI are from the international level because most of the language used is English. Moreover, the least document are in Norwegian and Ukrainian, with a percentage of less than 1% with 1 document (Figure 4).

The Result of Cross-country publications

Based on the number of cross-border's document, it can be seen that the most significant document number was dominated by Indonesia, with 29 documents from 2011 to 2020. Countries such as Russia and the USA contributed to this topic with 20 and 18 documents, respectively. Meanwhile, with almost the same amount, China, Australia, France, Sweden and Switzerland donated between 8-7 documents.

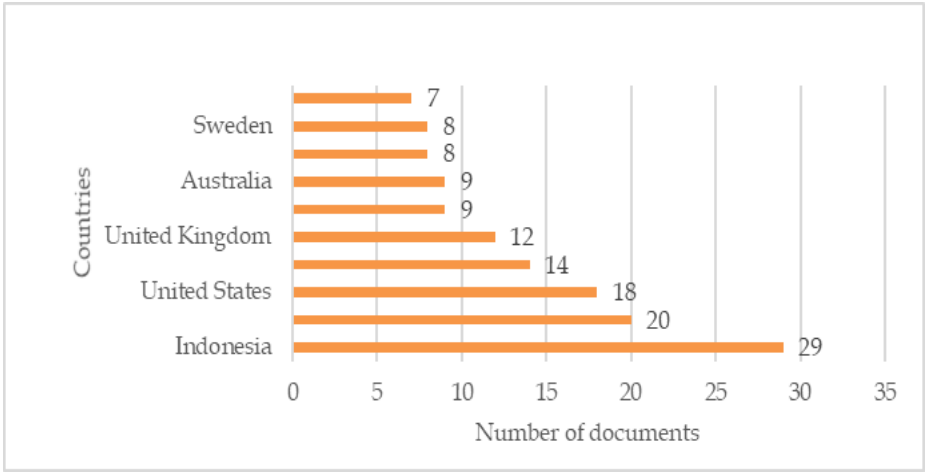

Figure 5. Distribution of the Top 10 countries contributions

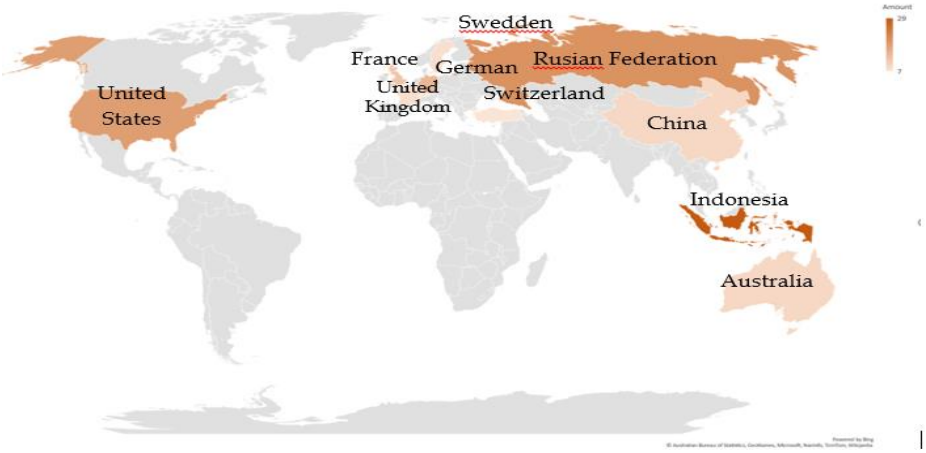

Figure 6. Cross-country of SSI distribution

Meanwhile, to see as a whole, the distribution of SSI research can be seen in Figure 5, which is about the cross-country distribution of SSI. In this figure, it can be seen that Indonesia dominates the number of researches on SSI. This is shown in the figure that the Indonesian region is dark brown and the oldest among other regions. It is followed by Russia and America. The areas of Australia, Korea, China are also quite dominant. However, some areas that are not brown does not mean that there is no research at all, but it is still quite rare.

Table 1: Rank of the top 5 agencies with the most document contributions

Rank	Affiliation	Document number
1	Universitas pendidikan Indonesia	11
2	Moscow State University	6
3	Russian Academy of Science	5
4	University of Missouri	4
5	universitas negeri Yogyakarta	3

The number of SSI documents (2011 – 2020) across all institutions can be seen in Table 1. Singapore places the two institutions, namely the Indonesian Education University with 11 documents ranked first and Yogyakarta State University ranked fifth with three documents. Meanwhile, Russia placed two representatives, namely Moscow State University and the Russian Academy of Science, in rank 2 and 3. In comparison, America (USA) placed one representative in fourth place, namely the University of Missouri.

From table 1, it shows that Universitas Pendidikan Indonesia have the largest contribution in SSI Research. One of the research from Universitas Pendidikan Indonesia is from Hendrayatno, et al (2020). The study is about Genetics in socio scientific issues, focus on Measuring rebuttal abilities in scientific argumentation. In the second place, there is Moscow State University. One of the documents was conducted by Zaykova (2020) it is about Green Spice for the Megacity and Urbanization. Third, there is Russian Academy of Science. On of the documents was conducted by Sukhodolov et al. (2019). It is about mathematical modelling of assessing the number of Baikal omul in

the socio-economic and legal aspects of environmental law violations. Fourth, there is the University of Missouri, and one of the research is about teachers select SSI material for teaching (Hancock et al. 2019). Fifth, there are Universitas Negeri Yogyakarta with one of the research that conducted by Dhisadewi (2020) it's about Chemistry-based socio-scientific issues (SSis) as a learning context: An exploration study of biofuels.

Top SSI Related Research Writers

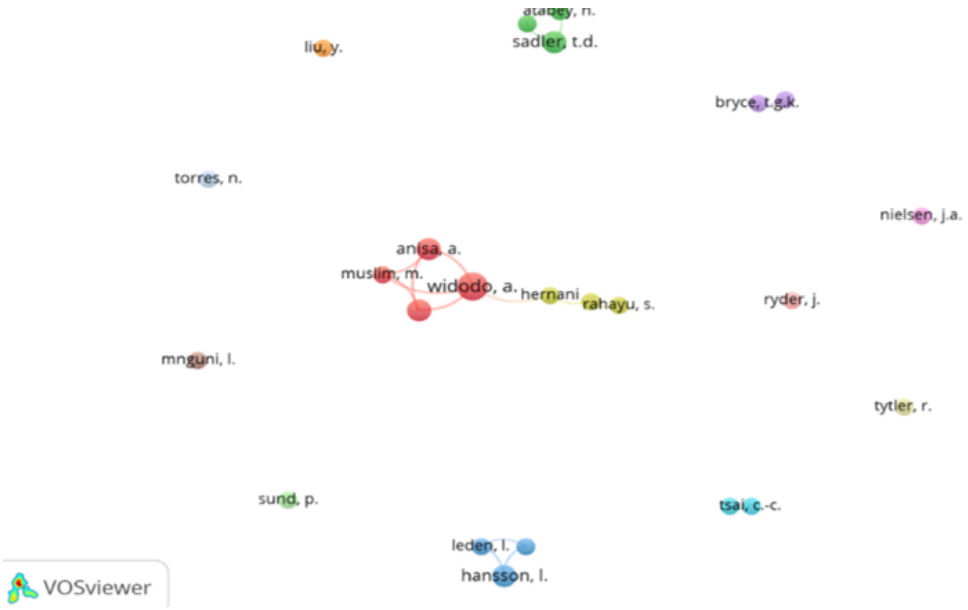

Figure 7. Top authors of SSI research

The most productive authors on research on SSI in physics are shown in Figure 7, which shows the top authors and their clusters in research, which indicates that the authors are productive in research on SSI in physics. Widodo, A., et al. lead cluster 1, which is shown in red. One of the research from Widodo, et al (2019) is about genetics in socio scientific issues: Measuring rebuttal abilities in scientific argumentation. They were then followed by Sadler, T. D., et al. in cluster 2. One of the research from Topcu et al (2018) is about the classroom observation protocol for socioscientific issue-based instruction: development and implementation of a new research tool. And Hansson, I. and Leiden, I. in cluster 3 and the lead in a cluster wich one of the article is about working with the nature of science in physics class: Turning 'ordinary' classroom situations into nature of science learning situations (Hansson and Leiden.2016) From the results of the mapping, it can also be seen that SSI research in Indonesia is quite popular because the author's mapping results show that there are researchers from Indonesia who are quite dominating, namely Widodo, A. et al. from the University of Education Indonesia.

SSI Research Trends Visualization in Physics using VOSViewer

From 225 documents related to SSI research in the Scopus database, the research trends on this topic were then visualized with the help of VoSViewer software. This effort helps find the novelty of research in this domain. The study results indicate several essential parameters or interrelationships between variables in SSI, such as the presentation of SSI in science learning, SSI issues, SSI with teaching materials, SSI related to skills, and global warming with SSI.

The coloured circle shows items or keywords and obtained as many as 104 items or keywords 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.

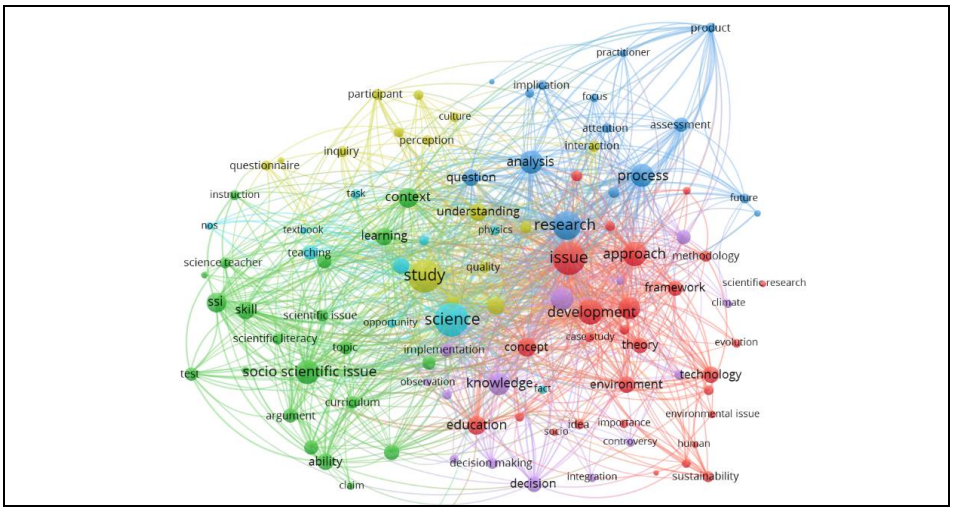

Figure 8. Network visualization of SSI research

From the mapping results, there are 6 clusters (red, blue, purple, green, yellow and light blue) that show a relationship between one topic and another (figure 8). Cluster 1 is shown in red. Cluster 2 is green. Cluster 3 is blue, cluster 4 is yellow, cluster 5 is purple, and cluster 6 is light blue. The focus of this research is the keyword socio-scientific issue which is in cluster 2 and has quite a several items related to SSI. (Figure 9).

Curriculum, science education, argumentation, learning, and context items are the same cluster with SSI. The skills show that the seven keywords have a reasonable close relationship. The word curriculum and science education related with SSI, it can be shown in the the figure 10. SSI can be implemented into curriculum design as a learning strategy to improve students' understanding, knowledge and development skills regarding science. Therefore, SSI is closely related to science education because SSI context are authentic, current, scientific, controversial and need to be discussed (figure 10b). This relationship can be said to be logical, as stated by Dawson and Carson (2018) that SSI is a controversial issue that has a scientific basis and is essential or public concern.

The application of SSI also affects some skills (figure 11). The skills show that the two keywords have a reasonable 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, while SSI was implemented in a learning context, it will be influence the quality of argumentation. Triani et al. (2020) research proves that there are an enhancement of students' scientific argumentation skills using the SSI learning strategy. Dawson and Carson (2018) also prove that the implementation of SSI in the context of learning can increase students' understanding of climate change.

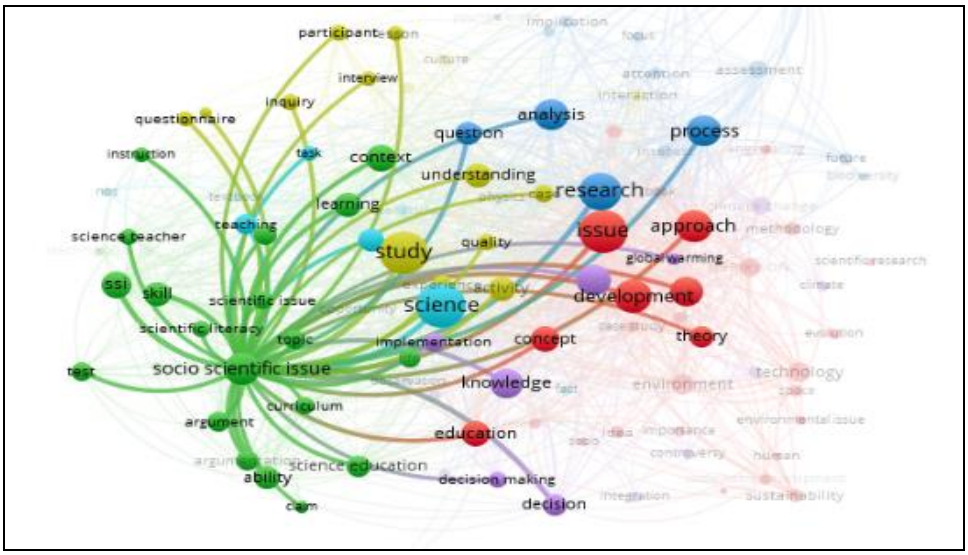

Figure 9. Visualization focusing on the SSI word

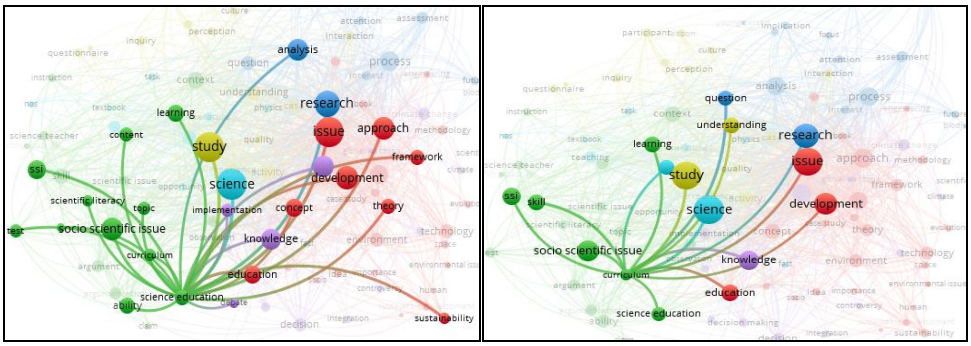

Figure 10. The relationship between SSI, curriculum and science education words

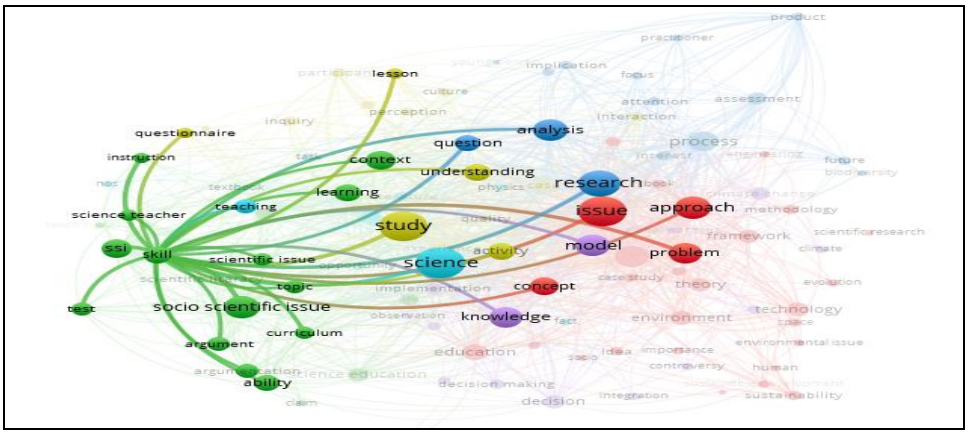

Figure 11. SSI related with some skill

The argumentation word is also in the same cluster with SSI. This relationship also means that the four words are closely related. From the mapping results, it can be seen that when SSI is applied as a learning context, it will affect the ability to argue scientifically (figure 12). The effect of SSI on improving the quality of students' argumentation has been proven in the research of Siska et al. (2020), where the implementation of SSI in learning strategies can improve the quality of students' scientific arguments. The implementation of SSI in learning also affects students' understanding (knowledge). These results are the following research conducted by Izma et al. (2019) regarding the use of teaching materials based on socio-scientific issues for improving understanding of the nature of science. Based on the search results, the keywords Science, study and issue often appear in several research articles. Which are indicated by the appearance keywords in yellow, as well as for socio-scientific issues and physics in yellow opaque (figure 13), which means the keywords socio-scientific issue and physics. It Has appeared quite a lot in titles and abstracts in several scientific articles. One of the keywords that do not appear often is natural science and decision making, which are still green in color.

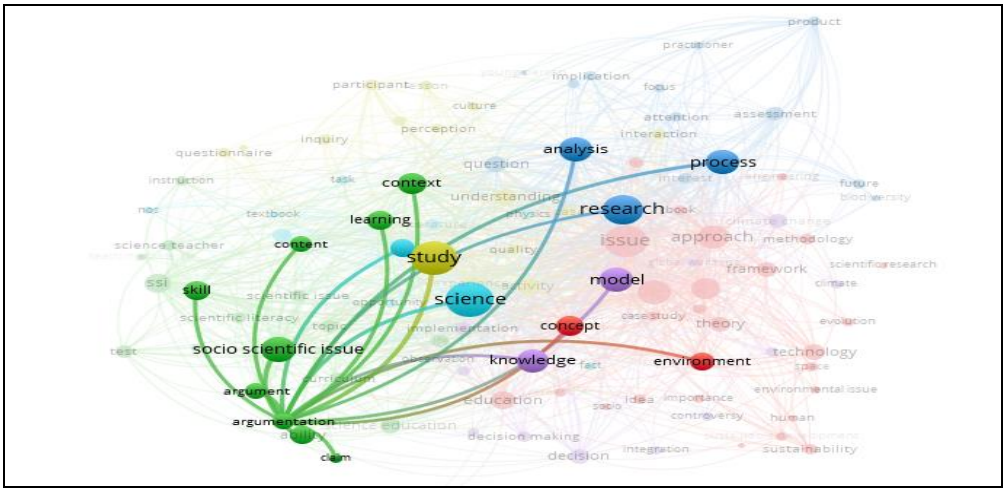

Figure 12. SSI related with argumentation

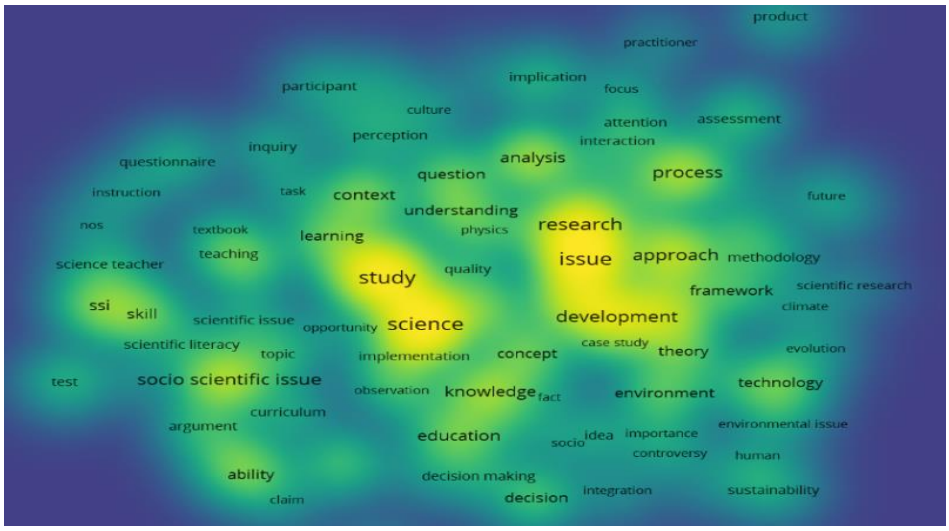

Figure 13. Topic mapping with VOSviewer on density visualization

The results of this study are expected that teachers can consider implementing SSI in a physics learning context. This result is because the issues raised are very current, complex, global, and require further discussion. SSI, which is current and authentic, can encourage students to work with actual events often reported in the media. Even SSI often involves global, regional and local dimensions, which can characterize environmental problems; for example, what is decided at the local level impacts global systems such as water and air systems. Since many issues involve ethical reasoning, decisions or opinions on issues reported in the media today are usually based on knowledge and values.

On the other hand, this research is only limited to analyzing word items obtained based on titles and keywords from the Scopus database. The strength of the relationship is not yet apparent. Data search results can also make it easier to find updates from research on SSI. For example, research on the topic of SSI has a reasonably significant relationship with students' argumentation skills, and it is shown that the SSI keyword is in the same cluster as the argumentation keyword. Because the search results contain the term or keyword stem but do not have a relationship with the SSI keywords and argumentation, the term stem can also be considered for researchers to conduct further research related to socio-scientific issues and argumentation.

Contribution of Indonesian Researchers on SSI.

If we add up, Indonesia has contributed quite a lot of 29 documents out of a total of 225 searched documents. From this amount, it can be seen that it only contributed two types of documents. Namely, conference papers and articles. (Figure.14)

The number of SSI documents from institutions in Indonesia is described in table 2. From table 2, it can be seen that UPI is the top Indonesian institution that contributes the most SSI documents or publications, which is ten documents. One of the authors from UPI is Widodo, A. et al. (2020), who researched the analysis of socio-scientific issues through algorithms.

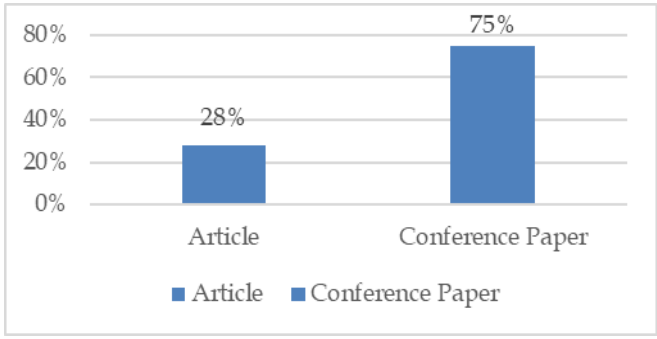

Figure 14. Document source's Graph of Indonesian Researcher

The top SSI researchers in Indonesia are obtained from the ranking results, which can be explained in Figure 15. The mapping results show that the most productive Indonesian writer is Widodo. This has also been explained to the top researchers in the world, where Widodo leads the highest cluster. Widodo contributed as many as five documents in research on SSI. One of the recent studies by Widodo et al. (2020) related to SSI is about SSI analysis through logarithms and exploration of rebuttal complexity in argumentation. Furthermore, Anisa and Riandi occupy the second position in the top SSI researchers in Indonesia. One of the studies conducted was about SSI in genetics, which measures rebuttal ability in the argument of Anisa et al.(2019).

Table 2. The Number of institutional SSI documents in Indonesia.

Rank	Affiliation	Document number
1	Universitas Pendidikan Indonesia	10
2	Universitas Negeri Yogyakarta	3
3	Universitas Negeri Jakarta	2
4	Universitas Negeri Malang	2
5	Universitas Negeri Surabaya	2
6	Universitas Jambi	1
7	Universitas Sumatera Utara	1
8	Universitas Jember	1
9	Universitas Sultan Ageng Tritayasa	1
10	Universitas Negeri Semarang	1
11	Universitas Sebelas Maret	1
12	Universitas Pakuan	1
13	Univesitas Trisakti	1
14	IAN Kediri	1
15	Universitas Ivet Semarang	1

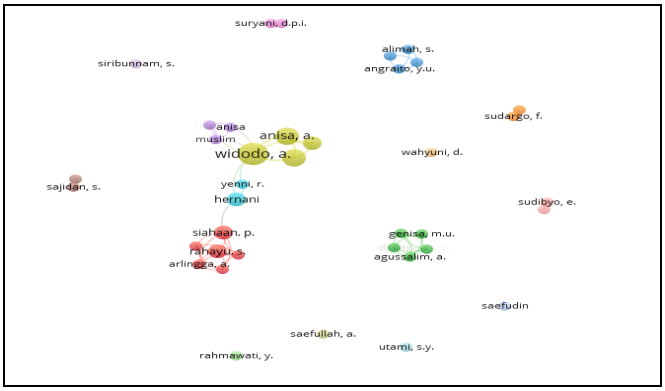

Figure 15. Top of Indonesian researcher in SSI

Conclusion

Based on the result research, it can be concluded that the most topic in SSI research is related to scientific literacy, argumentation, and global warming. The visualization result shows that SSI has many effects on science learning, especially to improve argumentation skills. Several important points have been obtained on the trend of SSI research during the period 2011 to 2020. This research has developed quite significantly starting from 2018. The number of SSI documents throughout the year has increased, which is dominated by articles in journals. Moreover, most of the articles use the international language, namely English. The distribution of SSI research publications across countries shows that Indonesia contributed the most significant number of documents from 35 countries by placing two representative institutions: the Indonesian Education University and Yogyakarta State University. Indonesia also contributed the most prolific SSI writer, namely Widodo. A was ranked first as the most prolific writer. Regarding the visualization of SSI research trends, there are six main clusters with several SSI parameters. From the visualization results, it can also be seen that SSI, if implemented in a learning context, will influence the quality of the argument.

Acknowledgments

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