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Research Trend in Socio Scientific Issues Integrated Inquiry Learning on Science Education: A Systematic Literature Review

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Abstract

The application of inquiry-based learning integrating socio-scientific issues (SSI) has become a trend in science education to enhance scientific understanding and connect scientific concepts with everyday life. Several articles have discussed the use of inquiry-based learning from various perspectives. However, research specifically focusing on the application of inquiry-based learning in science education, particularly in relation to socio-scientific issues, remains limited. This research aims to identify trends in the use of inquiry-based learning integrated with socio-scientific issues (SSI) in science education across various countries. It also reviews literature on the impact of this method on science learning outcomes and examines the challenges and limitations in its implementation. This research employs a systematic literature review approach, utilizing the PRISMA method. Based on the keywords used, a total of 600 articles were retrieved from various databases between 2011 and 2023. Then, 34 relevant articles were selected for further analysis. The research results indicate that, based on a bibliometric analysis, there is an increasing trend in integrated SSI inquiry-based learning education research, as reviewed from various aspects, including journals and citations, author-affiliated countries, popular keywords, discipline, level of education, and type of research methods.

Additionally, the application of integrated SSI inquiry-based learning in science education has a positive influence, as reflected in the progress toward learning objectives in cognitive, affective, psychomotor, and social aspects. However, challenges in implementing this learning include teacher and student readiness, curriculum limitations, technology utilisation, and execution of the learning process. The integration of socioscientific issues in inquiry-based learning can significantly support the achievement of science learning objectives, making it a strategic approach to developing students' science literacy in the era of the Fourth Industrial Revolution. Future research should focus on addressing these challenges through teacher training, curriculum integration, and strategic use of technology to enhance the learning process.

1. INTRODUCTION

Science learning is a crucial aspect of education, and it is essential to explore practical strategies to enhance students' understanding and engagement with scientific concepts. Science education is constantly evolving with discoveries and a deeper understanding of how students can learn effectively. Effective science education not only introduces scientific concepts but also engages students in critical thinking, independent discovery, and the application of their knowledge in real-world contexts (Fikriyah et al., 2020).

Understanding students' attitudes is crucial for creating a positive learning environment that supports active participation and interest in science, thereby encouraging more profound and more meaningful engagement with scientific concepts (Nasution et al., 2021). Currently, the development of science and technology requires a learning approach that not only emphasizes the mastery of concepts but also fosters critical thinking skills, personality development, and social skills.

One approach that is gaining increasing attention is the use of inquiry-based learning models integrated with socio-scientific issues. Inquiry-based learning integrated with socio-scientific issues (SSI) has emerged as a significant trend in science education, aiming to enhance scientific literacy and connect science with everyday life and societal challenges (Ke et al., 2021). SSI-based learning provides relevant contexts for students to engage with real-world problems related to science and technology, fostering their ability to confront, negotiate, and make decisions in everyday life situations (Nida et al., 2020).

This approach not only enhances students' understanding of scientific concepts but also improves their scientific reasoning skills, decision-making abilities, and evaluative skills (Saad et al., 2017). By integrating SSI into the curriculum, science education can address emerging socio-scientific issues such as global warming, climate change, and biotechnology, thereby fostering a responsible society capable of applying scientific knowledge and engaging in moral reasoning in decision-making (Meilianti et al., 2021).

Research indicates that students' awareness of environmental issues remains relatively low (Sulistina et al., 2021). Therefore, the use of inquiry-based learning approaches, such as guided inquiry, has proven effective in enhancing science literacy and environmental awareness among students. The integration of SSI with science, technology, engineering, arts, and mathematics (STEAM) education has been explored as a way to reform science education and enhance science literacy (Mang et al., 2021). However, the implementation of SSI-based learning presents challenges for science teachers and students, as these socio-scientific issues are complex and require careful consideration in teaching practices and assessments (Marty et al., 2018). Comprehensive professional development in the field of socio-scientific issues is necessary because it has been observed that certain science teachers may not have received specialized training in this area. Therefore, focusing on socio-scientific issues in school science requires the introduction of important social topics into the classroom, which demands the creation of an ecological framework and integrated assessment in science education (Fani & Armağan, 2022).

Thus, the integration of inquiry-based learning with socio-scientific issues in science education has great potential to enhance scientific literacy, reasoning skills, and students' awareness of societal challenges. By providing relevant contexts and real-world problems, SSI-based learning can empower students to engage with science in meaningful ways, fostering their ability to make informed decisions and contribute to addressing emerging socio-scientific issues.

In recent years, there has been an increasing interest in the use of inquiry-based learning integrated with socio-scientific issues in science education. This approach has been the subject of several systematic literature reviews (SLR) aimed at investigating its effectiveness and impact on various aspects of science learning. For example, the SLR research conducted by Urdanivia Alarcon et al. (2023) on inquiry-based learning in science education found that the use of inquiry-based learning approaches enables the development of research skills and the construction of scientific knowledge. Thus, when combined with effective teaching strategies, science becomes more accessible. Furthermore, the SLR research conducted by Genisa et al. (2020) on the application of socio-scientific issues as learning materials in science education suggests that the application of

socio-scientific issues (SSI) is an alternative approach in science education, which is often dominated by argumentation and decision-making in SSI research.

The use of inquiry-based learning in the context of SSI promises a learning process that is more oriented towards exploration, discovery, and solving real problems related to social and scientific issues. To date, articles on research trends have described the application of inquiry-based learning from various perspectives (Anuar et al., 2017). However, there remains a lack of research focusing on the application of inquiry-based learning in science topics, particularly when integrated with socio-scientific issues (SSI). This study aims to examine the research trends of using inquiry-based learning integrated with socio-scientific issues (SSI) in science education conducted in various countries. Additionally, this research also aims to conduct a systematic literature review on the impact of using inquiry-based learning integrated with socio-scientific issues (SSI) on achieving science learning objectives and to examine various challenges and limitations in the implementation of inquiry-based learning integrated with socio-scientific issues.

2. METHOD

This research employs a systematic literature review approach, utilizing the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to identify eligible research studies (Page et al., 2021). The PRISMA framework is a widely recognized and recommended tool for conducting systematic reviews and meta-analyses. This framework provides a structured approach to literature reviews, ensuring transparency and reproducibility in the selection and evaluation of relevant studies. By following the PRISMA guidelines, researchers can systematically search, screen, and select studies that meet the predetermined inclusion criteria, thereby minimizing bias and enhancing the rigor of the review process (Moher et al., 2009).

Develop Research Question

At this stage, the researchers developed the following questions as the basis for the study:

RQ1: What are the research trends in the use of inquiry-based learning integrated with socio-scientific issues (SSI) in science education as reviewed through bibliometric analysis?

RQ2: How does inquiry-based learning integrated with socio-scientific issues affect the achievement of science learning objectives?

RQ3: What are the challenges and limitations in the implementation of inquiry-based learning integrated with socio-scientific issues?

Inclusion Criteria and Exclusion Criteria

Based on the search strategy, the inclusion criteria included in this literature review study are: (i) articles related to science learning, (ii) articles reporting a combination of inquiry-based learning and describing socio-scientific issues (SSI), (iii) articles indexed in Scopus and Sinta (minimum Sinta 2), (iv) articles written in English or Indonesian, (v) articles published from 2011 to 2023. Regarding the exclusion criteria, such as (i) articles that are not related to science learning, (ii) absence of inquiry and SSI concepts in the abstract, (iii) review articles, conference papers, books, and book chapters.The word frequency in the title and abstract is set to three occurrences, assuming this is sufficient to represent the frequency of word usage in these sections. The results from VOSviewer are visualized through network mapping, overlay, and density representations. The Network Visualization function is used to interpret relationships between clusters, as well as relationships between clusters and items or between items themselves. The Overlay Visualization illustrates the research trends over the past few years (McAllister et al., 2022). The Density Visualization represents the concentration of research output (Sood et al., 2021).

Data Sources and Search Strategies

A systematic literature search was conducted using several databases, including ScienceDirect, the Education Resources Information Center (ERIC), and Semantic Scholar. Appropriate keywords were typed into these three databases to identify qualifying research studies. The keywords used in this systematic literature search included "socio-scientific issues," "SSI," "inquiry learning," "inquiry," "science education," and "science learning." Furthermore, this research

has predefined eligibility criteria to select the most qualified research studies specifically. The search collects all articles where the search criteria are present in the article title, abstract, and keywords.

The Study Selection Process

After identifying the research using the predetermined keywords, a total of 600 studies were searched across the three databases. Figure 1 illustrates the comprehensive procedure for identifying eligible research studies for the systematic literature review, following the PRISMA guidelines.
At the identification stage, a total of 600 articles were obtained from the three databases used by entering the predetermined keywords (n = 286 in ScienceDirect, n = 115 in ERIC, and n = 199 in Semantic Scholar). A total of 22 articles were removed due to duplication, leaving 578 articles to proceed to the next stage. At the screening stage, which involved filtering articles based on titles and abstracts, 520 articles were removed for the following reasons: the articles were review articles (n = 29), the articles were not science learning articles (n = 267), and the articles did not report inquiry-based learning integrated with SSI (n = 224). Thus, 58 articles proceeded to the next stage. At the feasibility stage, 58 articles were examined in full text, and 24 articles were removed because they did not meet the inclusion criteria. Finally, a total of 34 articles were included in the systematic review, which were subsequently analyzed to answer the questions of this systematic literature review. The results of the article selection process using PRISMA are presented in Figure 1.

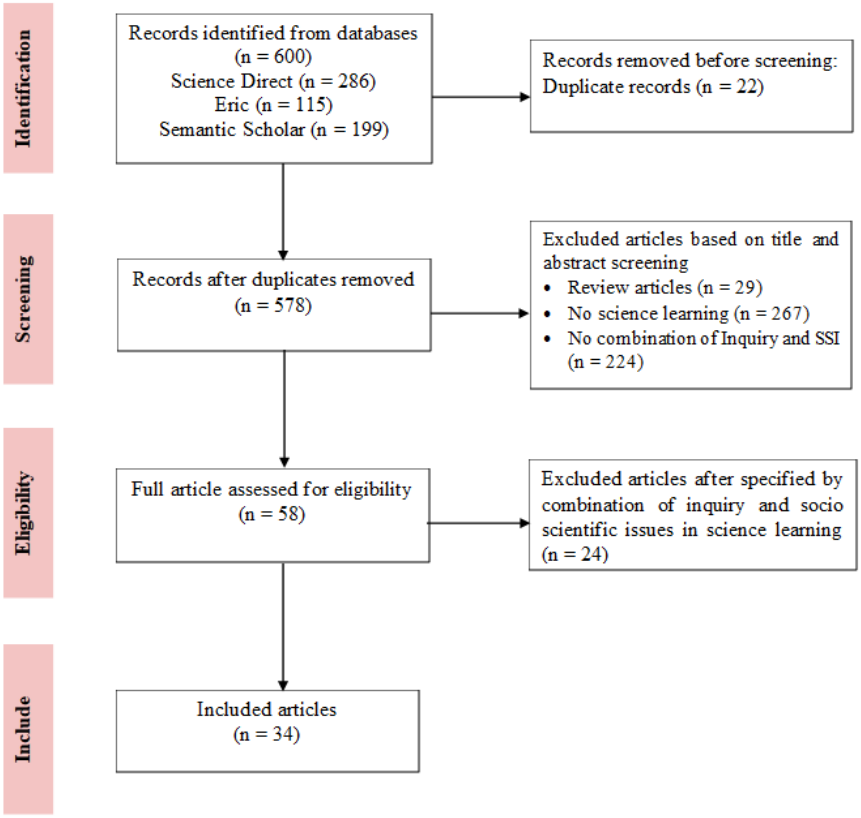

Figure 1. PRISMA Flow Diagram of Article Selection Process

3. RESULTS AND DISCUSSION

Research Trends on the Use of Inquiry Learning Integrated with Socio-Scientific Issues (SSI) based on Bibliometric Analysis (RQ1)

Journal and Citations

Inquiry-based learning integrated with socio-scientific issues has been widely used in various fields of education, particularly in science education, as expressed in 34 articles relevant to this research. The relevant articles in question are all sourced from 26 journals. The following Figure 2 shows the names of journals that have published two or more articles related to this research. The

journal with the most articles published is Research Science Education (3 articles), followed by several journals, each publishing two related articles.

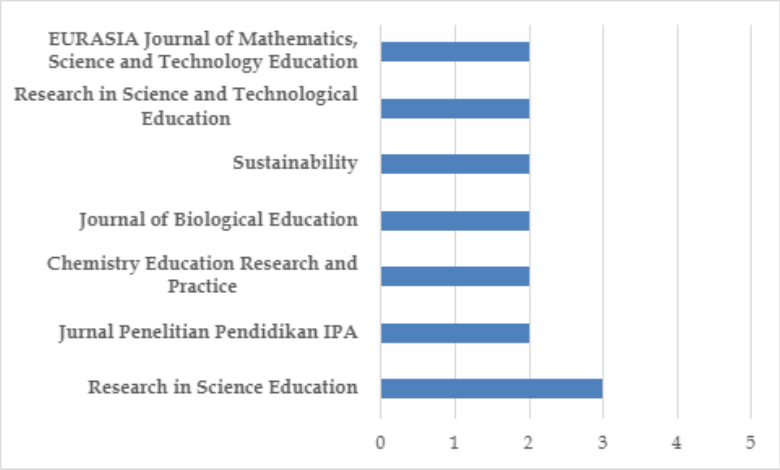

Figure 2. Names of journals with more than two published articles are used

Next, to calculate the number of citations from the related journals, the researchers used the Google Scholar site through the Publish or Perish application. The total number of citations in the 34 articles reviewed in this study is 680, with the number of citations in articles from 2011 to 2023 shown in Figure 3 below.

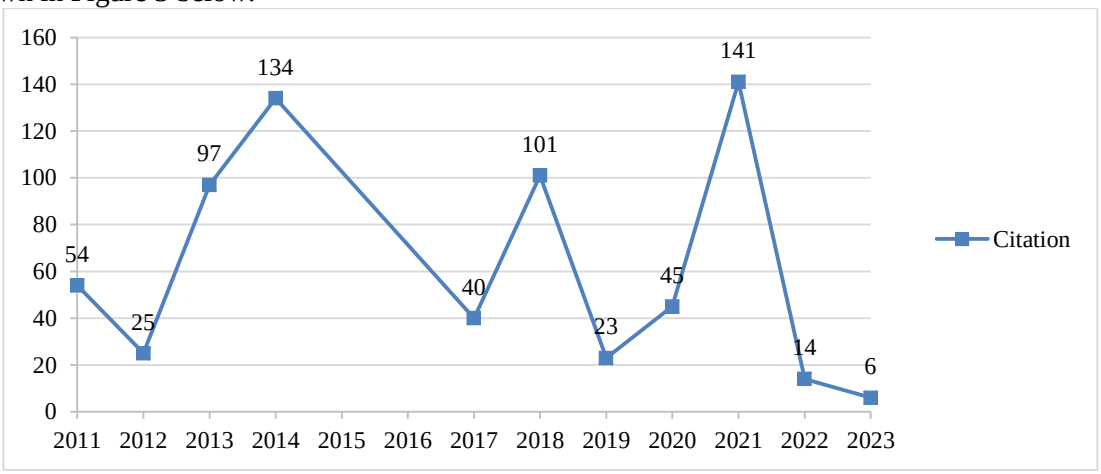

Figure 3. Citation trends based on the publication year of related articles

Author Affiliated Countries

To see the distribution of research based on the country of origin of the first author of the article, refer to Figure 4. The figure shows that Indonesia has the highest number of studies on integrated SSI inquiry learning in science education, with a total of 13 articles. Then followed by the United States and Cyprus with three articles each. Korea, Israel, Australia, Greece, Turkey, and Finland, with two articles each. And finally, China, South Africa, and Spain, with 1 article each.

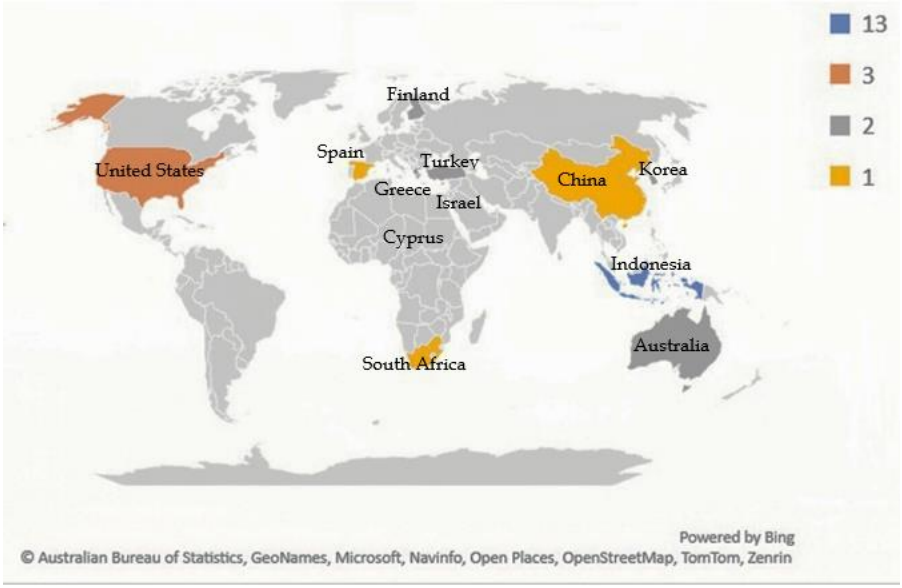

Figure 4. Trends in articles based on the distribution of the first author's country of origin

Popular Keywords

From the 34 articles reviewed in this study, an analysis of research trends was conducted using the software VoSViewer, which visualized keywords. Overall, 112 keywords are used. Figure 5 shows the top 5 keywords, where the most significant and frequently used keywords in this article are socio-scientific issues (18), inquiry-based learning (10), scientific literacy (3), climate change (3), and critical thinking. (3). The colored circles indicate the items or keywords obtained. The size of the circle indicates the frequency with which research is related to that topic. The higher the weight of the keyword or the more frequently the keyword appears, the larger the label and circle of that item will be.

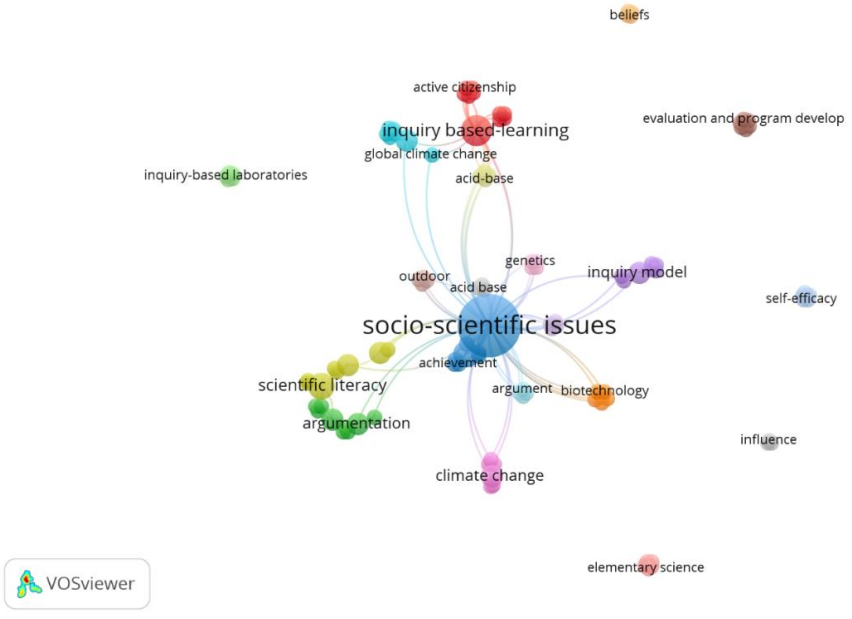

Figure 5. Trends of articles based on the keywords used

Discipline and Level of Education

Based on Figure 6, it is evident that the majority of the 34 articles reviewed were conducted at the High School education level (12), followed by Middle School (9), multi-level (6), higher education (5), and elementary school (2). Furthermore, the science learning disciplines mentioned in the related articles are dominated by science subjects (53%), followed by chemistry (32%) and biology (15%), as shown in Figure 7.

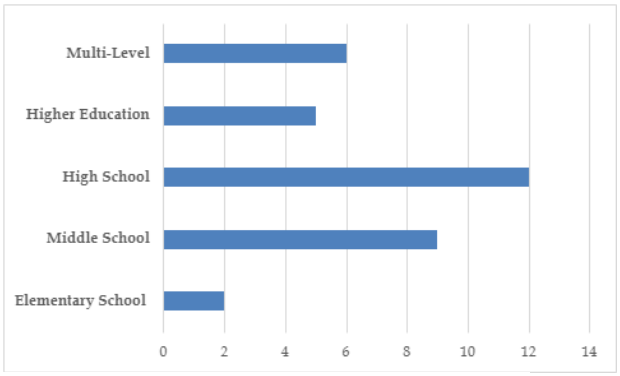

Figure 6. Research subjects based on education level

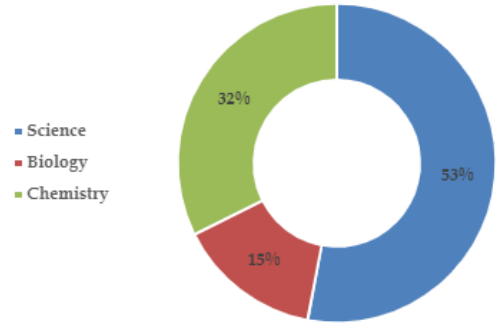

Figure 7. The discipline of science subjects is implemented in the article

Type of Research Methods

Table 1 shows the trend of research methods used in the systematic literature review of 34 articles, which is dominated by a quantitative approach with experimental research methods (50%). The experimental method is the most frequently used approach to determine the effectiveness of inquiry learning strategies integrated with socio-scientific issues, followed by qualitative research methods (26.1%) and other research methods (23.9%).

Table 1. Type of research used in the article

Approach	Research Methods	Percentage (%)
Quantitative	Experiment	50%
Quantitative	Case Study	5.8%
	Constructivist theory	5.8%
	Theoretical Framework	2.9%
	Design-Based Research	2.9%
	Exploratory Research	2.9%
Others	Research and Development (R&D)	5.8%
	Pedagogical Design	2.9%
	Mixed Methods	21%

The Influence of Inquiry-Based Learning Integrated with Socio-Scientific Issues on the Achievement of Science Learning Objectives (RQ2)

The learning model is one of the essential elements that must be present in education, as it has a significant impact on achieving learning objectives. The existence of a learning model enables teachers to help students learn more effectively and efficiently, ultimately contributing to the achievement of desired learning outcomes (Puspasari & Kurniasih, 2019). One of the learning models used in education, particularly in science education, is the inquiry-based learning model, which is often integrated with socio-scientific issues. The implementation of such learning has had several positive impacts related to the development of students' learning outcomes. Thus, this

learning can become an alternative that is considered better compared to conventional learning, which tends to be teacher-centered (Uzunboylu, 2018).

In this study, the researcher aims to discuss the impact of inquiry-based learning integrated with socio-scientific issues on the achievement of science learning objectives, viewed from cognitive, affective, psychomotor, and social aspects as presented in Figure 8. Based on Figure 8, it is observed that out of 34 articles reviewed, the impact of SSI-integrated inquiry learning is most significant on the affective aspect (65%), followed by the cognitive aspect (25%), the social aspect (8%), and the psychomotor aspect (2%). In this case, it is noted that the psychomotor aspect is rarely researched further

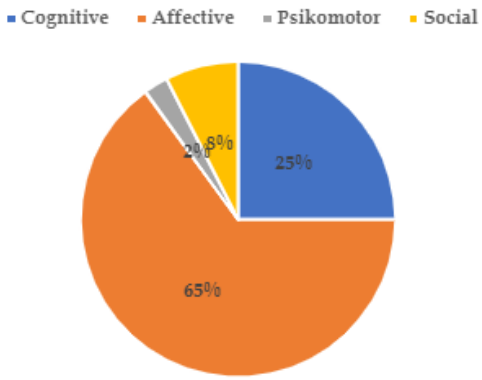

Figure 8. The Influence of Inquiry-Based Learning Integrated with Socio-Scientific Issues on Achieving Science Learning Objectives

The influence of SSI-integrated inquiry learning on cognitive, affective, psychomotor, and social aspects is further presented in the following Table 2

Table 2. The influence of inquiry-based learning integrated with socio-scientific issues viewed from various aspects

Aspects	Variable Measured	Author
Cognitive	Learning outcome	(Fuentes & Entezari, 2020; Lestari et al., 2021)
	Conceptual understanding	(Hadjichambis et al., 2019; Kusumawati et al., 2022; Laliyo et al., 2022; Mandrikas et al., 2019; Namdar, 2018; Ngwenya & Mavuru, 2021; Nicolaidou et al., 2011; Stavrou et al., 2018; Suwono et al., 2021; Zidny et al., 2021)
	Scientific literacy	(Georgiou & Kyza, 2023; M. Juntunen & Aksela, 2013; Kang et al., 2012; Putra et al., 2023; Sengul, 2023; Suwono et al., 2021; Wiyarsi et al., 2021)
	Argumentation skills	(Grooms et al., 2014; M. K. Juntunen & Aksela, 2014; Nam & Chen, 2017; Setyaningsih et al., 2019; Yang et al., 2022; Zidny et al., 2021)
	Critical thinking skills	(Mahanani et al., 2019; Qamariyah et al., 2021; Rika Dyanita Sari et al., 2021; Suwono et al., 2021)
	Scientific explanation skills	(Aldresti et al., 2018; Mahanani et al., 2019; Tal & Abramovitch, 2013)
	Habits of scientific thinking	(Wiyarsi et al., 2021)
Affective	Learning motivation	(Lestari et al., 2021)
	Raising awareness	(Namdar, 2018)
	Attitude toward science	(Baek et al., 2022; Fuentes & Entezari, 2020; M. Juntunen & Aksela, 2013)
	Decision making	(Ben-Horin et al., 2023; Kurup et al., 2021; Namdar, 2018)
	Perception toward science	(Romero-Ariza et al., 2021; Sengul, 2023; Stavrou et al., 2018)
Psikomotor	Practical skills	(Hastuti et al., 2018)
Social	Socio-scientific accountability (feeling of responsibility and willingness to act)	(Ben-Horin et al., 2023; Hadjichambis et al., 2019; Tal & Abramovitch, 2013)

In general, SSI-integrated inquiry learning has a profoundly positive impact on achieving science learning objectives, as shown in Table 3 above. The science learning process encompasses cognitive, affective, psychomotor, and social aspects that are very important for the overall development of students (Savitri et al., 2017). The cognitive aspect involves critical thinking, problem-solving, and knowledge acquisition, while the psychomotor aspect focuses on hands-on skills and practical application. Furthermore, the affective aspect encompasses attitudes, motivation, and emotional engagement in the learning process, while the social aspect involves collaboration, communication, and interaction with peers and the learning environment (Ermawati et al., 2019). These aspects are interconnected and contribute to a holistic approach in science education, which emphasizes the importance of meeting students' cognitive, affective, psychomotor, and social needs to facilitate practical learning experiences (Aningsih et al., 2023).

The results of the article analysis on cognitive aspects have demonstrated an enhancement of conceptual knowledge, learning outcomes, science literacy, argumentation skills, critical thinking, scientific explanation skills, and scientific thinking. The variable of concept knowledge improvement has been identified as a significant influence in Socio-Scientific Issues integrated inquiry learning. (SSI). These findings are supported by research conducted by Ermawati et al. (2019), which highlights the importance of an inquiry-based approach in enhancing conceptual knowledge within the SSI framework. The inquiry approach emphasizes student activity in discovering concepts and principles of the material through the classroom learning process. Students are encouraged to seek learning resources, gather information, and independently formulate problems and hypotheses (Rifianti & Joharmawan, 2019). In addition to cognitive aspects, there are affective aspects that influence this learning, including learning motivation, increased awareness, attitudes towards science, decision-making, and perceptions of science. For the psychomotor aspect, it is measured in terms of practical skills. Moreover, finally, the social aspect measured is in the form of social-scientific accountability.

Challenges and Limitations in the Implementation of Inquiry-Based Learning Integrated with Socio-Scientific Issues (RQ3)

There are several challenges and limitations in implementing inquiry-based learning integrated with socio-scientific issues (SSI) in science education. Some of the challenges faced by researchers include various factors, such as those related to teachers, students, and/or university students, curriculum limitations, the socio-scientific issues themselves, limitations in the use of technology, and limitations in the implementation of the learning process. These challenges and limitations are discussed in detail below.

First, teachers' unpreparedness to integrate socio-scientific issues through inquiry-based learning is due to their limited experience (Namdar, 2018). Teachers still struggle to incorporate socio-scientific issues that align with the subjects being taught (M. K. Juntunen & Aksela, 2014). Many teachers feel burdened by the implementation of SSI education in the classroom. They often feel insufficiently competent in teaching complex and politically sensitive topics, such as climate change, due to a lack of knowledge and expertise in this field (Baek et al., 2022). One example is the research conducted by Stavrou et al. (2018), which highlights the limitations of teachers' knowledge, particularly in connecting nanoscience and nanotechnology (NST) materials with SSI issues. Only a small number of teachers can understand and apply the aspects of subjectivity and socio-cultural elements of NOS. This suggests that their understanding of NOS remains limited when confronted with complex and multidimensional contexts, such as the COVID-19 pandemic (Sengul, 2023).

Furthermore, although teachers understand what scientific inquiry entails, they often have a limited grasp of how the sequence of inquiry steps is applied in the classroom. Additionally, teachers also face difficulties in effectively addressing SSI issues in facilitating students' understanding of abstract concepts in genetics. As a result, teachers show uncertainty about how SSI in the field of genetics can be taught using an inquiry-based approach (Ngwenya & Mavuru, 2021). The limited training of teachers participating in adopting a multicultural approach in diverse and inclusive classroom learning through inquiry-based practices (Romero-Ariza et al., 2021).

Second, the limitations of students' knowledge. Where learners struggle to apply complex scientific concepts to problem-solving tasks relevant to real-life situations (Kurup et al., 2021; Zidny et al., 2021), students tend not to use their scientific knowledge effectively in the context of SSI and

rely more on vocabulary similarities and cues rather than the scientific justifications they have learned. Students more often use moral or ethical justifications rather than scientific ones in SSI tasks, indicating that they view SSI as a moral or ethical issue rather than a scientific one, thereby reducing their reliance on scientific knowledge (Grooms et al., 2014). Research conducted by Kang et al. (2012) indicates that many students respond to cases passively by asking questions about simple information and employing passive approaches to answering questions, such as seeking advice from teachers or experts. Additionally, some students show little commitment to problem-solving and/or require simple cognitive procedures to answer questions. Questions like these tend to be asked merely for the sake of asking, without demonstrating deep understanding or active engagement in inquiry. Although there has been an increase in the number of students asking active inquiry questions after the inquiry curriculum experience, many students still face challenges in linking their questions to specific and hypothesis-based inquiry approaches. This finding is consistent with the research conducted by Widarti et al. (2017), which indicates that students still struggle to formulate hypotheses due to a lack of familiarity, necessitating gradual guidance from teachers. Furthermore, the teachers implementing this program stated that the learning at this stage is the most challenging to guide because students have little experience in finding solutions to problems on their own (Baek et al., 2022), students are not yet accustomed to participating in inquiry-based learning activities (Rika Dyanita Sari et al., 2021), and students face difficulties in following the learning steps in the E-LKPD because they are not yet familiar with using the SSIBL model in the IPA E-LKPD (Putra et al., 2023)

Third, the limitations of the school curriculum. The existing school curriculum does not provide effective opportunities to integrate real socio-scientific issues into inquiry-based learning. This results in a lack of student engagement with the real problems they face daily (Kurup et al., 2021). To determine the implementation of the educational program within the curriculum hours, the curriculum has been reorganized with an emphasis on achievement standards and the content of educational activities. However, there is a discrepancy between the performance standards and the educational activities, as well as the content required in the educational program. This program also feels prolonged. Although efforts are made to optimize activities during class hours, students still need to engage in activities after school at home or in the surrounding environment and share them during class. Therefore, the development of educational programs that utilize various settings and approaches, such as club activities, hands-on learning, and curriculum-based classes, can lead to more diverse practices (Baek et al., 2022).

Fourth, the limitations in applying socio-scientific issues. When the socio-scientific issues taught by the teacher are not yet familiar to the students, the implementation of the inquiry learning model may not always adhere to established syntaxes (Wiyarsi et al., 2021). Students are also not yet accustomed to using socio-scientific issue learning strategies and have difficulty understanding the terms related to scientific issues (Rika Dyanita Sari et al., 2021). Involvement in SSI debates often does not provide students with sufficient opportunities to engage in authentic scientific practices, such as manipulating variables, designing experiments, and collecting data to match evidence. This reduces students' opportunities to truly understand and apply scientific principles in their arguments (Nam & Chen, 2017). Furthermore, the application of SSI contexts often involves complex issues related to morality and ethics, such as the use of coal-fired power plants that produce substances causing acid rain and damage to coral reefs. This conflict can challenge students in analyzing, evaluating, and creating solutions because it requires considering various moral and ethical perspectives (Qamariyah et al., 2021).

Fifth, limitations in the use of technology. Although WISE (Web-based Inquiry Science Environment) supports collaborative activities, there are limitations to fully utilizing technology to enhance student engagement and performance in argumentation (Yang et al., 2022). The lack of experience with computer-based collaborative learning, where students have no prior experience with computer-supported collaborative learning, and have never worked in groups for inquiry-based learning. This adds to the challenges in implementing this inquiry model (Nicolaidou et al., 2011)—lastly, the limitations in implementing the learning process. The process of science learning often focuses too much on cognitive aspects without considering the importance of practical skills, which play a crucial role in the success of science education (Hastuti et al., 2018). Moreover, in teaching,

teachers often overlook aspects of learning styles, culture, and motivation that can change in response to educational interventions (Laliyo et al., 2022).

4. CONCLUSION

Bibliometric analysis identifies integrated inquiry-based learning of socio-scientific issues as a learning model that can be used to support various fields of study, particularly in the context of science education. Bibliometric analysis reveals an increasing trend in research on integrated SSI inquiry-based learning education, as reviewed from journals and citations, including the distribution of authors' countries, frequently used keywords, education levels, science learning disciplines, and research methods employed. The results of the systematic literature review of journal articles indicate a positive impact of using the SSI-integrated inquiry-based learning model in the context of science education. This impact is reflected in the improvement of learning objectives following the implementation of the model, which is reviewed from several aspects, including cognitive, affective, psychomotor, and social aspects. The implementation of inquiry-based learning integrated with socio-scientific issues (SSI) faces several challenges, including limited teacher and student knowledge and readiness, a lack of curriculum support, and technological constraints. Additionally, the complexity of SSI and the application of technology in inquiry-based learning often become obstacles in enhancing student engagement and understanding of scientific concepts.

REFERENCES

Aldresti, F., Rahayu, S., & Fajaroh, F. (2018). The Influence Of Inquiry-Based Chemistry Learning With The Context Of Socio-Scientific Issues On High School Students' Scientific Explanation Skills. *Jurnal Pengajaran MIPA, 23*(2), 139–146. https://doi.org/10.18269/jpmipa.v23i2.12413

Aningsih, A., Dermawan, D. D., & Habibah, H. (2023). Learning Outcomes in Science Subjects Through the Inkuri Learning Model in Elementary Schools. *AS-SABIQUN*, *5*(2), 604–618. https://doi.org/10.36088/assabiqun.v5i2.3168

Anuar, N. S. B. S., Sani, S. S. B., Ahmad, C. N. B. C., Damanhuri, M. I. B. M., & Borhan, M. T. B. (2017). *The Trend in Inquiry-Based Learning (IBL) Research from Many Perspectives: A Systematic Review*. 100001. https://doi.org/10.1063/1.4983916

Baek, S., Shin, H., & Kim, C.-J. (2022). Development of a Climate Change SSIBL-STEAM Program Aligned to the National Curriculum for SSI Elementary School in Korea. *Asia-Pacific Science Education, 8*(1), 109–148. https://doi.org/10.1163/23641177-bja10047

Ben-Horin, H., 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), 9708. https://doi.org/10.3390/su15129708

Ermawati, E., Suratno, S., & Pujiastuti, P. (2019). The Effect of Inquiry Learning Model Based on Cooperative Script on the Student Learning Achievement. *Pancaran Pendidikan*, *8*(1). https://doi.org/10.25037/pancaran.v8i1.216

Fani, H., & Armağan, F. Ö. (2022). Science Teachers' Opinions on Socio-Scientific Issues. *Contemporary Educational Research Journal*, *12*(3), 184–196. https://doi.org/10.18844/cerj.v12i3.6932

Fikriyah, A., Tjandrakirana, T., & Agustini, R. (2020). Enhancement of Students' Critical Thinking Skill in Fungi Concepts Based on Science, Technology, and Society Learning Approach. *Jurnal Inovasi Pembelajaran Biologi, 1*(2), 44–49. https://doi.org/10.26740/jipb.v1n2.p44-49

Fuentes, A.-L., & Entezari, M. (2020). Water in Your Neighbourhood: A Model For Implementing A Semester-Long Course-Based Undergraduate Research Project In Introductory Biology. *Education Inquiry, 11*(3), 211–275. https://doi.org/10.1080/20004508.2020.1716542

Genisa, M. U., Subali, B., Djukri, D., Agussalim, A., & Habibi, H. (2020). Socio-Scientific Issues Implementation as Science Learning Material. *International Journal of Evaluation and Research in Education (IJERE), 9*(2), 311. https://doi.org/10.11591/ijere.v9i2.20530

Georgiou, Y., & Kyza, E. A. (2023). Fostering Chemistry Students' Scientific Literacy for Responsible Citizenship through Socio-Scientific Inquiry-Based Learning (SSIBL). *Sustainability, 15*(8), 6442. https://doi.org/10.3390/su15086442

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

Hadjichambis, A. Ch., Georgiou, Y., Paraskeva Hadjichambi, D., Kyza, E. A., Agesilaou, A., & Mappouras, D. (2019). Promoting RRI and active citizenship in an inquiry-based controversial socio-scientific issue: The case of cholesterol regulation with statins. *Journal of Biological Education*, *53*(5), 548–560. https://doi.org/10.1080/00219266.2018.1530277

Hastuti, P. W., Tiarani, V. A., & Nurita, T. (2018). The Influence of Inquiry-Based Science Issues Learning on Practical Skills of Junior High School Students in the Environmental Pollution Topic. *Jurnal Pendidikan IPA Indonesia*, *7*(2), 232–238. https://doi.org/10.15294/jpii.v7i2.14263

Juntunen, M., & Aksela, M. (2013). Life-Cycle Thinking in Inquiry-Based Sustainability Education – Effects on Students' Attitudes towards Chemistry and Environmental Literacy. *Center for Educational Policy Studies Journal*, *3*(2), 157–180. https://doi.org/10.26529/cepsj.244

Juntunen, M. K., & Aksela, M. K. (2014). Improving Students' Argumentation Skills Through A Product Life-Cycle Analysis Project In Chemistry Education. *Chem. Educ. Res. Pract.*, *15*(4), 639–649. https://doi.org/10.1039/C4RP00068D

Kang, N., DeChenne, S. E., & Smith, G. (2012). Inquiry Learning of High School Students Through a Problem-Based Environmental Health Science Curriculum. *School Science and Mathematics*, *112*(3), 147–158. https://doi.org/10.1111/j.1949-8594.2011.00128.x

Ke, L., Sadler, T. D., Zangori, L., & Friedrichsen, P. J. (2021). Developing and Using Multiple Models to Promote Scientific Literacy in the Context of Socio-Scientific Issues. *Science & Education*, *30*(3), 589–607. https://doi.org/10.1007/s11191-021-00206-1

Kurup, P. M., Levinson, R., & Li, X. (2021). Informed Decision Regarding Global Warming and Climate Change Among High School Students in the United Kingdom. *Canadian Journal of Science, Mathematics and Technology Education*, *21*(1), 166–185. https://doi.org/10.1007/s42330-020-00123-5

Kusumawati, L., Rochintaniawati, D., & Riandi, R. (2022). Effectiveness of Learning using Web-Based Inquiry Based on Socioscientific Issues to improve students' understanding of Socioscientific Issues. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1569–1574. https://doi.org/10.29303/jppipa.v8i3.1734

Laliyo, L. A. R., Sumintono, B., & Panigoro, C. (2022). Measuring Changes In Hydrolysis Concept Of Students Taught By Inquiry Model: Stacking And Racking Analysis Techniques In Rasch Model. *Heliyon*, *8*(3), e09126. https://doi.org/10.1016/j.heliyon.2022.e09126

Lestari, R., Haryono, T., & Erman, E. (2021). Using Comic-Based Socio-Scientific Issues in Inquiry Learning to Increase Interest and Achievement in Science Learning. *THABIEA : JOURNAL OF NATURAL SCIENCE TEACHING*, *4*(1), 62. https://doi.org/10.21043/thabiea.v4i1.9919

Mahanani, I., Rahayu, S., & Fajaroh, F. (2019). The Effect Of Inquiry-Based Learning With Socioscientific Issues Context On Critical Thinking Skills And Scientific Explanation. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, *3*(1), 53–68. https://doi.org/10.21831/jk.v3i1.20972

Mandrikas, A., Michailidi, E., & Stavrou, D. (2019). Teaching Nanotechnology in Primary Education. *Research in Science & Technological Education*, *38*(4), 377–395. https://doi.org/10.1080/02635143.2019.1631783

Mang, H. M. A., Chu, H.-E., Martin, S. N., & Kim, C.-J. (2021). An SSI-Based STEAM Approach to Developing Science Programs. *Asia-Pacific Science Education*, *7*(2), 549–585. https://doi.org/10.1163/23641177-bja10036

Marty, L., Venturini, P., & Almqvist, J. (2018). Teaching Traditions in Science Education in Switzerland, Sweden, and France: A Comparative Analysis of Three Curricula. *European Educational Research Journal*, *17*(1), 51–70. https://doi.org/10.1177/1474904117698710

Meilianti, D. E., Yustina, Y., & Suwondo, S. (2021). Application of LGBT-Themed Socioscientific Issue Reference Books to Improve Students' Knowledge in Senior High Schools. *Journal of Educational Sciences*, *5*(2), 287. https://doi.org/10.31258/jes.5.2.p.287-295

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & for the PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ*, *339*(jul21 1), b2535–b2535. https://doi.org/10.1136/bmj.b2535

Nam, Y., & Chen, Y.-C. (2017). Promoting Argumentative Practice in Socio-Scientific Issues through a Science Inquiry Activity. *EURASIA Journal of Mathematics, Science and Technology Education*, *13*(7). https://doi.org/10.12973/eurasia.2017.00737a

Namdar, B. (2018). Teaching global climate change to pre-service middle school teachers through inquiry activities. *Research in Science & Technological Education*, 1–23. https://doi.org/10.1080/02635143.2017.1420643

Nasution, V. Y., Widestra, R. A., & Yulkifli, Y. (2021). Validity of Student Worksheets Using Inquiry-Based Learning Models with the Science, Technology, Society Approach for Physics Learning. *International Journal of Progressive Sciences and Technologies*, *25*(1), 63. https://doi.org/10.52155/ijpsat.v25.1.2681

Ngwenya, P., & Mavuru, L. (2021). Life Sciences Teachers' Views on Teaching Socio-Scientific Issues in Genetics using an Inquiry Approach. *International Journal of Learning, Teaching and Educational Research*, *20*(10), 133–153. https://doi.org/10.26803/ijlter.20.10.8

Nicolaidou, I., Kyza, E. A., Terzian, F., Hadjichambis, A., & Kafouris, D. (2011). A Framework For Scaffolding Students' Assessment Of The Credibility Of Evidence. *Journal of Research in Science Teaching*, *48*(7), 711–744. https://doi.org/10.1002/tea.20420

Nida, S., Rahayu, S., & Eilks, I. (2020). A Survey of Indonesian Science Teachers' Experience and Perceptions toward Socio-Scientific Issues-Based Science Education. *Education Sciences*, *10*(2), 39. https://doi.org/10.3390/educsci10020039

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. *BMJ*, n71. https://doi.org/10.1136/bmj.n71

Puspasari, R., & Kurniasih, E. (2019). Creative Learning Model to Support Senior High Students in Reading Comprehension. *Proceedings of the Social Sciences, Humanities and Education Conference (SoSHEC 2019)*. Proceedings of the Social Sciences, Humanities and Education Conference (SoSHEC 2019), Surabaya, Indonesia. https://doi.org/10.2991/soshec-19.2019.22

Putra, I. M. T. P., Sudiatmika, A. A. I. A. R., & Suardana, I. N. (2023). Effectiveness of E-LKPD IPA through Socioscientific Inquiry Based Learning (SSIBL) Model to Improve Students' Scientific Literacy Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6337–6344. https://doi.org/10.29303/jppipa.v9i8.3957

Qamariyah, S. N., Rahayu, S., Fajaroh, F., & Alsulami, N. M. (2021). The Effect of Implementation of Inquiry-based Learning with Socio-scientific Issues on Students' Higher-Order Thinking Skills. *Journal of Science Learning*, *4*(3), 210–218. https://doi.org/10.17509/jsl.v4i3.30863

Rifianti, I., & Joharmawan, R. (2019). *PENGEMBANGAN UNIT KEGIATAN BELAJAR MANDIRI (UKBM) MATERI KONFIGURASI ELEKTRON DAN SIFAT PERIODIK UNSUR BERBASIS INKUIRI TERBIMBING UNTUK SISWA KELAS X SMA*.

Rika Dyanita Sari, Rudiana Agustini, & Wahono Widodo. (2021). The Effectiveness of Science E-Magazine of Socioscientific Issues-Based Inquiry Model to Improve Critical Thinking Skill of Junior High School Students. *Studies in Learning and Teaching*, *2*(3), 10–20. https://doi.org/10.46627/silet.v2i3.72

Romero-Ariza, M., Quesada, A., Abril, A.-M., & Cobo, C. (2021). Changing Teachers' Self-Efficacy, Beliefs And Practices Through Steam Teacher Professional Development. *Journal for the Study of Education and Development*, *44*(4), 942–969. https://doi.org/10.1080/02103702.2021.1926164

Saad, M. I. M., Baharom, S., Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, Tanjung Malim, Perak, Malaysia, Mokhsein, S. E., & Faculty of Education and Human Development, Universiti Pendidikan Sultan Idris, Tanjung Malim, Perak, Malaysia. (2017). Scientific Reasoning Skills Based on Socio-Scientific Issues in The Biology Subject. *International Journal of ADVANCED AND APPLIED SCIENCES*, *4*(3), 13–18. https://doi.org/10.21833/ijaas.2017.03.003

Savitri, E. N., Wusqo, I. U., Ardhi, M. W., & Putra, P. D. (2017). Enhancement of Science Students' Process Skills through Implementation of Green Learning Method (GeLem) with Conservation-Based Inquiry Approach. *Jurnal Pendidikan IPA Indonesia*, *6*(2), 237.

https://doi.org/10.15294/jpii.v6i2.11286

Sengul, O. (2023). Pre-service mathematics teachers' views of nature of science in the context of COVID-19. *European Journal of Science and Mathematics Education*, *11*(3), 499–514. https://doi.org/10.30935/scimath/12982

Setyaningsih, A., Rahayu, S., Fajaroh, F., & Parmin, P. (2019). Pengaruh pembelajaran process oriented-guided inquiry learning berkonteks isu-isu sosiosaintifik dalam pembelajaran asam basa terhadap keterampilan berargumentasi siswa SMA kelas XI. *Jurnal Inovasi Pendidikan IPA, 5*(2). https://doi.org/10.21831/jipi.v5i2.20693

Stavrou, D., Michailidi, E., & Sgouros, G. (2018). Development and Dissemination of A Teaching Learning Sequence on Nanoscience and Nanotechnology in A Context of Communities of Learners. *Chemistry Education Research and Practice*, *19*(4), 1065–1080. https://doi.org/10.1039/C8RP00088C

Sulistina, O., Rahayu, S., Dasna, I. W., & Yahmin. (2021). *The Influence of Guided Inquiry-Based Learning Using Socio-Scientific Issues on Environmental Awareness of Pre-service Chemistry Teachers:* 7th International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS 2020), Yogyakarta, Indonesia. https://doi.org/10.2991/assehr.k.210305.036

Suwono, H., Rofi'Ah, N. L., Saefi, M., & Fachrunnisa, R. (2021). Interactive Socio-Scientific Inquiry For Promoting Scientific Literacy, Enhancing Biological Knowledge, and Developing Critical Thinking. *Journal of Biological Education*, *57*(5), 944–959. https://doi.org/10.1080/00219266.2021.2006270

Tal, T., & Abramovitch, A. (2013). Activity and Action: Bridging Environmental Sciences and Environmental Education. *Research in Science Education*, *43*(4), 1665–1687. https://doi.org/10.1007/s11165-012-9327-9

Urdanivia Alarcon, D. A., Talavera-Mendoza, F., Rucano Paucar, F. H., Cayani Caceres, K. S., & Machaca Viza, R. (2023). Science and Inquiry-Based Teaching and Learning: A Systematic Review. *Frontiers in Education, 8*, 1170487. https://doi.org/10.3389/feduc.2023.1170487

Uzunboylu, Prof. Dr. H. (2018). Message From the Guest Editors. *New Trends and Issues Proceedings on Humanities and Social Sciences*, *5*(4). https://doi.org/10.18844/prosoc.v5i4.3709

Widarti, A., Subandi, & Munzil. (2017). EFEKTIVITAS PEMBELAJARAN ELEKTROKIMIA SMA DENGAN INKUIRI TERBIMBING BERBANTUAN MULTIMEDIA TERHADAP PEMAHAMAN KONSEPTUAL DAN ALGORITMIK. *Jurnal Pembelajaran Sains*, *1*(1), 12–18.

Wiyarsi, A., Prodjosantoso, A. K., & Nugraheni, A. R. E. (2021). Promoting Students' Scientific Habits of Mind and Chemical Literacy Using the Context of Socio-Scientific Issues on the Inquiry Learning. *Frontiers in Education*, *6*, 660495. https://doi.org/10.3389/feduc.2021.660495

Yang, X., Zhao, G., Yan, X., Chao, Q., Zhao, X., Lu, T., & Dong, Y. (2022). Pre-setting Stances for Students During Collaborative Argumentation: Parallel Thinking Versus Adversarial Thinking. *Research in Science Education*, *52*(6), 1829–1850. https://doi.org/10.1007/s11165-021-10035-5

Zidny, R., Laraswati, A. N., & Eilks, I. (2021). A Case Study on Students' Application of Chemical Concepts and Use of Arguments in Teaching on the Sustainability-Oriented Chemistry Issue of Pesticides Use Under Inclusion of Different Scientific Worldviews. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(7), em1981. https://doi.org/10.29333/ejmste/10979