Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id

STRENGTHENING THE TENSION OF SOCIO-SCIENTIFIC ISSUES BASED LEARNING TO PROMOTING DEMOCRATIC LIFE : A SYSTEMATIC REVIEW

Laras Firdaus[1]*, Hunaepi[2], Herdiyana Fitriani[3], & Taufik Samsuri[4]
[1,2,3,&4]Department of Biology Education, Faculty of Applied Science and Engineering, Mandalika University of Education, Pemuda Street Number 59A, Mataram, West Nusa Tenggara 83125, Indonesia
**Email: larasfirdaus@undikma.ac.id*
Submit: 05-08-2023; Revised: 20-08-2023; Accepted: 21-08-2023; Published: 30-12-2023

ABSTRACT: Currently, Socio-Scientific Issues (SSI) are a learning approach that is widely used by educators, not only helping students to understand a topic but also improving students' scientific literacy skills, such as critical thinking, argumentation skills, and decision-making. Various studies related to SSI have been published but cannot provide specific recommendations for future SSI studies. Therefore, a research systematic review of literature related to SSI was carried out to identify and determine research trends related to SSI as a basis for conducting further SSI studies. In conducting this literature review, we collected SSI-related information from the Google Scholar publication database using socio-scientific issues as search keywords. In collecting and selecting it using PRISMA (Preferred Reporting Items for Systematic Review and Meta-analysis), 155 articles were found that met the predetermined criteria for further analysis using Vosviewer. From the results of the analysis that has been done, decision-making is an item that has been studied a lot related to SSI. Thus, this item (decision-making) is recommended for further study.

Keywords: Socio-Scientific Issues, PRISMA, Vosviewer.

How to Cite: Firdaus, L., Hunaepi., Fitriani, H., & Samsuri, T. (2023). Strengthening the Tension of Socio-Scientific Issues Based Learning to Promoting Democratic Life : A Systematic Review. *Bioscientist : Jurnal Ilmiah Biologi, 11*(2), 1911-1932. https://doi.org/10.33394/bioscientist.v11i2.8722

INTRODUCTION

Integrating controversial issues into learning is called socio-scientific issues (Cebesoy & Rundgren, 2021; Kutluca, 2021; Yapicioğlu & Kaptan, 2017), and recently, Socio-Scientific Issues (SSI) has been widely used by educators (Karpudewan & Roth, 2016), to help students master scientific literacy skills as the primary goal of education (Barrue & Albe, 2013; Cayci, 2020; Cebesoy, 2021; Jafari & Meisert, 2021; Lubis et al., 2022; Nida et al., 2021; Pitiporntapin et al., 2018; Solli, 2021; Yapıcıoğlu & Kaptan, 2017), including motivation, critical thinking, and the nature of science (Sadler et al., 2016), actively involved in making decisions to solve problems, both personal problems and problems that occur in society (Vesterinen et al., 2016). In short, using SSI facilitated students to use their knowledge to solve societal problems to create a democratic life (Nida et al., 2021).

Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id

Many experts have explained SSI with various models and from multiple perspectives (Atabey & Arslan, 2020; Atabey & Topcu, 2017; Genel & Topçu, 2016; Sadler et al., 2016). Nonetheless, at least, SSI-based learning is context-dependent learning (Cebesoy, 2021; Saputri et al., 2022), that is, it deals with open-ended, ill-structured, controversial, and complex problems (Çalik et al., 2014; Chang et al., 2014; Karahan & Roehrig, 2017, 2019; Sağlam & Eroglu, 2022), debateable, requires various considerations, perspectives, and solutions (Cebesoy, 2021; Chang et al., 2014; Eş & Öztürk, 2021), usually involves emotions and moral judgment (Guler, 2013; Kutluca & Aydin, 2016), not only related to issues or problems that occur in life (Sadler et al., 2016), such as cloning (Cebesoy, 2021; Özden, 2015), Genetic Modification of Organisms (GMO) (Cebesoy, 2021; Herman et al., 2020), pharmacogenomics, nuclear power plant, stem cell (Cebesoy, 2021), and global warming (Herman, 2015), but also deals with controversial conceptual issues (Sadler et al., 2016), such as the theory of evolution and climate change. Because of this, SSI is also sometimes called Controversial Science Issues (CSI) (Beniermann et al., 2021).

Related to SSI as a learning approach, several research finding show that SSI can improve student learning outcomes (increase students' understanding of scientific knowledge) (Chen & So, 2017; Lorite et al., 2023; Estigarribia et al., 2022; Karpudewan & Roth, 2016; Kolarova et al., 2013; Owens et al., 2020; Sadler et al., 2016; Wahono, Chang, et al., 2021; Wahono et al., 2021), the development of students' attitudes and motivation towards science (Bossér & Lindahl, 2020; Chang et al., 2013; Lindahl & Folkesson, 2016; Yahaya et al., 2016), related to epistemological beliefs (Baytelman et al., 2020; Chang et al., 2020; Eryasar & Kilinc, 2022; Hsu et al., 2014; Leung, 2020; Lin et al., 2020; Muis et al., 2021; Öztürk & Yilmaz-Tuzun, 2016; Zeidler et al., 2013), increasing students' understanding of the nature of science itself (Bilican, 2018; Christenson & Walan, 2023; Karahan et al., 2017; Khishfe et al., 2017; Kutluca & Aydın, 2018), critical thinking (Gül & Akcay, 2020; Pratiwi et al., 2016; Solbes et al., 2018), argumentation (Anwar & Ali, 2020; Capkinoglu et al., 2020; Evagorou & Osborne, 2013; Grooms, 2020; Grooms et al., 2014; Jumadi et al., 2021; Khishfe, 2014; Kutluca & Aydin, 2016; Özcan & Balim, 2021; Robertshaw & Campbell, 2013; Torres & Cristancho, 2018; Türköz & Öztürk, 2019), related to metacognitive (Eggert et al., 2013; Hsu & Lin, 2017; Öztürk, 2017), informal reasoning (Cebesoy, 2021; Lorite et al., 2023; Karpudewan & Roth, 2016; Kolarova et al., 2013; Yapicioglu & Aycan, 2018), socio-scientific reasoning (SSR) (Eggert et al., 2017; Kinslow et al., 2019; Owens et al., 2019, 2022; Romine et al., 2017), decision making (Grace et al., 2015; Gresch et al., 2013; Halim & Saat, 2017; Ladachart & Ladachart, 2021; Sakamoto et al., 2021; Zo`bi, 2014).

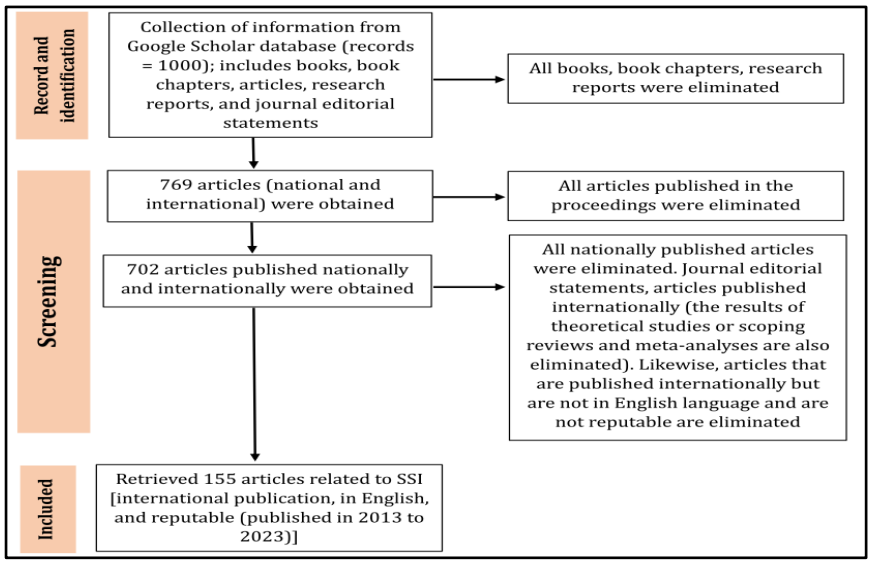
From the description above, we know that SSI has been studied by many researchers using various methods. We do not deny all of this. However, we must understand that the results of studies conducted by researchers regarding SSI have yet to provide specific recommendations regarding topics or themes for further research related to SSI. Therefore, as part of the scientific culture, we need to

Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id

carry out a systematic analysis of the literature in our effort to find and determine future research topics related to SSI.

METHOD

This research is a systematic review of the literature that aims to identify research trends related to SSI. The research question to be answered is whether research themes are related to SSI, what items are trending related to SSI as a basis for further SSI studies. In the analysis, we collect articles related to socio-scientific issues from the Google Scholar publication database. In the collection and selection process, we use PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analysis), as shown in Picture 1. *First*, we collected data using Publish or Perish (PoP8) for Windows using socio-scientific issues as the search keywords. We will collect and analyze articles published in the last ten years (from 2013 to 2023). At this stage, we get 1000 publication data.



Picture 1. PRISMA Systematic Review Flow Diagram.

Second, from the 1000 data publications, we will choose only those in the form of articles. Alternatively, in this second stage, we eliminate publication data such as books, magazines or news, book chapters, research reports, and proceedings articles, and we also eliminate journal editorial statements. In this second phase, 769 articles were obtained (including articles published nationally and internationally). Furthermore, from these 769 articles, we selected articles related to SSI with several criteria. Among others, the article must be in the English language, not an article resulting from a theoretical review (literature analysis or meta-analysis). The article must be reputable. Finally, we obtained 155 articles related to SSI from this elimination process. Then, we visualize all these articles using Vosviewer for Windows version 1.6.19 to make the information more meaningful, including publication fluctuation, themes related to SSI, and author relationships.

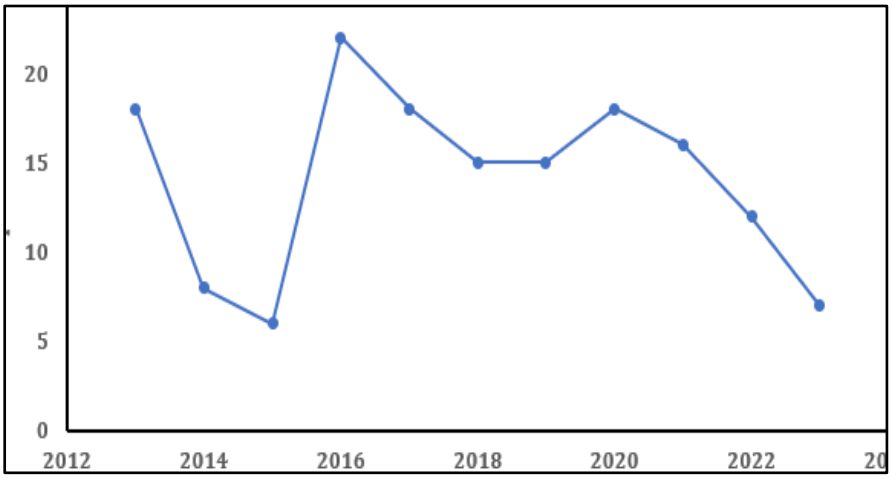
Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id

RESULTS AND DISCUSSIONS

This study aims to identify and determine future research themes or topics related to SSI. Nonetheless, several points become the focus of discussion in this study, including publication fluctuations, trend items related to SSI, and relationships between authors.

Results

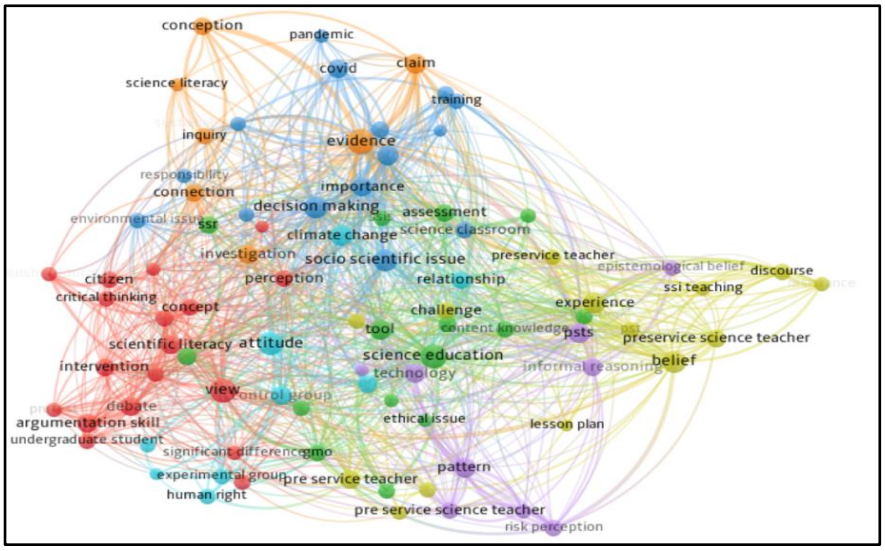
SSI is an essential part of education, providing opportunities for students to connect their knowledge with current issues, such as the use of technology, social issues (such as abortion) (Juntunen & Aksela, 2014). In short, SSI-based learning is believed to help students increase their motivation and scientific literacy skills (Sakamoto et al., 2021). From the screening results that have been carried out, fluctuations in the number of SSI-related article publications per year can be seen in Picture 2; namely, the highest publication occurred in 2016 (22 articles). Then, it decreased in 2017 (18 articles), 2018 and 2019 (15 articles) and increased again in 2020 (18 articles). Then, it decreases until 2023.



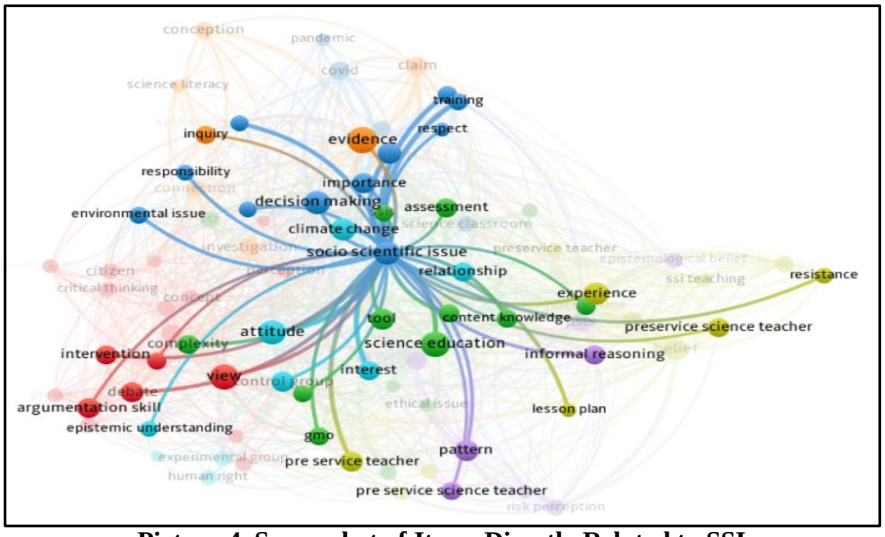
Picture 2. Number of Article Publications Related to SSI Screening Results in the Last 10 Years.

Picture 3 is a Vosviewer visualization network showing the relationships between items from the 155 articles analyzed, consisting of 87 items with 1354 links. The colour difference in each item indicates each cluster. From the 87 items, some items need to be visible. This is because each item overlaps between items and with every existing link. Then, Picture 4 shows items that are directly related to socio-scientific issues, including epistemic understanding, argumentation skill, complexity, attitude, tool, pre-service science techer, lesson plan, informal reasoning, content knowledge, assessment, decision-making, responsibility, environmental issue, inquiry, training, respect, gmo, interest, science education, and other items.

Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id



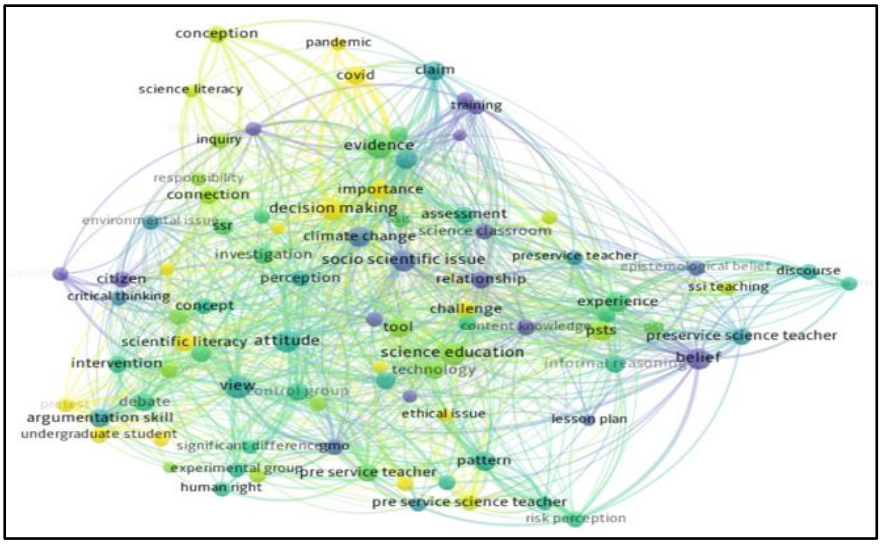
Picture 3. Network Visualization Items Related to SSI by Vosviewer.



Picture 4. Screenshot of Items Directly Related to SSI.

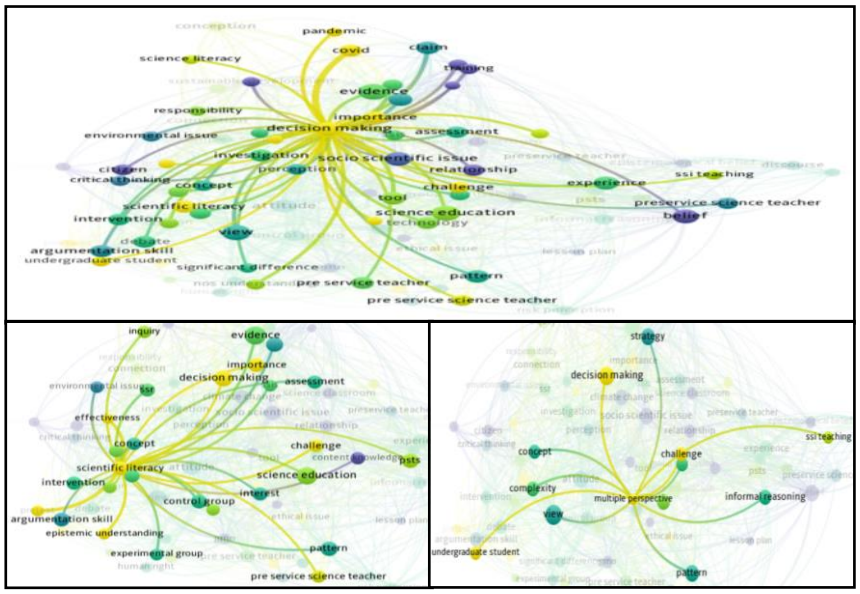
Furthermore, Picture 5 (overlay visualization) shows items related to SSI that are being studied a lot, marked in yellow, where decision-making is the anchor item. Items in yellow, or related to them, are recommended for further study. In summary, the trend of items related to SSI can be seen in Picture 6, where decision making is related to scientific literacy, argumentation skills, debate, claim, training, multiple perspectives, nos understanding, critical thinking, perception, responsibility, environmental issues, epistemic understanding, and others.

Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id



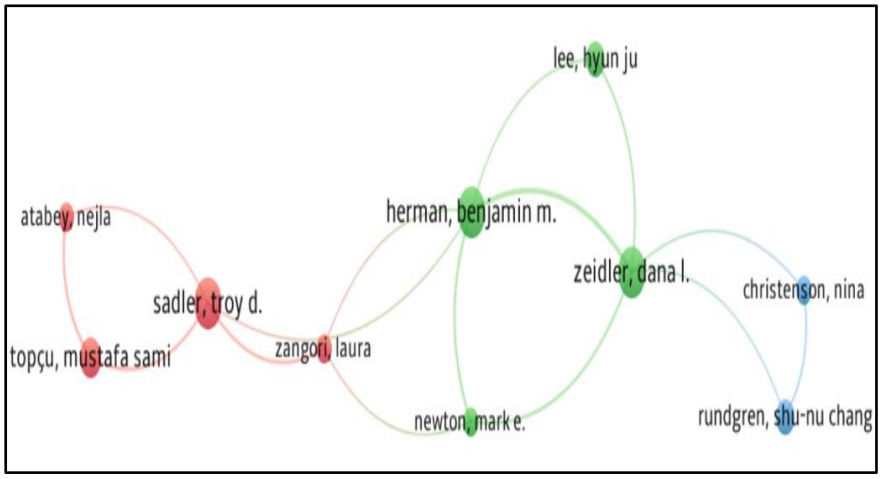
Picture 5. Overlay Visualization by Vosviewer.

Besides that, we can also visualize the relationship between authors in bibliometric analysis. In this process, we determined the criteria based on the number of documents for each author, namely, at least the author has 3 documents, and there are 21 authors. However, we take the top 10 authors (as shown in Table 1) and based on the relationship between authors (Picture 7), centred on Zeidler, Dana L; and Herman, Benjamin M (10 links). Then, Sadler, Troy D (6 links); Topcu, Mustafa M (5 links), Newton, Mark E (6 links), Atabey, Nejla; and Zangori, Laura (4 links each), Lee, Hyun-Ju; Rundgren, Shu-Nu Chang; Christenson, Nina; Karahan, Engin; and Roehrig, Gillian H (3 links each), and the Table 2 shows the top 10 most cited author.



Picture 6. Overlay Visualization of Trend Items Related to SSI by Vosviewer.

Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id



Picture 7. Author Relationship Related to SSI.

Table 1. Top 10 Productive Authors.

No.	Author	Document	Affiliation	Country
1	Herman, Benjamin M	7	Department of Learning, Teaching and Curriculum, College of Education, University of Missouri.	Columbia, MO, USA
2	Zeidler, Dana L	7	Department of Teaching and Learning, University of South Florida.	Tampa, Florida, USA
3	Sadler, Troy D	7	The ReSTEM institute, University of Missouri.	Columbia, MO, USA
4	Topçu, Mustafa S	5	Department of Mathematics and Science Education, College of Education, Yıldız Technical University.	Istambul, Turkey
5	Lindahl, Mats	5	Department of Chemistry and Biomedical Sciences, Linnaeus University.	Sweden
6	Lee, Hyun J	4	WCU Global Institute for STS Education, Ewha Womans University.	Seoul, Republic of Korea
7	Rundgren, Shu-Nu Chang	4	Faculty of Health, Science and Technology, Department of Engineering and Chemical Sciences, Karlstad University.	Karlstad, Sweden
8	Dauer, Jenny M	4	University of Nebraska-Lincoln.	Holdrege, Lincoln, USA
9	Dawson, Vaile	4	School of Education, University of Western Australia.	Perth, Australia
10	Leung, Jessica W. T	4	Faculty of Education, The University of Hong Kong.	Pokfulam, Hong Kong

Discussions

Publications Fluctuation

In this section, we will describe in general the results of our analysis. The research results related to SSI, which researchers have published, have inspired teachers, lecturers, and other researchers. Considering the number of SSI-related

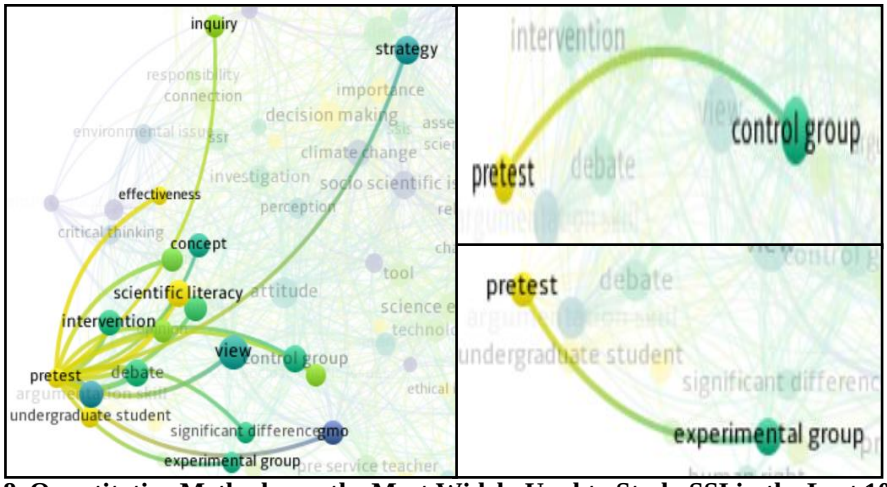
Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id

publications in the last 10 years (as shown in Picture 2), 2016 was the year SSI-related articles were published (22 articles). The specified criteria and the database used strongly influence fluctuations in the number of published articles related to SSI.

Table 2. Top 10 Most Cited Author.

No.	Author/year	Title	Source	Cited
1	Evagorou and Osborne (2013)	Exploring young students' collaborative argumentation within a socioscientific issue.	Journal of Research in Science Teaching.	162
2	Lee et al. (2013)	Socioscientific issues as a vehicle for promoting character and values for global citizens.	International Journal of Science Education.	92
3	Khishfe (2014)	Explicit nature of science and argumentation instruction in the context of socioscientific issues: An effect on student learning and transfer.	International Journal of Science Education.	88
4	Sadler et al. (2016)	Learning science content through socio-scientific issues-based instruction: A multi-level assessment study.	International Journal of Science Education.	72
5	Jho et al. (2013)	The relationship of science knowledge, attitude and decision making on socio-scientific issues: The case study of students' debates on a nuclear power plant in Korea.	Science & Education.	72
6	Tidemand & Nielsen (2017)	The role of socioscientific issues in biology teaching: From the perspective of teachers.	International Journal of Science Education.	69
7	Zeidler et al. (2013)	Cross-cultural epistemological orientations to socioscientific issues.	Journal of Research in Science Teaching.	66
8	Birmingham & Barton (2013)	Putting on a green carnival: Youth taking educated action on socioscientific issues.	Journal of Research in Science Teaching.	63
9	Gresch et al. (2013)	Training in decision-making strategies: An approach to enhance students' competence to deal with socio-scientific issues.	International Journal of Science Education.	58
10	Romine et al. (2017)	Assessment of scientific literacy: Development and validation of the quantitative assessment of socio-scientific reasoning (QuASSR).	Journal of Research in Science Teaching.	53

Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id



Picture 8. Quantitative Methods are the Most Widely Used to Study SSI in the Last 10 Years.

We do not analyze the method used to study SSI, but regarding this, we can photograph it through an overlay visualization, as shown in Picture 8, it can be said that the quantitative method is a method that is widely used to study SSI. The type of research is generally classified into quantitative, qualitative, and mixed research. As a research method, quantitative research is not only related to laboratories but is also widely used in social sciences, such as education or psychology (Rashid & Sipahi, 2021). In its process, quantitative research uses the rules of deductive logic to test, improve knowledge or solve problems by making systematic, standardized observations and then looking at the relationships between variables from a population. Because quantitative research works on populations, the findings are usually generalized to the entire population, which is one of the strengths of quantitative research. However, on the other hand, quantitative research cannot cover social phenomena (Rahman, 2016). But, in our view, all types of research have advantages and disadvantages. The choice of research method depends on the paradigm used by a researcher and the goals to be achieved (Daniel, 2016).

Researchers with a positivist view consider the world (reality) to be static, so quantitative research is chosen to explain a phenomenon, analyzing the data statistically (Rahman, 2016). Then, researchers who are of the view that humans socially construct reality and can be changed and understood subjectively will tend to choose qualitative methods (Daniel, 2016) to describe and provide a thorough interpretation of the phenomenon under study (Sousa, 2014), this can be done using various methods, such as phenomenology, grounded theory, hermeneutics, ethnography, content analysis, and phenomenography (Bengtsson, 2016). Meanwhile, researchers who think a phenomenon can be explained using two perspectives tend to use mixed methods (Dawadi et al., 2021; Walton, 2016; Warfa, 2016).

Trend Items Related to SSI

From the results of the analysis that has been done, as shown in Picture 6, decision-making is an item that has been studied a lot. As we know, SSI-based learning is context-dependent learning, using controversial issues that occur in

Bioscientist : Jurnal Ilmiah Biologi
E-ISSN 2654-4571; P-ISSN 2338-5006
Volume 11, Issue 2, December 2023; Page, 1911-1932
Email: bioscientist@undikma.ac.id

life, not an issue that is engineered to be controversial. The use of controversial issues, such as GMOs, cloning, and covid pandemic is expecting students to use their knowledge and participate (both personally and collectively) to solve and make decisions regarding these controversial issues (Gresch et al., 2015). Or in other word, helping students develop the ability to make decisions is a major element in educational goals (Cebesoy & Rundgren, 2021; Fang et al., 2019).

Decision-making related to SSI is not simple, just relying on basic logic (cause and effect) (Sakamoto et al., 2021). However, this kind of process is an essential process in decision-making, looking at the pros and cons aspects of an issue before arriving at a final decision (Fang et al., 2019). In decision-making related to SSI, students must be able to see issues from multiple perspectives (Horin et al., 2023), ongoing inquiries, and exhibiting scepticism when presented potentially biased information (Ha et al., 2022).

Helping students make decisions regarding SSI is helping them not to make decisions intuitively but helping them to make decisions from various alternatives and points of view (Cebesoy & Rundgren, 2021). In short, in making decisions related to SSI, students are not only required to use their knowledge including content knowledge (or conceptual knowledge) (Sakschewski et al., 2014), knowledge about ethics and morality (Steffen & Hößle, 2017), as an essential part of develop arguments and making decisions, they must be able to evaluate solutions critically (Sakamoto et al., 2021), but also in making decisions related to SSI, they are required to use their understanding of the nature of science (NOS), in which the NOS is a tool for obtaining knowledge, constructing arguments, and evaluating evidence (Bilican, 2018), improve students' personal qualities, and improve students' social-scientific skills (Yapıcıoğlu & Kaptan, 2017).

However, the NOS does not always provide assurance in making decisions regarding SSI because NOS is considered declarative knowledge. So, the students experience difficulty applying NOS as part of making decisions related to SSI (Leung, 2020). To solve open-ended or ill-structured problems, students need epistemic understanding (Öztürk & Tuzun, 2016), that is an understanding of knowledge is tentative, there are many methods to solve a problem (Carmona, 2021). Several studies have shown that epistemic understanding correlates with the quality of students' reasoning regarding SSI (Chang et al., 2020). Students who believe that knowledge is tentative are more readily accepting evidence that contradicts with their prior beliefs and knowledge (Leung et al., 2015). Therefore, expecting students to solve problems and make decisions related to SSI, it is recommended for teachers to provide epistemic understanding to students (Baytelman et al., 2020), this really helps students to be more productive in evaluating issues related to SSI from multiple perspectives (Leung, 2020).

Relationship Between Authors

If we pay attention to Table 1, the top 3 authors related to SSI are Sadler, Troy D; Herman, Benjamin M; and Zeidler, Dana L, with 7 documents each. Meanwhile, if we pay attention to Figure 7; Zeidler, Dana L collaborated with many authors. Of course, this provides distinct advantages for Zeidler and other authors. Meanwhile, there are (at least) two categories in this scientific

publication, namely single author or co-author, and of course, this benefits the scientific community itself. However, published papers must be available in open access to provide more benefits, allowing other authors to access or cite them (Rodrigues et al., 2020).

Regarding scientific publications (especially articles), there has been a significant increase in author collaboration (Abramo & D'Angelo, 2015; Eberle et al., 2021; Estevez et al., 2022), caused by various factors, including the increasing complexity and interdisciplinary nature of science, increasing production factor costs in research projects, innovations in information and communication technology. Various studies in scientometric literature offer empirical evidence that co-authored publications achieve higher visibility and impact. In addition, being part of the relevant scientific community and collaborating with other researchers is very important for the scientific career development of an author (or researcher) (Eberle et al., 2021).

Collaboration between authors can be understood in two aspects: different authors but from the same country or institution (domestic collaboration) and different authors (both from institutions and countries) or international collaboration. Both forms of author collaboration (domestic and international) positively impact authors. However, international collaboration is even more important in increasing the citation rate far above domestic national collaboration (Bote et al., 2013). Other benefits obtained in collaboration between authors are improved quality of articles, gain much knowledge, authors can learn from another author in the same article (Yeo & Lewis, 2019), increasing the number of citations as they relate to scientific aspects and relevance, and have been used as proxies for evaluating research in different scientific contexts, including institutions (Estevez et al., 2022).

CONCLUSION

From the analysis that has been done, it is concluded that the most published articles related to SSI were in 2016 (22 articles). There were top 10 authors, among which there were 3 most productive authors (Sadler, Troy D; Herman, Benjamin M; and Zeidler, Dana L). In addition, the analysis results also asked us to conclude that decision-making is a trend item related to SSI that has been extensively explored quantitatively. However, it is necessary to understand that SSI (in this case, decision-making as an SSI trend item) is not always studied quantitatively but can also be studied qualitatively and in mixed methods, and this, of course, depends on the paradigm used by the researcher.

SSI-based learning as learning that is synonymous with controversial issues, ill-structured, involving various perspectives and solutions, such as GMOs, cloning, and covid-19, is believed to be a means to prepare students to become citizens who are actively involved in maintaining and shaping democratic life by applying his knowledge to make decisions in solving problems that occur in life.

RECOMENDATIONS

A systematic literature review needs to be carried out in an effort to identify and define research themes related to SSI in the future. From the results

of the analysis that has been done, future research is recommended to focus on decision-making. Suppose we pay attention to factors related to decision-making, such as content knowledge or conceptual understanding and epistemic understanding (including understanding of NOS). Then, the further studies can be carried out by looking at the relationship between these factors and the ability to make decisions related to SSI. It can also be done by increasing the ability to make decisions related to SSI. In addition, learning resources also have an impact on the quality of decision-making, so developing teaching materials related to SSI becomes something that can be recommended. Furthermore, regarding issues that can be used in further studies, we can use issues that are widely used (such as GMOs, cloning, weather changes, gene therapy, organ transplantation, and other conceptual issues), local issues, and ethical issues (such as abortion). In short, the selection and use of controversial issues are adjusted to the learning topic.

REFERENCES

Abramo, G., & D'Angelo, C. (2015). The Relationship Between the Number of Authors of a Publication, its Citations and the Impact Factor of the Publishing Journal: Evidence from Italy. *Journal of Informetrics, 9*(1), 746-761. https://doi.org/10.1016/j.joi.2015.07.003

Anwar, N. P., & Ali, M. A. (2020). The Effect of Socio-Scientific Issue (SSI) Based Discussion: A Student-Centred Approach to the Teaching of Argumentation. *Scholarship of Teaching and Learning in the South, 4*(2), 76-89. https://doi.org/10.36615/sotls.v4i2.76

Atabey, N., & Arslan, A. (2020). The Effect of Teaching Socio-Scientific Issues with Cooperative Learning Model on Pre-Service Teachers' Argumentation Qualities. *İlköğretim Online, 19*(2), 491-514. http://doi.org/10.17051/ilkonline.2020.689681

Atabey, N., & Topcu, M. S. (2017). The Development of a Socioscientific Issues-Based Curriculum Unit for Middle School Students: Global Warming Issue. *International Journal of Education in Mathematics, Science and Technology, 5*(3), 153-170. https://doi.org/10.18404/ijemst.296027

Barrue, C., & Albe, V. (2013). Citizenship Education and Socioscientific Issues: Implicit Concept of Citizenship in the Curriculum, Views of French Middle School Teachers. *Science & Education, 22*(5), 1089-1114. https://doi.org/10.1007/s11191-012-9571-4

Baytelman, A., Iordanou, K., & Constantinou, C. P. (2020). Epistemic Beliefs and Prior Knowledge as Predictors of the Construction of Different Types of Arguments on Socioscientific Issues. *Journal of Research in Science Teaching, 57*(8), 1199-1227. https://doi.org/10.1002/tea.21627

Bengtsson, M. (2016). How to Plan and Perform a Qualitative Study Using Content Analysis. *Nursing Plus Open, 2*(1), 8-14. https://doi.org/10.1016/j.npls.2016.01.001

Beniermann, A., Mecklenburg, L., & Upmeier zu Belzen, A. (2021). Reasoning on Controversial Science Issues in Science Education and Science Communication. *Education Sciences, 11*(9), 1-18. https://doi.org/10.3390/educsci11090522

Bilican, K. (2018). Analysis of Pre-Service Science Teachers' Understanding of Nature of Science and Proposed Arguments on Socio-Scientific Issues. *International Journal of Research in Education and Science, 4*(2), 420-435. http://doi.org/10.21890/ijres.410632

Birmingham, D. J., & Barton, A. C. (2013). Putting on a Green Carnival: Youth Taking Educated Action on Socioscientific Issues. *Journal of Research in Science Teaching, 51*(3), 286-314. https://doi.org/10.1002/tea.21127

Bossér, U., & Lindahl, M. (2020). Students' Use of Open-Minded Attitude and Elaborate Talk in Group Discussion and Role-Playing Debate on Socioscientific Issues. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(12), 1-13. https://doi.org/10.29333/ejmste/9127

Bote, V. P. G., Gómez, C. O., & Anegón, F. d. M. (2013). Quantifying the Benefits of International Scientific Collaboration. *Journal of the American Society for Information Science and Technology, 64*(2), 392-404. https://doi.org/10.1002/asi.22754

Çalik, M., Turan, B., & Coll, R. (2014). A Cross-Age Study of Elementary Student Teachers'scientific Habits of Mind Concerning Socioscientific Issues. *International Journal of Science and Mathematics Education, 12*(1), 1315-1340. https://doi.org/10.1007/s10763-013-9458-0

Capkinoglu, E., Yilmaz, S., & Capkinoglu, E. (2020). Quality of Argumentation by Seventh-Graders in Local Socioscientific Issues. *Journal of Research in Science Teaching, 57*(6), 827-855. https://doi.org/10.1002/tea.21609

Carmona, A. G. (2021). Learning About the Nature of Science Through the Critical and Reflective Reading of News on the COVID-19 Pandemic. *Cultural Studies of Science Education, 16*(4), 1015-1028. https://doi.org/10.1007/s11422-021-10092-2

Cayci, B. (2020). A Study on the Effectiveness of a Teaching Based on Socio-Scientific Issues in the Training of Pre-Service Teachers. *Cypriot Journal of Educational Science, 15*(2), 220-231. https://doi.org/10.18844/cjes.v15i2.4604

Cebesoy, Ü. B. (2021). Pre-Service Science Teachers Informal Reasoning Patterns and Risk Perceptions in SSI: Case of Gene Therapy. *European Journal of Science and Mathematics Education, 9*(4), 211-229. https://doi.org/10.30935/scimath/11237

Cebesoy, U. B., & Rundgren, S. C. (2021). Embracing Socioscientific Issues-Based Teaching and Decision-Making in Teacher Professional Development. *Educational Review, 75*(3), 507-534. https://doi.org/10.1080/00131911.2021.1931037

Chang, H., Liang, J., & Tsai, C. (2020). Students' Context-Specific Epistemic Justifications, Prior Knowledge, Engagement, and Socioscientific Reasoning in a Mobile Augmented Reality Learning Environment. *Journal of Science Education and Technology, 29*(1), 399-408. https://doi.org/10.1007/s10956-020-09825-9

Chang, H., Wu, H., & Hsu, Y. (2013). Integrating a Mobile Augmented Reality Activity to Contextualize Student Learning of a Socioscientic Issue.

British Journal of Educational Technology, 44(3), 95-99. http://dx.doi.org/10.1111/j.1467-8535.2012.01379.x

Chang, H. Y., Hsu, Y. S., & Wu, H. K. (2014). A Comparison Study of Augmented Reality Versus Interactive Simulation Technology to Support Student Learning of a Socio-Scientific Issue. *Interactive Learning Environments, 24*(6), 1148-1161. https://doi.org/10.1080/10494820.2014.961486

Chen, Y., & So, W. (2017). An Investigation of Mainland China High School Biology Teachers' Attitudes Toward and Ethical Reasoning of Three Controversial Bioethics Issues. *Asia-Pacific Science Education, 3*(1), 1-9. https://doi.org/10.1186/s41029-016-0012-6

Christenson, N., & Walan, S. (2023). Developing Pre-Service Teachers' Competence in Assessing Socioscientific Argumentation. *Journal of Science Teacher Education, 34*(1), 1-23. https://doi.org/10.1080/1046560X.2021.2018103

Daniel, E. (2016). The Usefulness of Qualitative and Quantitative Approaches and Methods in Researching Problem-Solving Ability in Science Education Curriculum. *Journal of Education and Practice, 7*(15), 91-100.

Dauer, J. M., Lute, M. L., & Straka, O. (2016). Indicators of Informal and Formal Decision-Making about a Socioscientific Issue. *International Journal of Education in Mathematics, Science and Technology, 5*(1), 124-124. https://doi.org/10.18404/ijemst.05787

Dawadi, S., Shrestha, S., & Giri, R. A. (2021). Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms. *Journal of Practical Studies in Education, 2*(2), 25-36. https://doi.org/10.46809/jpse.v2i2.20

Dawson, V. (2015). Western Australian High School Students' Understandings About the Socioscientific Issue of Climate Change. *International Journal of Science Education, 37*(7), 1024-1043. https://doi.org/10.1080/09500693.2015.1015181

Eberle, J., Stegmann, K., Barrat, A., Fischer, F., & Lund, K. (2021). Initiating Scientific Collaborations Across Career Levels and Disciplines – A Network Analysis on Behavioral Data. *International Journal of Computer-Supported Collaborative Learning, 16*(2), 151-184. https://doi.org/10.1007/s11412-021-09345-7

Eggert, S., Nitsch, A., Boone, W., Nückles, M., & Bögeholz, S. (2017). Supporting Students' Learning and Socioscientific Reasoning about Climate Change - The Effect of Computer-Based Concept Mapping Scaffolds. *Research in Science Education, 47*(1), 137-159. https://doi.org/10.1007/s11165-015-9493-7

Eggert, S., Ostermeyer, F., Hasselhorn, M., & Bögeholz, S. (2013). Socioscientific Decision Making in the Science Classroom: The Effect of Embedded Metacognitive Instructions on Students' Learning Outcomes. *Hindawi Publishing Corporation Education Research International, 2013*. http://dx.doi.org/10.1155/2013/309894

Eryasar, A. S., & Kilinc, A. (2022). The Coherence Between Epistemologies and SSI Teaching: A Multiple-Case Study with Three Science Teachers.

Science & Education, 31(1), 123-147. https://doi.org/10.1007/s11191-021-00200-7

Eş, H., & Öztürk, N. (2021). An Activity for Transferring the Multidimensional Structure of SSI to Middle School Science Courses: I Discover Myself in the Decision-Making Process with SEE-STEP! *Research in Science Education, 51*(3), 889-910. https://doi.org/10.1007/s11165-019-09865-1

Estevez, A. V., García-Sánchez, P., Moral-Munoz, J. A., & Cobo, M. J. (2022). Why do Papers from International Collaborations Get More Citations? A Bibliometric Analysis of Library and Information Science Papers. *Scientometrics, 127*(12), 7517-7555. https://doi.org/10.1007/s11192-022-04486-4

Estigarribia, L., Chalabe, J. T., Cisnero, K., & Romano, L. G. (2022). Co-Design of a Teaching-Learning Sequence to Address Covid-19 as a Socio-Scientific Issue in an Infodemic Context. *Science & Education, 31*(6), 1-10. https://doi.org/10.1007/s11191-022-00362-y

Evagorou, M., & Osborne, J. (2013). Exploring Young Students' Collaborative Argumentation Within a Socioscientific Issue. *Journal of Research in Science Teaching, 50*(2), 1-20. https://doi.org/10.1002/tea.21076

Fang, S. C., Hsu, Y. S., & Lin, S. S. (2019). Conceptualizing Socioscientific Decision Making from a Review of Research in Science Education. *International Journal of Science and Mathematics Education, 17*(3), 427-448. https://doi.org/10.1007/s10763-018-9890-2

Genel, A., & Topçu, M. (2016). Turkish Preservice Science Teachers' Socioscientific Issues-Based Teaching Practices in Middle School Science Classrooms. *Research in Science & Technological Education, 34*(1), 105-123. https://doi.org/10.1080/02635143.2015.1124847

Grace, M., Lee, Y., Asshoff, R., & Wallin, A. (2015). Student Decision-Making About a Globally Familiar Socioscientific Issue: The Value of Sharing and Comparing Views with International Counterparts. *International Journal of Science Education, 37*(11), 1855-1874. https://doi.org/10.1080/09500693.2015.1054000

Gresch, H., Hasselhorn, M., & Bögeholz, S. (2013). Training in Decision-Making Strategies: An Approach to Enhance Students' Competence to Deal with Socio-Scientific Issues. *International Journal of Science Education, 35*(15), 2587-2607. https://doi.org/10.1080/09500693.2011.617789

_____. (2015). Enhancing Decision-Making in STSE Education by Inducing Reflection and Self-Regulated Learning. *International Journal of Science Education, 47*(1), 95-118. https://doi.org/10.1007/s11165-015-9491-9

Grooms, J. (2020). A Comparison of Argument Quality and Students' Conceptions of Data and Evidence for Undergraduates Experiencing Two Types of Laboratory Instruction. *Journal of Chemical Education, 97*(8), 2057-2064. https://doi.org/10.1021/acs.jchemed.0c00026

Grooms, J., Sampson, V., & Golden, B. (2014). Comparing the Effectiveness of Verification and Inquiry Laboratories in Supporting Undergraduate Science Students in Constructing Arguments Around Socioscientific

Issues. *International Journal of Science Education, 36*(9), 1412-1433. https://doi.org/10.1080/09500693.2014.891160.

Gül, M., & Akcay, H. (2020). Structuring a New Socioscientific Issues (SSI) Based Instruction Model: Impacts on Pre-Service Science Teachers'(PSTS) Critical Thinking Skills and Dispositions. *International Journal of Research in Education and Science, 6*(1), 141-159. https://doi.org/10.46328/ijres.v6i1.785

Guler, M. P. D. (2013). Investigation on the Inclusion of Socio-Scientific Acquisitions in Curriculum of Science and Technology Lesson. *Educational Research and Reviews, 8*(24), 2295-2302. https://doi.org/10.5897/ERR2013.1607

Ha, H., Park, W., & Song, J. (2022). Preservice Elementary Teachers' Socioscientific Reasoning During a Decision-Making Activity in the Context of Covid-19. *Science & Education, 32*(1), 1869-1886. https://doi.org/10.1007/s11191-022-00359-7

Halim, M., & Saat, R. (2017). Exploring Students' Understanding in Making a Decision on a Socioscientific Issue Using a Persuasive Graphic Organiser. *Journal of Baltic Science Education, 16*(5), 813-824. https://doi.org/10.33225/jbse/17.16.813

Herman, B. C. (2015). The Influence of Global Warming Science Views and Sociocultural Factors on Willingness to Mitigate Global Warming. *Science Education, 99*(1), 1-38. https://doi.org/10.1002/sce.21136

Herman, B. C., Owens, D. C., Oertli, R. T., Zangori, L. A., & Newton, M. H. (2019). Exploring the Complexity of Students' Scientific Explanations and Associated Nature of Science Views Within a Place-Based Socioscientific Issue Context. *Science & Education, 28*(1), 329-366. https://doi.org/10.1007/s11191-019-00034-4

Herman, B., Zeidler, D., & Newton, M. (2020). Students' Emotive Reasoning Through Place-Based Environmental Socioscientific Issues. *Research in Science Education, 50*(1), 2081-2109. https://doi.org/10.1007/s11165-018-9764-1

Horin, H. B., Kali, Y., & Tal, T. (2023). The Fifth Dimension in Socio-Scientific Reasoning: Promoting Decision-Making about Socio-Scientific Issues in a Community. *Sustainability, 15*(12), 1-23. https://doi.org/10.3390/su15129708

Hsu, C., Tsai, M., Hou, H., & Tsai, C. (2014). Epistemic Beliefs, Online Search Strategies, and Behavioral Patterns While Exploring Socioscientific Issues. *Journal of Science Education and Technology, 23*(1), 471-480. https://doi.org/10.1007/s10956-013-9477-1

Hsu, Y., & Lin, S. (2017). Prompting Students to Make Socioscientific Decisions: Embedding Metacognitive Guidance in an E-Learning Environment. *International Journal of Science Education, 39*(7), 964-979. https://doi.org/10.1080/09500693.2017.1312036

Jafari, M., & Meisert, A. (2021). Activating Students' Argumentative Resources on Socioscientific Issues by Indirectly Instructed Reasoning and

Negotiation Processes. *Research in Science Education, 51*(2), 913-934. https://doi.org/10.1007/s11165-019-09869-x

Jho, H., Yoon, H. G., & Kim, M. J. (2013). The Relationship of Science Knowledge, Attitude and Decision Making on Socio-Scientific Issues: The Case Study of Students' Debates on a Nuclear Power Plant in Korea. *Science & Education, 23*(5), 1131-1151. https://doi.org/10.1007/s11191-013-9652-z

Jumadi, Perdana, R., Riwayani, & Rosana, D. (2021). The Impact of Problem-Based Learning with Argument Mapping and Online Laboratory on Scientific Argumentation Skill. *International Journal of Evaluation and Research in Education, 10*(1), 16-23. http://doi.org/10.11591/ijere.v10i1.20593

Juntunen, M. K., & Aksela, M. K. (2014). Improving Students' Argumentation Skills Through a Product Life-Cycle Analysis Project in Chemistry Education. *Chemistry Education Research and Practice, 15*(4), 639-649. https://doi.org/10.1039/C4RP00068D

Karahan, E., Andzenge, S., & Roehrig, G. (2017). Eliciting Students' Understanding of a Local Socioscientific Issue Through the Use of Critical Response Pedagogies. *International Journal of Education in Mathematics, Science and Technology, 5*(2), 88-100. http://doi.org/10.18404/ijemst.41401

Karahan, E., & Roehrig, G. (2017). Case study of science and social studies teachers co-teaching socioscientific issues-based instruction. *Eurasian Journal of Educational Research, 72*(1), 63-82. https://doi.org/10.16986/huje.2018044772

Karpudewan, M., & Roth, W. (2016). Changes in Primary Students' Informal Reasoning During an Environment-Related Curriculum on Socio-Scientific Issues. *International Journal of Science and Mathematics Education, 16*(3), 401-419. https://doi.org/10.1007/s10763-016-9787-x

Khishfe, R. (2014). Explicit Nature of Science and Argumentation Instruction in the Context of Socioscientific Issues: an Effect on Student Learning and Transfer. *International Journal of Science Education, 36*(6), 974-1016. https://doi.org/10.1080/09500693.2013.832004

Khishfe, R., Alshaya, F., BouJaoude, S., & Alrudiyan, K. (2017). Students' Understandings of Nature of Science and Their Arguments in the Context of Four Socio-Scientific Issues. *International Journal of Science Education, 39*(3), 299-334. https://doi.org/10.1080/09500693.2017.1280741

Kinslow, A. T., Sadler, T. D., & Nguyen, H. T. (2019). Socio-Scientific Reasoning and Environmental Literacy in a Field-Based Ecology Class. *Environmental Education Research, 25*(3), 388-410. https://doi.org/10.1080/13504622.2018.1442418

Kolarova, T., Hadjiali, I., & Denev, I. (2013). High School Students' Reasoning in Making Decisions about Socio-Ethical Issues of Genetic Engineering: Case of Gene Therapy. *Biotechnology & Biotechnological Equipment, 27*(2), 3737-3747. https://doi.org/10.5504/BBEQ.2012.0133

Kutluca, A. Y. (2021). An Investigation of Elementary Teachers' Pedagogical Content Knowledge for Socioscientific Argumentation: The Effect of a Learning and Teaching Experience. *Science Education, 105*(4), 743-775. https://doi.org/10.1002/sce.21624

Kutluca, A. Y., & Aydin, A. (2016). An Examination of Prospective Elementary Science Teachers' Perspective Towards Socio-Scientific Argumentation. *Science Education International, 27*(3), 320-343.

_____. (2018). Pre-Service Science Teachers' Nature of Science Understandings' Influence on Their Socioscientific Argumentation Quality. *Elementary Education Online, 17*(2), 642-657. https://doi.org/10.17051/ilkonline.2018.419009

Ladachart, L., & Ladachart, L. (2021). Preservice Biology Teachers' Decision-Making and Informal Reasoning about Culture-Based Socioscientific Issues. *International Journal of Science Education, 43*(5), 641-671. https://doi.org/10.1080/09500693.2021.1876958

Lee, H. J., Yoo, J., Choi, K., Kim, S. W., Krajcik, J., Herman, B. M., & Zeidler, D. L. (2013). Socioscientific Issues as a Vehicle for Promoting Character and Values for Global Citizens. *International Journal of Science Education, 35*(12), 2079-2113. https://doi.org/10.1080/09500693.2012.749546

Lee, H., Lee, H. J., & Zeidler, D. L. (2020). Examining Tensions in the Socioscientific Issues Classroom: Students' Border Crossings into a New Culture of Science. *Journal of Research in Science Teaching, 57*(5), 672-694. https://doi.org/10.1002/tea.21600

Leung, J. S. C. (2020). Promoting Students' Use of Epistemic Understanding in the Evaluation of Socioscientific Issues Through a Practice-Based Approach. *Instructional Science, 48*(1), 591-622. https://doi.org/10.1007/s11251-020-09522-5

Leung, J. S. C., Wong, A. S. L., & Yung, B. H. W. (2015). Understandings of Nature of Science And Multiple Perspective Evaluation of Science News by Non-Science Majors. *Science & Education, 24*(7), 887-912. https://doi.org/10.1007/s11191-014-9736-4

Leung, J. W. T. (2020). A Practice-Based Approach to Learning Nature of Science Through Socioscientific Issues. *Research in Science Education, 52*(1), 259-285. https://doi.org/10.1007/s11165-020-09942-w

Lin, J., Cheng, T., Wang, S., & Chung, C. (2020). The Effects of Socioscientific Issues Web Searches on Grade 6 Students' Scientific Epistemological Beliefs: The Role of Information Positions. *International Journal of Science Education, 42*(15), 2534-2553. https://doi.org/10.1080/09500693.2020.1821258

Lindahl, M., & Folkesson, A. (2016). Attitudes and Language Use in Group Discussions on Socio-Scientific Issues. *Eurasia Journal of Mathematics, Science & Technology Education, 12*(2), 283-301. https://doi.org/10.12973/eurasia.2016.1214a

Lindahl, M. G., & Lundin, M. (2016). How Do 15-16 Year Old Students Use Scientific Knowledge to Justify their Reasoning about Human Sexuality

and Relationships? *Teaching and Teacher Education, 60*(1), 121-130. https://doi.org/10.1016/j.tate.2016.08.009

Lorite, I. M. C., Robles, D. C., Expósito, M. d. C. A., & Evagorou, M. (2023). Analysis of the Informal Reasoning Modes of Preservice Primary Teachers When Arguing About a Socio-Scientific Issue on Nuclear Power During a Role Play. *Sustainability, 15*(5), 1-20. https://doi.org/10.3390/su15054291

Lubis, S. P. W., Suryadarma, I. G. P., Paidi, & Yanto, B. E. (2022). The Effectiveness of Problem-Based Learning with Local Wisdom Oriented to Socio-Scientific Issues. *International Journal of Instruction, 15*(2), 455-472. https://doi.org/10.29333/iji.2022.15225a

Muis, K., Chevrier, M., Denton, C., & Losenno, K. (2021). Epistemic Emotions and Epistemic Cognition Predict Critical Thinking about Socio-Scientific Issues. *Frontiers in Education, 6*(1), 1-18. https://doi.org/10.3389/feduc.2021.669908

Nida, S., Pratiwi, N., & Eilks, I. (2021). A Case study on the Use of Contexts and Socio-Scientific Issues-Based Science Education by Pre-Service Junior High School Science Teachers in Indonesia During their Final Year Teaching Internship. *Frontiers in Education, 5*(1), 1-8. https://doi.org/10.3389/feduc.2020.592870

Owens, D., Herman, B., Oertli, R., Lannin, A., & Sadler, T. (2019). Secondary Science and Mathematics Teachers' Environmental Issues Engagement Through Socioscientific Reasoning. *Eurasia Journal of Mathematics, Science and Technology Education, 15*(6), 1-27. https://doi.org/10.29333/ejmste/103561

Owens, D., Petitt, D., Lally, D., & Forbes, C. (2020). Cultivating Water Literacy in Stem Education: Undergraduates' Socio-Scientific Reasoning about Socio-Hydrologic Issues. *Water, 12*(10), 1-18. https://doi.org/10.3390/w12102857

Owens, D., Sadler, T., Petitt, D., & Forbes, C. (2022). Exploring Undergraduates' Breadth of Socio-Scientific Reasoning Through Domains of Knowledge. *Research in Science Education, 52*(1), 1643-1658. https://doi.org/10.1007/s11165-021-10014-w

Özcan, E., & Balim, A. G. (2021). The Effect of Socio-Scientific Argumentation Method on Students' Entrepreneurship Perceptions. *Participatory Educational Research, 8*(1), 309-321. http://dx.doi.org/10.17275/per.21.18.8.1

Özden, M. (2015). Prospective Elementary School Teachers' Views about Socioscientific Issues: A Concurrent Parallel Design Study. *International Electronic Journal of Elementary Education, 7*(3), 333-354.

Öztürk, A. (2017). An Investigation of Prospective Science Teachers' Socio-Scientific Argumentation Processes in Terms of Metacognition: A Causal-Comparative Study. *Pegem Journal of Education and Instruction, 7(*4), 547-582. https://doi.org/10.14527/pegegog.2017.020

Öztürk, N., & Tuzun, O. Y. (2016). Preservice Science Teachers' Epistemological Beliefs and Informal Reasoning Regarding Socioscientific Issues.

Research in Science Education, 47(6), 1275-1304. https://doi.org/10.1007/s11165-016-9548-4

Pitiporntapin, S., Yutakom, N., Sadler, T. D., & Hines, L. M. (2018). Enhancing Pre-Service Science Teachers' Understanding and Practices of Socioscientific Issues (SSIs)-Based Teaching Via An Online Mentoring Program. *Asian Social Science, 14*(5), 1-12. https://doi.org/10.5539/ass.v14n5p1

Pratiwi, Y., Rahayu, S., & Fajaroh, F. (2016). Socioscientific Issues (SSI) in Reaction Rates Topic and its Effect on the Critical Thinking Skills of High School Students. *Jurnal Pendidikan IPA Indonesia, 5*(2), 1-15. https://doi.org/10.15294/jpii.v5i2.7676

Rahman, M. S. (2016). The Advantages and Disadvantages of Using Qualitative and Quantitative Approaches and Methods in Language "Testing and Assessment" Research: A Literature Review. *Journal of Education and Learning, 6*(1), 102-113. https://doi.org/10.5539/jel.v6n1p102

Rashid, H., & Sipahi, E. (2021). The Importance of Quantitative Research in Language Testing and Assessment: In the Context of Social Works. *Linguistics and Culture Review, 5*(1), 317-330. https://doi.org/10.21744/lingcure.v5nS1.1413

Robertshaw, B., & Campbell, T. (2013). Constructing Arguments: Investigating Pre-Service Science Teachers' Argumentation Skills in a Socio-Scientific Context. *Science Education International, 24*(2), 195-211.

Rodrigues, R. S., Neubert, P. D. S., & De Araújo, B. K. H. (2020). The Publications of Brazilian Authors: Access, Distribution and Ppublishers. *Em Questão, 26*(2), 13-31. https://doi.org/10.19132/1808-5245262.13-31

Romine, W., Sadler, T., & Kinslow, A. (2017). Assessment of Scientific Literacy: Development and Validation of the Quantitative Assessment of Socio-Scientific Reasoning (QuASSR). *Journal of Research in Science Teaching, 54*(2), 274-295. https://doi.org/10.1002/tea.21368

Rundgren, C. J., Eriksson, M., & Rundgren, S. N. C. (2016). Investigating the Intertwinement of Knowledge, Value, and Experience of Upper Secondary Students' Argumentation Concerning Socioscientific Issues. *Science & Education, 25*(9), 1049-1071. https://doi.org/10.1007/s11191-016-9859-x

Sadler, T., Romine, W., & Topçu, M. (2016). Learning Science Content Through Socio-Scientific Issues-Based Instruction: A Multi-Level Assessment Study. *International Journal of Science Education, 38*(10), 1622-1635. https://doi.org/10.1080/09500693.2016.1204481

Sağlam, H., & Eroglu, B. (2022). A Mixed-Method Study on Pre-Service Teachers' Informal Reasoning Regarding Nuclear Energy Use. *Journal of Turkish Science Education, 19*(2), 594-607. http://doi.org/10.36681/tused.2022.139

Sakamoto, M., Yamaguchi, E., Yamamoto, T., & Wakabayashi, K. (2021). An Intervention Study on Students' Decision-Making Towards Consensus Building on Socio-Scientific Issues. *International Journal of Science Education, 43*(12), 1965-1983. https://doi.org/10.1080/09500693.2021.1947541

Sakschewski, M., Eggert, S., Schneider, S., & Bögeholz, S. (2014). Students' Socioscientific Reasoning and Decision-making on Energy-related Issues-Development of a Measurement Instrument. *International Journal of Science Education, 36*(14), 2291-2313. https://doi.org/10.1080/09500693.2014.920550

Saputri, M., Muliadi, A., & Safnowandi. (2022). Profil Minat Belajar Siswa dengan Model Pembelajaran *Problem Based Learning* (PBL) pada Kelas XI. *Educatoria : Jurnal Ilmiah Ilmu Pendidikan, 2*(3), 148-155. https://doi.org/10.36312/ejiip.v2i3.98

Solbes, J., Torres, N., & Traver, M. (2018). Use of Socio-Scientific Issues in Order to Improve Critical Thinking Competences. *Asia-Pacific Forum on Science Learning and Teaching, 19*(1), 1-22.

Solli, A. (2021). Appeals to Science: Recirculation of Online Claims in Socioscientific Reasoning. *Research in Science Education, 51*(1), 983-1013. https://doi.org/10.1007/s11165-019-09878-w

Sousa, D. (2014). Validation in Qualitative Research: General Aspects and Specificities of the Descriptive Phenomenological Method. *Qualitative Research in Psychology, 11*(2), 211-227. https://doi.org/10.1080/14780887.2013.853855

Steffen, B., & Hößle, C. (2017). Assessing Students' Performances in Decision-Making: Coping Strategies of Biology Teachers. *Journal of Biological Education, 51*(1), 44-51. https://doi.org/10.1080/00219266.2016.1156012

Tidemand, S., & Nielsen, J. A. (2017). The Role of Socioscientific Issues in Biology Teaching: From the Perspective of Teachers. *International Journal of Science Education, 39*(1), 44-61. https://doi.org/10.1080/09500693.2016.1264644

Topçu, M. S., Foulk, J. A., Sadler, T. D., Pitiporntapin, S., & Atabey, N. (2017). The Classroom Observation Protocol for Socioscientific Issue-Based Instruction: Development and Implementation of a New Research Tool. *Research in Science & Technological Education, 36*(3), 302-323. https://doi.org/10.1080/02635143.2017.1399353

Torres, N., & Cristancho, J. (2018). Analysis of the Forms of Argumentation of Teachers in Training in the Context of a Socio-Scientific Issue. *Journal of Turkish Science Education, 15*(1), 57-79. http://doi.org/10.12973/tused.10221a

Türköz, G., & Öztürk, N. (2019). Determining the Argument Quality of Pre-Service Science Teachers Regarding to Socio-Scientific Issues: Youtube as a Source of Argumentation. *Science Education International, 30*(4), 319-328. https://doi.org/10.33828/sei.v30.i4.9

Vesterinen, V., Tolppanen, S., & Aksela, M. (2016). Toward Citizenship Science Education: What students do to Make the World a Better Place? *International Journal of Science Education, 38*(1), 30-50. https://doi.org/10.1080/09500693.2015.1125035

Wahono, B., Chang, C., & Khuyen, N. (2021). Teaching Socio-Scientific Issues Through Integrated STEM Education: An Effective Practical Averment from Indonesian Science Lessons. *International Journal of Science*

Education, *43*(16), 2663-2683. https://doi.org/10.1080/09500693.2021.1983226

Wahono, B., Narulita, E., Chang, C.Y., Darmawan, E., & Irwanto, I. (2021). The Role of Students' Worldview on Decision-Making: An Indonesian Case Study by a Socio-Scientific Issue-Based Instruction Through Integrated STEM Education. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(11), 1-15. https://doi.org/10.29333/ejmste/11246

Walton, T. (2016). Using a Mixed Methods Approach to Investigate University Student Success after Support Service Interaction: A Case Study and Analysis. *Journal of the Australian and New Zealand Student Services Association*, *48*(1), 38-49.

Warfa, A.R. M. (2016). Mixed-Methods Design in Biology Education Research: Approach and Uses. *CBE—Life Sciences Education*, *15*(4), 1-11. https://doi.org/10.1187/cbe.16-01-0022

Yahaya, J., Nurulazam, A., & Karpudewan, M. (2016). College students' attitudes towards sexually themed science content: A socioscientific issues approach to resolution. *International Journal of Science Education, 38*(7), 1174-1196. https://doi.org/10.1080/09500693.2016.1174349

Yapicioglu, A., & Aycan, S. (2018). Pre-Service Science Teachers' Decisions and Types of Informal Reasoning about the Socioscientific Issue of Nuclear Power Plants. *Educational Policy Analysis and Strategic Research, 13*(1), 31-53.

Yapicioğlu, A. E., & Kaptan, F. (2017). A Mixed Method Research Study on the Effectiveness of Socioscientific Issue-Based Instruction. *Education and Science, 42*(1), 113-137. http://doi.org/10.15390/EB.2017.6600

Yeo, M., & Lewis, M. (2019). Co-Authoring in Action: Practice, Problems and Possibilities. *Iranian Journal of Language Teaching Research, 7*(3), 109-123.

Zeidler, D. L., Herman, B. C., Ruzek, M., Linder, A., & Lin, S.S. (2013). Cross-Cultural Epistemological Orientations to Socioscientific Issues. *Journal of Research in Science Teaching*, *50*(3), 1-9. https://doi.org/10.1002/tea.21077

Zo`bi, A. (2014). The Effect of Using Socio-Scientific Issues Approach in Teaching Environmental Issues on Improving the Students' Ability of Making Appropriate Decisions Towards These Issues. *International Education Studies, 7*(8), 113-123. https://doi.org/10.5539/ies.v7n8p113