JOURNAL OF CHEMISTRY EDUCATION AND INTEGRATION
P-ISSN : 2829-2774 , E-ISSN : 2829-1921
DOI: http://dx.doi.org/10.24014/jcei.v5i1.39182
Available online at:
http://ejournal.uin-suska.ac.id/index.php/JCEI

THE EFFECTIVENESS OF SOCIO-SCIENTIFIC APPROACHES TO 21ST CENTURY SKILLS IN HIGH SCHOOL STUDENTS' CHEMISTRY LEARNING: SYSTEMATIC LITERATURE REVIEW

Naila Novianti[1], Zakiyah Asri[2], Miterianifa [3*], Yetty Trisnayanti[4]

[1,2,3*] **Chemistry Education Department, Faculty of Tarbiyah and Teacher Training, Univeristas Islam Negeri Sultan Syarif Kasim Riau**
[4] **Elementary Teacher Education, Universitas PGRI Silampari**

***Email: miterianifa@uin-suska.ac.id**

Received: February 19, 2026; Accepted: February 27, 2026; Published: February 28, 2026

Abstract

Contemporary chemistry education aims to help students connect abstract concepts to real-world contexts. However, research indicates that many students continue to struggle to understand scientific literacy and its significance. The Socioscientific Issues (SSI) approach is implemented as a pedagogical strategy to bridge the gap between societal concerns and scientific content in educational settings. This study examines the impact of the SSI approach on high school students' chemistry learning outcomes. A Systematic Literature Review (SLR) was conducted in accordance with PRISMA guidelines. Inclusion criteria were set for peer-reviewed journal articles, in English or Indonesian, published between 2020 and 2025, and focused on the implementation of SSI in high school chemistry classes. Exclusion criteria included articles outside the field of chemistry, studies at the elementary or higher education level, and articles that were only conceptual reviews without empirical data. The selection process was carried out through four stages: initial identification in the Google Scholar databases; screening of titles and abstracts; assessment of full-text eligibility; until 14 articles were obtained. The results demonstrate that the SSI approach is shows consistent positive effects in enhancing students' learning abilities. The majority of research emphasises Critical Thinking (43%). Scientific Literacy (36%), whereas Argumentation (14%) and Creative Thinking (7%) receive comparatively less attention. Green Chemistry emerges as the predominant topic, accounting for 65% of the studies. At the same time, subjects such as Acid-Base and Rate of Reaction are underrepresented. The SSI approach contributes to the development of Higher Order Thinking Skills (HOTS), motivation, and scientific understanding. To further cultivate these competencies, it is recommended that SSI be integrated into a broader range of chemistry topics, with increased emphasis on creative thinking and advanced argumentation.

Keywords : Socioscientific Issues (SSI), Chemistry Education, Learning skills.

INTRODUCTION

Today's education demands 21st-century skills; intelligence is no longer measured by how many facts it can memorise, but rather by the mastery of flexible and adaptive mental skills. This is summarised in the '4C' competencies: the ability to think sharply to assess the truth (Critical), create new solutions (Creativity), work well together (Collaboration), and convey ideas appropriately (Communication) (Miterianifa, 2020). Academically, this concept confirms that, amid the onslaught of advanced technology, the principal value of humans lies in the 'agility' of thinking and problem-solving, a lifelong learning ability that cannot be entirely replaced by machines or artificial intelligence.

Science education in the 21st century has undergone a significant paradigm shift, moving from mere factual knowledge transfer to the development of Higher Order Thinking Skills (HOTs) and to a holistic strengthening of science literacy. In this context, education is considered not solely as a process of knowledge acquisition but as an important effort aimed at developing procedural skills, attitudes, and human resource potentials holistically (Ernawati et al., 2022). Nevertheless, the facts available today highlight a clear difference. According to the findings of the Programme for International Student Assessment (PISA), as examined in various recent questions, the scientific literacy of Indonesian students remains among the lowest, with students facing considerable challenges in relating scientific concepts to social, physical, and environmental realities (Febriya & Desnita, 2024).

This challenge is increasingly complicated in a chemistry learning environment. Chemistry is often seen as an unreal subject, difficult to understand, and less relevant to everyday life (Miranti & Refelita, 2023). The use of a teacher-focused approach hinders the depth of understanding of concepts. This affects students' overall ability to learn chemistry, including their understanding of concepts, argumentative skills, and skills in the science process. Meanwhile, research shows that science process ability and learning interests are interrelated and greatly affect students' academic success. (Ernawati et al., 2022). Therefore, a pedagogical approach is needed that bridges the gap between non-concrete chemical concepts and real-life phenomena, while also increasing students' interest and process skills.

One learning strategy that has the potential to overcome these challenges is the Socioscientific Issues (SSI) approach. In this approach, dilemmatic issues that bring science and society together are placed as the main context of learning. (Genisa et al., 2020; Laksono & Wibowo, 2022). Through SSI, students are encouraged not only to understand the content of science but also to negotiate with the social, ethical, and moral dimensions of decision-making. (Okmarisa et al., 2025).

A diverse body of literature consistently confirms that the SSI approach has a strong, well-tested basis. A global meta-analysis by Badeo & Duque, (2022) Revealed that SSI has a large effect size on students' science competence and reasoning. The latest findings from Villarojo & Floro, (2024) Further strengthen this argument by noting that the integration of Socioscientific Issues-Based Education (SSIBE) at the high school level has been shown to improve students' science achievement to the mastery level significantly and to sharpen critical thinking and problem-solving skills compared to traditional instructional methods. This is in line with the findings of Aripin et al., (2025) and Saija et al., (2022) Who reported on the effectiveness of local issue-based strategies in improving science literacy? SSI research trends in topics such as acid-base and reaction rates continue to grow in chemistry education research (Kansha et al., 2025; Okmarisa et al., 2025). The consistency of its positive impact on student learning success is a strong foundation for its broader application.

Although the positive impact of SSI has been widely publicised, there is still limited information that needs to be explored more deeply in these studies. Previously, most research tended to focus on the development of learning tools (R&D) (Kristiana et al., 2022; Febriani et al., 2022) Alternatively, highlight only one partially bound variable, such as scientific arguments. (Amburika et al., 2025) or science literacy alone (Husniyyah et al., 2023). On the other hand, although the variables of science process skills and interests have been explored in other active learning models, such as Problem-Based Learning (Aripin et al., 2025). There is still a limited number of studies that examine the impact of SSI in its entirety (covering aspects of knowledge, science skills, and student interest simultaneously), especially those that focus on high school students.

Given the urgency of the problem and the research opportunities, this study aims to assess the effectiveness of the SSI approach in improving students' ability to learn chemistry in high school. The results of this study provide comprehensive evidence to strengthen the theory of contextual learning and offer concrete steps to improve the quality of chemistry education to meet the demands of 21st-century skills.

METHODS

This research was conducted using the Systematic Literature Review method, a structured and standardised study methodology designed to identify, evaluate, and synthesise findings from relevant research articles through the prism filtering method, which comprises three essential stages: planning, conducting, and reporting. Inclusion criteria were set for peer-reviewed journal articles, in English or Indonesian, published between 2020 and 2025, and focused on the implementation of SSI in high school chemistry classes. The selection process was carried out through four stages: initial identification in the Google Scholar databases; screening of titles and abstracts; assessment of full-text eligibility; until 20 articles were obtained. The planning stage includes determining the inclusion and exclusion criteria for articles as well as review protocols; The conduct stage focuses on the collection and screening of literature that meets the quality criteria; Meanwhile, the reporting involves presenting a transparent and systematic synthesis of the findings. Page et al., 2021). Exclusion criteria included articles outside the field of chemistry, studies at the elementary or higher education level, and articles that were only conceptual reviews without empirical data

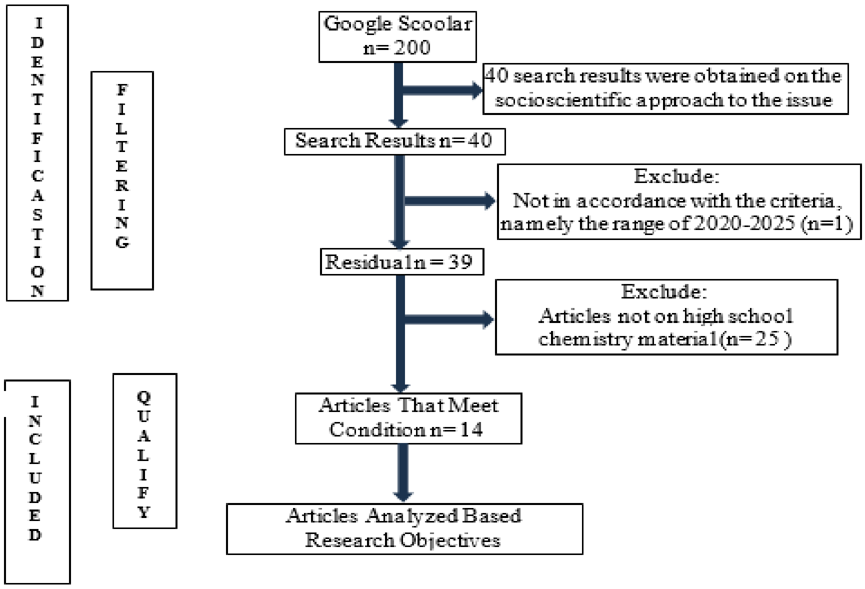

Figure 1. Prism Model Filtration Stage

Table 1. Inclusion and Exclusion Criteria

Criteria	Inclusion (Articles Accepted)	Exclusion (Article Rejected)
Time Range	Articles published between 2020 and 2025 provide the latest information.	Articles published outside of that time range (e.g. 2019 or earlier).
Topics & Content	An article that discusses the Socio-Scientific Issues (SSI) approach in the context of learning explicitly.	Articles that are irrelevant or do not fit the criteria of the topic of the socio-scientific approach.
Subjects	Research that focuses on Chemistry learning materials.	Articles that discuss science in general or other fields that are not specific to chemistry.
Education Level	Research subjects or materials intended for the Senior High School (SMA/High School) level.	Articles that do not cover chemistry material for the high school level (e.g. for university level or elementary education).
Database Source	Indexed literature that can be accessed through Google Scholar search.	Literature that was not identified through the initial search protocol in Google Scholar.

The literature selection in this study was carried out gradually and systematically using the Google Scholar database. In the initial identification stage, the search yielded 200 articles, which were then narrowed to 40 that were specifically related to media topics. The articles are then screened at the screening stage based on the criterion of year of publication, namely those published from 2020 to 2025. One of the articles was excluded because it was published in 2019, leaving 39 articles. The researchers' assessment stage on the 39 articles is more in-depth to ensure the suitability of the material context, so articles that do not discuss chemistry at the high school level are excluded. So, as many as 25 articles were excluded because they did not discuss the content of high school chemistry material. After the elimination process, the researchers initially obtained 14 articles as final results that met all inclusion criteria. All articles were selected for further analysis according to the purpose of this research.

Table 2. Research Questions

No	Research Questions	Purpose
1.	How did students' chemistry learning skills improve after using the socio-scientific issues approach?	To determine students' chemistry learning skills following the use of the socio-scientific issue approach.
2.	What learning skills are produced from chemistry learning that uses a socio-scientific approach to issues?	To determine learning skills generated from chemistry learning using a socio-scientific approach to issues.
3.	What materials are taught to students using the socio-scientific approach?	To find out the material taught to students using a socio-scientific approach to issues.

FINDINGS AND DISCUSSION

From the Google Scholar search results, 200 articles were initially obtained. Because the screening was initially conducted according to the socioscientific approach to the issue, 40 relevant articles were identified. Then the article was re-selected using the inclusion criteria, focusing on high school chemistry material and publications from 2020 to 2025. From this year's selection, 1 article was excluded, leaving 39 articles. As a result of content filtering, as many as 25 articles were dropped because they were not relevant to high school chemistry. A total of 14 relevant and qualified articles were collected to analyse the socioscientific effectiveness of the issue in relation to high school students' chemistry learning abilities.

Table 3. Descriptive Article Analysis

No	Author	Findings	Index
1.	(Prastika & Arianingrum, 2024)	This article finds that integrating SSI into chemistry education can bridge the gap between abstract concepts and students' real social experiences. The literature review concludes that this approach is efficacious in improving students' conceptual understanding, motivation, interest, and higher-order thinking and argumentation skills.	SINTA 1

No	Author	Findings	Index
2.	(Nita & Nada, 2024)	The findings of this article indicate that the application of the Problem-Based Learning (PBL) model based on Socio-Scientific Issues is effective in stimulating students' creative thinking skills in green chemistry. The effectiveness test showed an effect size of 0.708, which is classified as moderate, and significant t-test results.	SINTA 2
3.	(Kusumaningtyas et al., 2020)	This article's findings show that the use of socio-scientific issues in the Discovery Learning model significantly enhances students' critical thinking skills in the context of acid-base material. The apparent difference in learning outcomes between the experimental and control classes evidences this.	SINTA 3
4.	(Aini et al., 2024)	The findings of this article indicate an urgent need to develop Student Worksheets (LKPD) on Socio-Scientific Issues related to acid-base material. The survey shows that students have difficulty connecting concepts to everyday life, and both teachers and students respond positively to the need for teaching materials that train critical thinking through socio-scientific issues.	SINTA 3
5.	(Husniyyah et al., 2023)	This article's findings show that the application of Socio-Scientific Issues (SSI)-based learning using the Problem-Based Learning (PBL) model is efficacious in improving students' science literacy competence. This improvement in science literacy is classified as "High" with an N-Gain score of 0.71.	SINTA 3
6.	(Purwandari et al., 2024)	This article's findings show that the SSI approach plays an important role in improving scientific literacy in chemistry learning. The literature review shows that SSI helps students analyse environmental problems, assess the credibility of information, and formulate appropriate solutions, making it relevant to the 21st-century curriculum.	SINTA 4
7.	(Bambut & Tangpen, 2024)	The findings of this article show that the distribution of students' levels of argumentation on socio-chemical issues forms an "inverted pyramid" pattern, with the majority of students at Level 2 (32%), followed by Level 3 (28%), Level 1 (18.7%), Level 4 (13.3%), and Level 5 (8%). The claim component appeared in 100% of responses, whereas rebuttals appeared in only 14.7% of responses.	SINTA 5

No	Author	Findings	Index
8.	(Hasibuan & Sugiharti, 2025)	The findings of this article are that the development of an e-module based on Socio Scientific Issues (SSI) on reaction rate material was proven to be "highly valid" by subject matter experts (scores of 3.49-3.67) and media experts (3.95). Student responses were very positive (95.75%), and the e-module was effective in improving critical thinking skills.	SINTA 4
9.	(Nuraini et al., 2024)	The findings of this article indicate that applying the SSI learning strategy significantly improves students' science literacy on global warming. The average posttest score of the experimental class (66.46) was higher than that of the control class (59.17), with a statistically significant difference at $p = 0.003$.	SINTA 4
10.	(Afrilya et al., 2022)	This article's findings indicate that the SSI approach significantly affects science literacy in petroleum-related materials. The increase (N-gain) in science literacy in the experimental class was classified as "high," while that in the control class was classified as "moderate."	SINTA 4
11.	(Sismawarni et al., 2020)	The findings of this article indicate that the use of socio-scientific issues in the Problem-Based Learning (PBL) model significantly affects students' higher-order thinking skills in the subject of Basic Laws of Chemistry.	SINTA 3
12.	(Pauzi & Windiaryani, 2021)	This article's findings show that learning with the SSI approach improves students' critical thinking skills in global warming. The experimental class had an N-gain of 0.38 (higher than the control class's 0.24) with a significant difference.	SINTA 2
13.	(Rasyih et al., 2024)	The findings of this article show that SSI-based e-modules on Green Chemistry material are valid and practical. The use of e-modules significantly improves critical thinking and environmental awareness skills, with an N-gain of 0.71 (High) in the experimental class compared to 0.42 (Moderate) in the control class.	SINTA 2
14.	(Hikami et al., 2025)	The findings of this article indicate that the Socio-Scientific Issues (SSI) learning approach significantly affects students' chemistry literacy skills. The increase in science literacy in the experimental class was moderate (N-Gain 0.60), while that in the control class was low (N-Gain 0.28).	SINTA 4

Most studies in the table indicate that the SSI approach effectively promotes higher-order cognitive skills. Kusumaningtyas et al. found that integrating SSI into the Discovery

Learning model significantly enhances students' critical thinking in acid-base topics. Sismawarni et al. (2020) reported that using SSI in PBL significantly improves higher-order thinking skills in Basic Chemistry. Nita & Nada (2024) also found that SSI-based PBL effectively stimulates creative thinking, with a moderate effect size. Additionally, these articles emphasise the importance of improving science literacy. Purwandari et al. (2024) state that SSI is important for students when analysing problems and evaluating propaganda, which is highly relevant to the 21st-century curriculum.

Husniyyah et al. (2023) Demonstrated that SSI effectively increases science literacy among students in the "High" category. Nuraini et al. (2024) and Afrilya et al. (2022) Reported similar challenges related to global warming and petroleum. Hikami et al. (2025) Observed a greater improvement in science literacy in the experimental class. This table further underscores the urgency and validity of developing SSI-based teaching materials, as highlighted by Aini et al. (2024).

SSI-based LKPD is essential because students often struggle to connect abstract concepts to authentic experiences. Hasibuan & Sugiharti (2025) Found that SSI-based e-modules on reaction rates are "highly valid" and effective. Rasyih et al. (2024) Reported similar results with Green Chemistry e-modules. Beyond cognitive gains, SSI also supports the development of affective and argumentative skills. Prastika & Arianingrum (2024) Noted that SSI can motivate students to learn through real-world experiences. However, Bambut & Tangpen (2024) Observed that, despite a 100% claim, only 14.7% of students demonstrated the ability to argue at the foundational level and provide rebuttals.

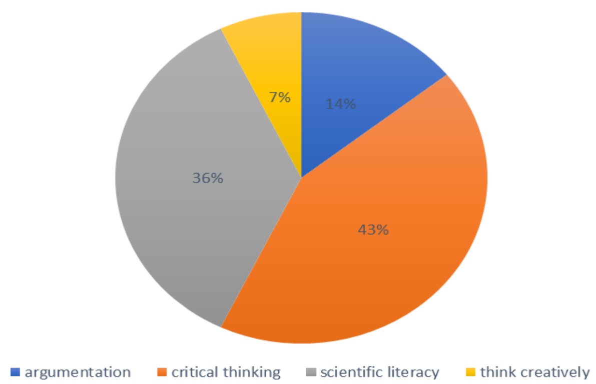

Figure 2. Analysed Learning Abilities

Critical thinking constitutes 43% of the quantitative data, closely followed by science literacy at 36%. Together, these two aspects account for 79% of the total. This indicates that, regardless of whether the focus is on curricular content, student abilities, or research topics, there is a strong emphasis on logical reasoning and scientific understanding. Conversely, expressive and generative abilities play a much smaller role.

Argumentation ranks highest among them at 14%, while creative thinking is the lowest at 7%. The significant gap between critical thinking (43%) and creative thinking (7%) highlights current competency priorities, emphasising the greater importance placed on evaluating information rather than generating new ideas or innovations. This distribution clearly demonstrates a competency hierarchy, with a strong preference for HOTS-based analytical and scientific literacy skills over HOTS-based rhetorical and divergent thinking skills, which are included under creative HOTS. This analysis may provide a basis for revising the balance of competency proportions to better incorporate the creative aspect.

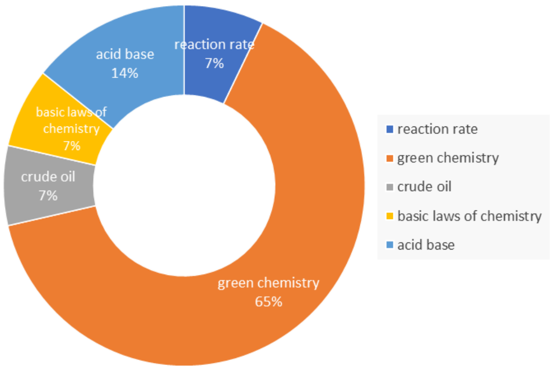

Figure 3. Chemical Material Analysed

Quantitative data show that Green Chemistry accounts for 65%, making it the most prominent topic by a wide margin. The next highest, Acids and Bases, represents only 14%. This gap of over 50 percentage points demonstrates a clear priority given to Green Chemistry in the material, research focus, or module content. This dominance reinforces the view that Green Chemistry is most relevant, as the material inherently contains SSI per se and thus directly relates to social, scientific, and environmental aspects

Reaction Rates, Fundamental Laws, and Petroleum each account for 7%, totalling only 21%, which is significantly lower than the percentage for Green Chemistry. This equal distribution suggests these topics receive balanced, though limited, attention. The data indicate a shift in focus toward environmental issues and sustainability. The much higher percentage for Green Chemistry, compared to traditional topics such as stoichiometry, fundamental laws, and kinetics, highlights a clear move toward prioritising environmental concerns, with conventional topics now serving a more supportive role.

Rasyih et al. (2024) reported a positive trend, demonstrating that Green Chemistry e-modules based on SSI are valid, practical, and effective in enhancing both environmental awareness and critical thinking. These findings reflect a broader pedagogical shift from content-centered instruction toward sustainability-oriented learning. However, the implementation of SSI remains limited in more abstract chemistry topics, such as stoichiometry and kinetics. This gap is pedagogically significant because abstract domains require students to operate across macroscopic, symbolic, and submicroscopic representations, which are cognitively demanding and less intuitively connected to socio-scientific contexts. The limited integration of SSI in these areas therefore reveals an unresolved instructional tension between conceptual abstraction and contextual relevance. While Hasibuan & Sugiharti (2025) demonstrated that SSI-based e-modules on kinetics can be both efficient and effective, such findings remain underrepresented in broader curriculum practices. A closer examination of the literature positions SSI as a potential “cognitive bridge” capable of mediating this tension. Prastika & Arianingrum (2024) further affirm that SSI facilitates the linkage between abstract chemical concepts and authentic socio-educational issues, shifting learning from procedural correctness toward evaluative and contextual reasoning.

CONCLUSION

Based on an analysis of 14 articles, the Socioscientific Issues (SSI) method is effective in connecting complex chemical concepts to real-world societal problems. This has been shown to improve high school students’ achievement, especially in critical thinking and science literacy. Although the impact is positive, students’ ability to formulate arguments, especially in rebuttals, still needs improvement. In addition, the current research topic is dominated by Green Chemistry materials (65%), while basic materials such as the fundamental laws of chemistry and reaction rates are still rarely addressed. Therefore, educators and curriculum developers are advised to expand the use of SSI not only to environmental issues but also to other abstract chemistry materials, to make it easier for students to understand. Future research should advance beyond the basic development of learning tools by designing integrated SSI instructional models for abstract chemistry topics such as buffer solutions. Such innovation should embed structured scientific argumentation frameworks aligned with macroscopic–submicroscopic–symbolic representations, accompanied by validated assessment instruments capable of capturing the quality of students’ reasoning and sustainability-oriented decision-making. Future research should move beyond the mere development of learning tools and instead prioritize instructional design innovations that systematically cultivate advanced scientific argumentation within socioscientific contexts. This includes the integration of structured argumentation frameworks, validated assessment instruments to measure the quality of reasoning, and longitudinal studies to examine the sustained impact of SSI-based interventions on students’ epistemic development.

REFERENCES

Afrilya, N., Afrianis, N., & Nurhadi. (2022). Pengaruh Penerapan Pendekatan Socio Scientific Issues terhadap Kemampuan Literasi Sains Siswa Pada Materi Minyak Bumi. JRPK: Jurnal Riset Pendidikan Kimia, 12(1), 10–19. https://doi.org/10.21009/jrpk.121.02

Aini, D. A., Solekha, N. A., Juvitasari, S., Nisfah, U. A., Tia, R., Siti Aisyah, R. S., Irhamni, I., & Zidny, R. (2024). Survei Analisis Kebutuhan Pengembangan Lembar Kerja Peserta Didik Berbasis Socio Scientific Issues pada Materi Asam Basa. Jambura Journal of Educational Chemistry, 6(1), 1–10. https://doi.org/10.37905/jjec.v6i1.23505

Amburika, N., Khoiri, A., & Lailiyah, S. (2025). Penerapan Contextual Teaching and Learning Berbasis Socio Scientific Issues untuk Meningkatkan Kemampuan Argumentasi Ilmiah. Educatoria : Jurnal Ilmiah Ilmu Pendidikan, 5(3), 140–150. https://doi.org/10.36312/educatoria.v5i3.489

Aripin, N., Mufit, F., Lufri, A., & Festiyed. (2025). The Role of Problem-Based Learning in Developing Science Literacy and 21st-Century Skills in High School Students: A Meta-Analysis. Jurnal Ilmiah Pendidikan MIPA, 15(1), 269–284. https://doi.org/10.30998/formatif.v15i1.27799

Badeo, J. M., & Duque, D. A. (2022). THE EFFECT OF SOCIO-SCIENTIFIC ISSUES (SSI) IN TEACHING SCIENCE: A META-ANALYSIS STUDY. Journal of Technology and Science Education, 12(2), 291–302. https://doi.org/10.3926/jotse.1340

Bambut, K. E. N., & Tangpen, J. M. (2024). Kajian Argumentasi Mahasiswa dalam Isu Sosial-Kimia: Pendekatan Socio-Scientific Issues (The Study of Students’ Argumentation on Socio-Chemical Issues: A Socio-Scientific Issues Approach). Jurnal Beta Kimia, 4(2). https://doi.org/10.35508/jbk.v4i2.23075

Ernawati, M. D. W., Asrial, A., Perdana, R., Pratama, W. A., & Septi, S. E. (2022). A Scientific Learning Model for Interest and Science Process Skills. Formatif: Jurnal Ilmiah Pendidikan MIPA, 12(2). https://doi.org/10.30998/formatif.v12i2.10149

Febriani, Ibnusaputra, M., Pradana, P. W., & Jumadi, J. (2022). Socioscientific Issues-based Guided-inquiry E-worksheet on Optical Instruments Topic. Jurnal Ilmiah Pendidikan Fisika Al-Biruni, 11(2), 231–241. https://doi.org/10.24042/jipfalbiruni.v11i2.12603

Febriya, D., & Desnita. (2024). Correlation Study Between Scientific Literacy And Environmental Literacy Of Jambi City High School Students In The Subject Of Physics. Formatif: Jurnal Ilmiah Pendidikan MIPA, 14(1). https://doi.org/10.30998/formatif.v14i1.22319

Genisa, M. U., Subali, B., Djukri, A., A., & Habibi, H. (2020). Socio-scientific issues implementation as a science learning material. International Journal of Evaluation and Research in Education, 9(2), 311–317. https://doi.org/10.11591/ijere.v9i2.20530

Hasibuan, Y. R., & Sugiharti, G. (2025). Pengembangan E-Modul Berbasis Socio Scientific Issues (SSI) pada Materi Laju Reaksi untuk Meningkatkan Keterampilan Berpikir Kritis. Panthera : Jurnal Ilmiah Pendidikan Sains Dan Terapan, 5(3), 833–845. https://doi.org/10.36312/panthera.v5i3.601

Hikami, N., Andayani, Y., & Loka, I. N. (2025). Pengaruh Pendekatan Pembelajaran Socio-Scientific Issue Terhadap Kemampuan Literasi Sains Kimia Peserta Didik. Lambda Jurnal

Ilmiah Pendidikan MIPA Dan Aplikasinya, 5(1), 194–204. https://doi.org/10.58218/lambda.v5i1.1311

Husniyyah, A. A., Erman, E., Purnomo, T., & Budiyanto, M. (2023). Scientific Literacy Improvement Using Socio-Scientific Issues Learning. IJORER : International Journal of Recent Educational Research, 4(4), 447–456. https://doi.org/10.46245/ijorer.v4i4.303

Kansha, T., Miterianifa, M., & Aulia, L. (2025). Systematic Literature Review: Pengaruh Isu-Isu Sosiosaintifik terhadap Keberhasilan Pelajaran Kimia di Sekolah Menengah Atas. Journal of Chemistry Education and Integration, 4(1), 15. https://doi.org/10.24014/jcei.v4i1.35260

Kristiana, T., Afandi, & Wahyuni, E. S. (2022). Konstruksi Perangkat Pembelajaran Menggunakan Model Guided Inquiry Disertai Socioscientific Issues (SSI) terhadap Keterampilan Berpikir Kritis. Edu Sains Jurnal Pendidikan Sains Dan Matematika, 2, 132–145.

Kusumaningtyas, P., Oktafiani, R., Nurhadi, M., & Sulistyaningwarni, S. (2020). Pengaruh Isu Sosiosaintifik dalam Model Discovery Learning terhadap Keterampilan Berpikir Kritis Siswa pada Materi Asam Basa Orbital: Jurnal Pendidikan Kimia, 4(1).

Laksono, R. K. S., & Wibowo, Y. (2022). Pengembangan Bahan Ajar berbasis Socio-Scientific Issues untuk Meningkatkan Higher Order Thinking Skill. Jurnal Pendidikan Sains Indonesia, 10(4), 752–765. https://doi.org/10.24815/jpsi.v10i4.25719

Miranti, I., & Refelita, F. (2023). Pengembangan Media Pop Up Book Materi Minyak Bumi Berbasis Sosio-Scientific Issue (SSI). Journal of Chemistry Education and Integration, 2(1), 58. https://doi.org/10.24014/jcei.v2i1.21625

Nita, P. N. T., & Nada, E. I. (2024). Efektivitas Efektivitas Model Problem Based Learning Berbasis Socio Scientific Issue terhadap Keterampilan Berpikir Kreatif. JRPK - Jurnal Riset Pendidikan Kimia, 14(2), 136–143. https://doi.org/10.21009/jrpk.142.08

Nuraini, Idris, S., & Ayunda, D. S. (2024) Pengaruh Strategi Pembelajaran Socio Scientific Issues (SSI) terhadap Kemampuan Literasi Sains Siswa pada Materi Pemanasan Global. Relativitas: Jurnal Riset Inovasi Pembelajaran Fisika, 7(2), 64–73. https://doi.org/10.29103/relativitas.v7i2.16523

Okmarisa, H., Nabila, A. S., & Humaira, T. (2025). Isu Sosiosaintifik dalam Pembelajaran Kimia : Systematic Literature Review. Konfigurasi: Jurnal Pendidikan Kimia Dan Terapan, 09(02), 27–36. https://doi.org/10.24014/konfigurasi.v10i2.37800

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. In BMJ (Vol. 372). BMJ Publishing Group. https://doi.org/10.1136/bmj.n71

Pauzi, R. Y., & Windiaryani, S. (2021). The critical thinking skills on the global warming issue: Effect of the socio-scientific problems approach on problem-solving for students. Biosfer, 14(2), 228–237. https://doi.org/10.21009/biosferjpb.19963

Prastika, F. N. K., & Arianingrum, R. (2024). The Socioscientific Issues Approach in Chemistry Education: A Literature Study and Its Implications. Jurnal Pendidikan MIPA, 25(4), 1880–1892. https://doi.org/10.23960/jpmipa/v25i4.pp1880-1892

Purwandari, A., Ayu Deaningtyas, S., Izzah Faradillah, N., Anjelika Putrikundia, S., & Sulistina, O. (2024). The Role of Socio-Scientific Issue (SSI) Approach in Improving Scientific Literacy in Chemistry Learning. UNESA Journal of Chemical Education, 13(2), 118–128.

Rasyih, H., Noer, A. M., & Rasmiwetti, R. (2024). Pengembangan E-Modul Berbasis Social Scientific Issue (Ssi) untuk Meningkatkan Kemampuan Berpikir Kritis dan Enviromental Care pada Materi Kimia Hijau di Kelas X SMA dengan Menggunakan Aplikasi Fliphtm. Jurnal Penelitian Pendidikan IPA, 10(8), 6059–6069. https://doi.org/10.29303/jppipa.v10i8.8102

Saija, M., Rahayu, S., Fajaroh, F., & Sumari. (2022). Enhancement of High School Students' Scientific Literacy Using Local-Socioscientific Issues in OE3C Instructional Strategies. Jurnal Pendidikan IPA Indonesia, 11(1), 11–23. https://doi.org/10.15294/jpii.v11i1.33341

Sismawarni, W. U. D., Usman, H. N., & Kusumaningtyas, P. (2020). Pengaruh Penggunaan Isu Sosiosaintifik dalam Model Pembelajaran Berbasis Masalah Terhadap Keterampilan Berpikir Tingkat Tinggi Siswa. Jambura Journal of Educational Chemistry, 2(1).

Villarojo, B. P., & Floro, M. (2024). The Integration of Socioscientific Issues-Based Education in Disaster Readiness and Risk Reduction in Enhancing Student Science Achievement. Formatif: Jurnal Ilmiah Pendidikan MIPA, 14(2). https://doi.org/10.30998/formatif.v14i2.21771