HYDROGEN
JURNAL KEPENDIDIKAN KIMIA
https://e-journal.undikma.ac.id/index.php/hydrogen/index

February 2026. 14(1)
e-ISSN: 2656-3061
p-ISSN: 2338-6487
pp. 114-124

The Effectiveness of the Socio-Scientific Issues (SSI) Approach on Senior High School Students' Critical Thinking in Chemistry: A Literature Review

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Article History
Received: 23-01-2026
Revised: 16-02-2026
Published: 28-02-2026

Keywords: chemistry learning; critical thinking skills; socio-scientific issues

Abstract
21st century learning emphasizes higher-order thinking skills, one of which is critical thinking. However, the 2022 PISA report shows that Indonesian students' achievements in critical thinking and science literacy are still low. One relevant approach to improving students' critical thinking skills is Socio-Scientific Issues (SSI), which is learning based on contextual, complex, controversial, and everyday science issues. Although the Socio-Scientific Issues (SSI) approach has been widely applied in chemistry learning to train higher-order thinking skills, empirical findings are still scattered and have not been systematically synthesized. This study aims to examine the effectiveness of the SSI approach in improving high school students' critical thinking skills through the Systematic Literature Review (SLR) method based on the PRISMA model. A total of 13 empirical articles published between 2016 and 2025 and indexed on Google Scholar, Sinta, and Scopus were analysed. The results of the study show that SSI-based chemistry learning is effective in improving critical thinking skills, particularly in the aspects of argumentation, evidence evaluation, science-based decision making, and problem solving. These findings indicate that the SSI approach has the potential to become the basis for curriculum development and chemistry learning design oriented towards strengthening critical thinking.

How to Cite: Pratiwi, N. K. M., Wijaya, K. J., & Redhana, I. W. (2025). The Effectiveness of the Socio-Scientific Issues (SSI) Approach on Senior High School Students' Critical Thinking in Chemistry: A Literature Review. *Hydrogen: Jurnal Kependidikan Kimia*, *14*(1), 114-124. https://doi.org/10.33394/hjkk.v14i1.19437

https://doi.org/10.33394/hjkk.v14i1.19437

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INTRODUCTION

All levels of education in the 21st century require higher order thinking skills (HOTS) summarized in 4C (Critical Thinking, Creativity, Collaboration, and Communication) as a prepa-rateion for students to cope with the complexities of reallife situations (Azkia & Wibowo, 2024). Redhana (2019) states that mastery of critical thinking, collaboration, and communication skills are four 21st-century skills that students must possess in order to be prepared to face global dynamics. The results of the 2022 Programme for International Student Assessment (PISA) confirm that Indonesian students' achievements are still low, especially in scientific reasoning, problem solving, and critical thinking (Bilad et al., 2024). This condition shows the urgency of implement-ing an approach that can integrate real contexts, encourage scientific reasoning, and hone critical thinking skills. Innovative learning approaches must be able to integrate real-life contexts into the teaching and laming process so as to systema-tically and continuously encourage scientific reasoning and critical thinking skills in students.

Chemistry education is one area of science education that has the potential to develop 21st century skills, particularly critical thinking skills. century skills, particularly critical thinking skills. Chemistry education emphasizes conceptual un-

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derstanding, scientific reasoning, and linking phenomena at the macroscopic and microscopic levels (Musa et al., 2023). These characteristics require students to not only master factual concepts, but also be able to analyze cause and effect (Firanti & Erna, 2024).

However, the implementation of chemistry learning in schools still faces various obstacles, such as limitations in relating chemistry material to everyday contexts (Redhana et al., 2018). In addition, the learning habits of beginner students, who tend to combine inductive and deductive reasoning in an unstructured manner, cause students to prioritize memorization over conceptual understanding (Sudria et al., 2019). This condition causes students to tend to be passive and less involved in higher-order thinking processes. Subagia and Wiratma (2020) stated that chemistry learning that emphasizes student active involvement through discussion, observation, and problem-solving activities can improve the quality of the learning process and student learning outcomes. Therefore, chemistry learning requires an approach that can encourage active student involvement and train critical thinking skills systematically and continuously (Sudiana et al., 2019).

One promising approach is Socio-Scientific Issues (SSI), which is a science-based learning approach that addresses issues closely related to social, ethical, and environmental dimensions (Gul & Akcay, 2020; Sadler et al., 2017; Selamat & Priyanka, 2024). This approach involves contextual and controversial scientific issues, encouraging students to engage in discussions to support the problem-solving process (Suardana et al., 2025). The SSI approach is specifically designed to address fundamental problems in chemistry learning, which tends to be passive and disconnected from real-world contexts. In the context of chemistry, environmental issues such as water pollution, the use of household chemicals, renewable energy, pesticides, and plastic waste are often used as learning topics (López-Fernández et al., 2022). By raising authentic issues that are open and controversial, SSI encourages students to actively engage in discussions, construct evidence-based arguments, and evaluate various alternative solutions (Amelia et al., 2025).

This characteristic means that students no longer act as recipients of information, but rather as active participants in the learning process (Sadler et al., 2016). In addition, the SSI approach in chemistry learning helps bridge microscopic concepts with real phenomena that are close to students' lives, thereby supporting the creation of a deeper conceptual understanding and training critical thinking skills (Ratnawati et al., 2016).

In chemistry education, the SSI approach has been widely applied to help students improve their critical thinking skills. This is because students can apply theory to solve given problems or scientific social issues. To solve these problems, students must master chemical concepts conceptually, be able to analyze the relationships between concepts, and use these concepts as a basis for constructing arguments and making decisions (Freani, 2024).

Various empirical studies support the effectiveness of the SSI approach in chemistry learning. Research conducted by Pandela et al. (2019) was found that the implementation of the SSI approach in chemistry learning on the topic of electrolyte and nonelectrolyte solutions was proven to be effective in increasing students' interest in chemistry, argumentation skills, ability to define terms, and capacity to consider definitions.

Study conducted by Fitria et al. (2023) stated that chemistry leaming using the SSI approach was able to significantly develop students' argumentation skills in the subject of buffer solutions related to climate change issues. Students find it easier to relate chemistry concepts to environmental issues that are close to their daily lives, such as the use of fossil fuels and their impact on climate change (Fitria et al., 2023).

Based on this, SSI has great potential to help improve students' critical thinking skills, especially in chemistry learning. Although the SSI approach shows great potential in improving critical thinking skills in chemistry learning, studies examining its application are still fragmented and scattered across various topics, methods, and different critical thinking indicators. To date, there has been no systematic synthesis that comprehensively summarizes and analyze empirical findings on the effectiveness of the SSI approach in chemistry learning at the high school level. This situation means that a complete picture of the role of SSI in developing students' critical thinking skills is still not clearly structured.

Therefore, a systematic review through a Systematic Literature Review (SLR) is needed to collect, analyze, and evaluate the results of previous studies, so as to provide a strong empirical basis for the development of chemistry learning and curriculum oriented towards strengthening students' critical thinking skills. This review was conducted to address this gap by presenting a comprehensive understanding of the role of the SSI approach in improving critical thinking skills in various chemistry subjects, ranging from acid-base topics to environmental chemistry.

Based on the background above, the problem formulation in the study are: What are the chemistry materials/topics applied in previous studies related to the application of SSI in the chemistry learning process at the senior high school level? What types of research are used in chemistry learning with the SSI approach in senior high schools? How effective is chemistry learning using the SSl approach in improving the critical thinking skills of senior high school students?

METHOD

Type of Research

This study used the systematic literature review method (Snyder, 2019) with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) method (Page et al., 2021). The PRISMA-based SLR method was chosen because it provides a systematic and transparent framework for the process of searching, screening, and selecting literature (Wiraspanggi, 2025).

The literature selection process using the PRISMA method was carried out through the stages of initial article identification, screening of titles and abstracts, and evaluation of eligibility based on the full text, so that the decision to select articles was based on consistent criteria and reduced the risk of selection bias.

Using the method, thirteen articles were found related to the keywords used. The methods used to collect information related to each research question are presented in Table 1.

Table 1. Research question

No	Question	The analysis sought
1	What are the chemistry materials/topics applied in previous studies related to the application of SSI in the chemistry learning process at the senior high school level?	At this stage, the researchers analyzed articles on what chemistry materials/topics had been applied in chemistry learning using the SSI approach in senior high schools.
2	What types of research are used in chemistry learning with the SSI approach in senior high schools?	At this stage, the researchers analyzed articles on the types of research used to implement chemistry learning with the SSI approach in high schools.
3	How effective is chemistry learning using the SSl approach in improving the critical thinking skills of senior high school students?	At this stage, researchers analyzed the effectiveness of chemistry learning with the SSI approach in improving high school students' critical thinking skills.

Research Procedures

Articles in the literature review were obtained from the Google Scholar, Sinta, and Scopus databases using the keywords "socio-scientific issues, chemistry learning, chemistry instruction, critical thinking" in the research literature search. The search was conducted on articles published between 2016 and 2025. Meanwhile, the exclusion and inclusion criteria used are presented in Table 2.

The quality and relevance of articles were assessed qualitatively by considering the suitability of the research objectives with the focus of the study, the clarity of the research design and methods, the relevance of the chemistry learning context, and the clarity of the research results reporting.

Articles are considered relevant if they explicitly discuss the application of the SSI approach in chemistry learning and examine critical thinking skills as one of the research variables. Although no quantitative weighting of study quality was performed, the application of strict inclusion criteria and this qualitative evaluation ensures that the articles analyzed are of sufficient quality and relevance to support the literature synthesis process.

Table 2. Exclusion and inclusion criteria

Exclusion criteria	1)	Articles cannot be accessed in their entirety
	2)	Non-empirical articles (opinions and editorials)
	3)	Articles that measure aspects other than senior high school chemistry
	4)	Do not measure critical thinking skills
Inclusion criteria	1)	Articles published between 2016 to 2025
	2)	Research context on senior high school students
	3)	Focus on the application of SSI in chemistry learning
	4)	Peer-reviewed articles (journals, proceedings, published theses)
	5)	Measures critical thinking skills (directly or through indicators such as argumentation, problem solving, and evidence evaluation)

RESULTS AND DISCUSSION

Overview of Articles Reviewed

Based on the systematic literature review that has been conducted, thirteen articles were found to be worthy of analysis. The articles used were from Indonesia and international sources. The results of the analysis of these fifteen articles are presented in Table 3.

Table 3. Results of the analysis of articles on the application of SSI in chemistry learning to develop critical thinking skills in senior high school students

No	Author (year)	Article title	Types of research	Learning materials/topic	Effectiveness
1	Pandela et al. (2019)	The Influence of Socio-Scientific Issues in Improving Critical Thinking Skills in the Study of Electrolyte and Non-Electrolyte Solutions	Quasi-experiment	Electrolyte and Non-Electrolyte Solutions	Able to improve students' critical thinking skills, thereby positively influencing their critical thinking skills in relation to electrolyte and non-electrolyte solutions
2	Kusumaningtyas et al. (2020)	The Effect of Socio-Scientific Issues in the Discovery Learning Model on Students' Critical Thinking Skills in Acid-Base Material	Quasi-experiment	Acid-Base	Able to improve students' critical thinking skills, particularly in the indicators of the ability to make further explanations and draw conclusions
3	Khusmawardani et al. (2022)	Impact of Explicit Scientific Inquiry Instruction Hybrid Mode with Socioscientific Issue Context on Students' Critical Thinking Skills in Chemical Kinetics	Quasi-experiment	Chemical Kinetics	Able to improve students' critical thinking skills through a scientific approach (scientific inquiry) by applying discussion, presentation, and experiment methods
4	López-Fernández et al. (2022)	How Can Socio-scientific Issues Help Develop Critical Thinking in Chemistry Education? A Reflection on the Problem of Plastics	Quasi-experiment	Polimers	Able to improve students' critical thinking skills such as argumentation and decision-making abilities

No	Author (year)	Article title	Types of research	Learning materials/topic	Effectiveness
5	Azkia & Wibowo (2024)	Analysis of Students' Critical Thinking Skills in Chemistry Learning with SSI (Socio Scientific Issue) Content	Qualitative	Petroleum	Able to improve students' critical thinking skills, particularly in the indicators of drawing conclusions, providing simple explanations, and organizing strategies.
6	Hasibuan & Sugiharti (2025)	Development of E-Modules Based on Socio Scientific Issues (SSI) in Reaction Rate Material to Improve Critical Thinking Skills	Research and Development (R&D)	Reaction Rate	Able to effectively improve students' critical thinking skills
7	Nurfikri et al. (2025)	Development of Electrochemistry Enrichment Books Based on Integrated STEAM Socio Scientific Issues (SSI-STEAM)	Research and Development (R&D)	Electrochemistry	Able to effectively improve students' critical thinking skills and reflective attitudes
8	Nurhayati et al. (2016)	The Effect of SSI-Contextualized LC-5E–Based Chemistry Learning on Senior High School Students' Critical Thinking Skills in Solubility Topics	Quasi-experiment	Solubility	Able to effectively improve students' critical thinking skills, particularly reconstructing arguments (presenting reasons related to the problem given).
9	Purwanto et al. (202a)	Socio-Critical and Problem-Oriented Approach in Environmental Issues for Students' Critical Thinking Skills Development in Chemistry Learning	Qualitative	Acid-Base	Able to effectively enhance students' critical thinking skills, particularly argumentation abilities and increased student motivation.
10	Rasyih et al. (2024)	Development of an E-Module Based on Social Scientific Issues (SSI) to Improve Critical Thinking and Environmental Care Skills on Green Chemistry Material Using the Fliphtml5 application	Research and Development (R&D)	Green Chemistry	Able to effectively improve students' critical thinking skills and environmental awareness
11	Ardianti et al. (2024)	The Effect of Problem Based Learning Models Based on Socio-Scientific Issues	Quasi-experiment	Hydrocarbons	Able to effectively enhance critical thinking skills, particularly in

No	Author (year)	Article title	Types of research	Learning materials/topic	Effectiveness
		on Students' Critical Thinking Skills on Hydrocarbon Burning Materials			questioning and answering, considering definitions, and evaluating the credibility of sources
12	Hajijah et al. (2025)	Fostering Critical Thinking through Socio-Scientific Issue-Based Problem-Based Learning in Stoichiometry Instruction	Quasi-experiment	Stuichiometry	Able to effectively improve thinking skills, especially in considering inductive results, focusing on questions, and identifying assumptions
13	Sugrah et al. (2023)	Promoting students' critical thinking and scientific attitudes through socio-scientific issues-based flipped classroom	Quasi-experiment	Additives and chemicals	Able to effectively enhance students' critical thinking skills (such as constructing arguments, drawing conclusions, and making decisions) as well as their scientific attitudes

Analysis of Research Methods in the Studies Reviewed

Based on the analysis of 13 articles that met the inclusion criteria, data was obtained on chemistry materials/topics that have applied SSI to improve high school students' critical thinking skills, as presented in Figure 1.

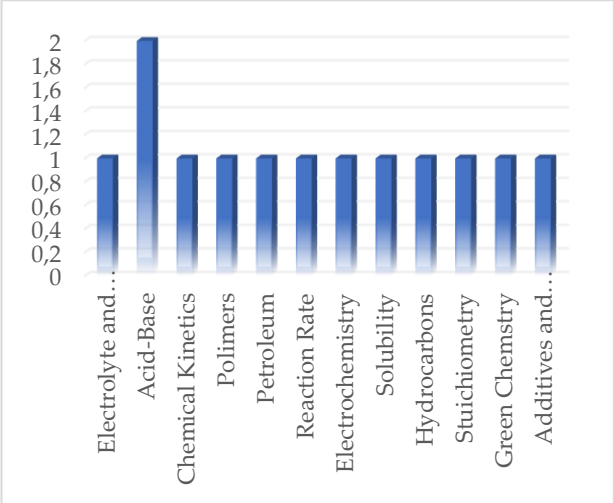

Figure 1. Percentage of Chemistry Material/Topics

Figure 1 shows that the most commonly used high school chemistry material/topic in previous studies was acids and bases. The dominance of this topic arose because its conceptual characteristics are contextual and closely related to everyday phenomena. These characteristics make it easier for teachers to integrate scientific concepts that are relevant to social issues. The topic of acids and bases was chosen in chemistry learning using the SSI approach because it has a strong connection to everyday life and various relevant environmental issues (Purwanto et al., 2022).

Issues related to acids and bases in the context of SSI-based chemistry learning include various phenomena that are developing in society, such as environmental pollution, food or beverage products, cleaning products, and so on (Agnia et al., 2021). One issue that often arises is the controversy over the cause of sourness in fruits, which is often associated with high vitamin C content. This issue falls into the category of open problems because it does not yet have a definite solution and still causes debate in society (Kusumaningtyas et al., 2020).

When students master the concept of acids and bases, they will be able to relate their conceptual knowledge to the context of the socio-scientific issues presented, evaluate them from various perspectives, and draw conclusions based on scientific evidence. Thus, learning with the SSI approach not only strengthens conceptual understanding, but also fosters critical thinking

skills and responsible decision-making in complex scientific social contexts (Kusumaningtyas et al., 2020). Meanwhile, other chemistry topics such as chemical kinetics, reaction rates, stoichiometry, chemical bonding, and other topics only appeared in one study. This low frequency is thought to be related to limitations in linking learning materials to relevant scientific social issues. Reaction rate material, for example, has characteristics that are predominantly microscopic and mathematical, making it relatively difficult to directly relate to open scientific social issues (Cylindrica et al., 2021).

In addition, chemistry materials/topics such as reaction rates and stoichiometry require a high level of science literacy because they require students to integrate various scientific representations, ranging from symbolic, mathematical, to conceptual (Sevian & Talanquer, 2014). The lack of scientific literacy among students is one of the main factors hindering the application of the SSI approach in the classroom learning process (Widad et al., 2025). This finding is in line with the opinion of Chowdhury et al., 2020) who emphasized that the success of learning with the SSI approach is greatly influenced by the level of relevance between the subject matter and the scientific social context that is close to students' lives. Therefore, acid-base material is a dominant topic in SSI research because it provides a balance between chemical concepts and their social relevance.

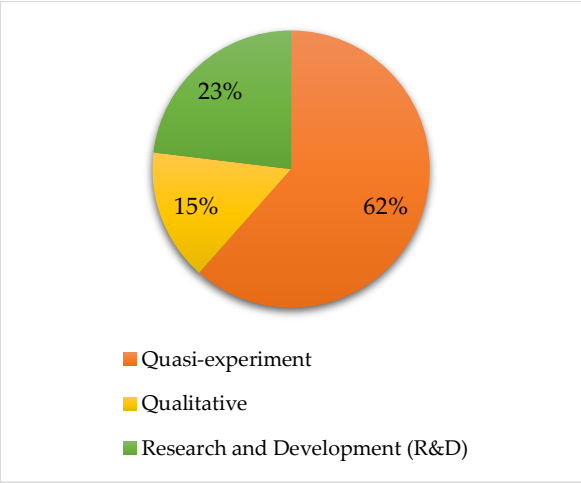

Figure 2. Percentage of Research Types

Figure 2 shows that the most commonly used type of research in previous studies was quasi-experimental, with a percentage of 62%. The quasi-experimental method is a type of experiment that does not use randomization in dividing subjects into experimental and control groups because the groups used have been formed previously (Hastjarjo, 2019). The high use of this type of research shows the researchers' focus on testing the direct effectiveness of integrating social science issues on improving students' critical thinking skills through control and experimental class designs. Through quasi-experimental research, researchers can compare learning outcomes between classes that use the SSI approach and classes that use conventional learning (Wildan & Siahaan, 2016). This approach makes it easier for researchers to demonstrate the direct effect of applying the SSI approach on students' critical thinking skills.

In addition to quasi-experiments, Figure 2 also shows that research and development (R&D) research accounts for 23% and qualitative research accounts for 15%. R&D research is generally used to develop SSI-based learning tools such as modules, student worksheets, and learning media (Okpatrioka, 2023). The learning tools developed are then tested in chemistry lessons to assess their feasibility and effectiveness in improving the quality of learning (Hardianti et al., 2020). One example is research on the development of SSI-based e-modules for chemistry lessons on reaction rates to improve students' critical thinking skills (Hasibuan & Sugiharti, 2025).

The development model used is ADDIE, which consists of five stages, namely analysis, design, development, implementation, and evaluation. The ADDIE development model is used because each stage is structured systematically, clearly, and is easy to understand. Therefore, the ADDIE development model is suitable for developing valid e-modules that are ready for use before being implemented widely. Meanwhile, qualitative research was used to examine the development of students' critical thinking during the learning process through various data collection techniques, such as interviews, reflection journals, classroom observations, worksheets, and researcher notes (Purwanto et al., 2022). The use of qualitative research plays an important role in providing an overview of the learning process that supports the development of students' critical thinking skills.

Various studies have been conducted on the application of the SSI approach in chemistry

learning. These studies show positive results on critical thinking skills in chemistry learning. Of the thirteen articles, it shows that the application of the SSI approach in chemistry learning can improve students' scientific thinking skills and scientific attitudes (Sugrah et al., 2023). Based on the analysis of the articles reviewed, the most frequently reported indicators of critical thinking that experienced improvement were the ability to provide arguments, the ability to provide further explanations, and drawing conclusions. The ability to make arguments developed through SSI-based chemistry learning because students were actively involved in discussion and problem-solving activities (Ratnawati et al., 2016). Differences in views among students in SSI discussions stimulate students to critically defend other arguments (López-Fernández et al., 2022). This activity encourages students to relate the chemistry concepts they have learned to available facts, so that the arguments they construct become more rational (Purwanto et al., 2022).

In SSI-based learning, students are presented with socio-scientific issues that are relevant to their daily lives, enabling them to provide answers accompanied by appropriate reasoning (Kusumaningtyas et al., 2020). This condition trains students' ability to provide further explanations, because students not only convey answers but also explain the thought process and the relationship between the chemical concepts underlying the answers (Nurhayati et al., 2016). In addition, learning with the SSI approach also trains students' ability to draw conclusions. Through the analysis of the socio-scientific issues discussed, students integrate various information and chemical concepts to formulate logical conclusions that are consistent with the evidence (Azkia & Wibowo, 2024). This shows that problems related to socio-scientific issues can stimulate students to understand problems comprehensively and draw logical conclusions based on the chemical concepts they have learned (Kusumaningtyas et al., 2020).

In addition to improving the ability to present arguments, provide further explanations, and draw conclusions, SSI-based chemistry learning also contributes to the development of other critical thinking skills. Through discussions of socio-scientific issues, students are trained to ask and answer questions critically as part of the process of clarifying and deepening their understanding of the issues (Ardianti et al., 2024). Students are also encouraged to consider the definitions and concepts used so that they are appropriate to the scientific context being discussed (Jariah & Aminatun, 2022). In addition, learning with the SSI approach requires students to assess the credibility of the sources of information used in constructing arguments, so that students do not accept information directly without evaluation (Ardianti et al., 2024). These skills play a role in improving students' ability to consider the results of induction, focus their attention on the main questions, and identify the assumptions underlying a statement or arg(Azkia & Wibowo, 2024). Thus, the SSI approach supports the development of students' critical thinking more comprehensively in chemistry learning.

These findings have important implications for chemistry teaching practices and curriculum development. Empirical evidence shows that SSI integration is most effective when linked to chemistry topics that are relevant to students' daily lives, such as acids and bases, environmental pollution, and green chemistry. Therefore, chemistry teachers need to design learning that is not only oriented towards conveying concepts, but also towards exploring relevant socio-scientific issues as a learning context. The integration of SSI in the chemistry curriculum has the potential to encourage more meaningful, contextual, and student-centered learning (Bencze et al., 2020).

In the broader context of education, the findings of this study are relevant to the demands for educational reform that emphasize strengthening science literacy and critical thinking skills, especially given the low achievement of Indonesian students in scientific reasoning based on the 2022 PISA results. The SSI approach, which integrates scientific and social issues, has the potential to be an alternative in supporting education policies oriented towards the development of higher-order thinking skills and student readiness to face global challenges (Gül & Akcay, 2020). However, the studies reviewed are still dominated by short-term studies and local contexts, so the long-term impact of SSI implementation and the influence of

cultural and geographical differences have not been widely studied. Therefore, further research needs to develop longitudinal studies and expand the research context to gain a more comprehensive understanding of the effectiveness of the SSI approach in chemistry learning.

CONCLUSION

Based on the analysis of thirteen scientific articles, it can be concluded that the application of the SSI approach in chemistry learning at the high school level has been proven effective in improving students' critical thinking skills. The application of SSI is commonly found in contextual chemistry material that is closely related to everyday life. The topic of acids and bases was the most dominant material, followed by environmental pollution, green chemistry, buffer solutions, and others. These studies used several types of research, namely quasi-experiments (62%), followed by research and development (R&D) (23%), and qualitative research (15%). The dominance of quasi-experimental research shows the direct focus of the research on testing the direct effectiveness of the SSI approach on students' critical thinking skills. The results of the analysis show that the critical thinking indicators that most often experience improvement include the ability to provide arguments, provide further explanations, and draw conclusions. In addition, chemistry learning using the SSI approach also contributes to improving the ability to ask and answer questions, consider definitions, assess the credibility of sources, consider inductive results, and focus questions. Thus, it can be concluded that the application of the SSI approach in chemistry learning at the high school level can effectively improve critical thinking skills. In practical terms, these findings recommend that secondary school chemistry educators integrate relevant socio-scientific issues into their teaching as a context for training students in reasoning, argumentation, and decision-making. In the context of global education, strengthening critical thinking skills through the SSI approach is in line with the demands of 21st century education, which emphasizes science literacy, higher-order thinking skills, and students' readiness to face complex problems in the real world.

RECOMMENDATION

Based on the results of this systematic literature review, further research is recommended to examine the application of the SSI approach using more diverse research method, learning models, and chemistry topics at the senior high school level. This is necessary to obtain a more comprehensive and contextual understanding of the effectiveness of the SSI approach in developing students' critical thinking skills across various domains of chemistry.

BIBLIOGRAPHY

Agnia, N., Permanasari, A., & Hernani. (2021). Uji Kelayakan Modul Asam-Basa Berbasis Socioscientific Issues dan Berorientasi Literasi Sains. *Jurnal Riset Dan Praktik Pendidikan Kimia*, *9*(2), 113–120.

Amelia, S., Johan Wicaksana, E., & Mursyd, D. (2025). SSI-Based PBL Integrated Essay Test as a Solution to the Problem of Scientific Argumentation Skill. *Pedagogia: Jurnal Pendidikan*.

Ardianti, D. L., Feronika, T., & Wardani, M. (2024). The effect of problem based learning models based on socio-scientific issues on students' critical thinking skills on hydrocarbon burning materials. *SPIN Jurnal Kimia & Pendidikan Kimia*, *6*(2), 135–148. https://journal.uinmataram.ac.id/index.php/spin/article/view/10214

Azkia, R., & Wibowo, T. (2024). Analisis Keterampilan Berpikir Kritis Siswa pada Pembelajaran Kimia Bermuatan SSI (Socio Scientific Issue). *MIPA Insight: Journal of Science, Technology, Education, and Mathematics*, (1), 49–58. https://journal.innoscientia.org/index.php/mipainsight/indexISSNxxxx-xxxx

Bencze, L., Pouliot, C., Pedretti, E., Simonneaux, L., Simonneaux, J., & Zeidler, D. (2020). SAQ, SSI and STSE education: Defending and extending "science-in-context." *Cultural Studies of Science Education*, *15*(3), 825–851.

Bilad, M. R., Zubaidah, S., & Prayogi, S. (2024). Addressing the PISA 2022 Results: A Call for Reinvigorating Indonesia's Education System. *International Journal of Essential Competencies in Education*, *3*(1), 1–12.

Chowdhury, T. B. M., Holbrook, J., & Rannikmäe, M. (2020). Socioscientific Issues within Science Education and their Role in Promoting the Desired Citizenry. *Science Education International*, *31*(2), 203–208.

Cylindrica, V. B., Wayan Dasna, I., & Sumari. (2021). Pengaruh Model Pembelajaran Learning Cycle 5E berbantuan E-scaffolding pada Materi Laju Reaksi terhadap Pemahaman Konsep Siswa dengan Motivasi Berprestasi Berbeda. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *6*(7), 1115–

1133. https://doi.org/https://doi.org/10.17977/jptpp.v6i7.14934

Firanti, F., & Erna, M. (2024). Uji Kelayakan E-Modul Asam Basa Berbasis SSI (Socio-Scientific Issues) Berbantuan Flip PDF Professional. *Jurnal Pendidikan Kimia Undiksha*, *8*(1), 20–28. https://doi.org/https://doi.org/10.23887/jjpk.v8i1.70540

Fitria, R., Wiyarsi, A., Dyana, M. R., & Arifa, M. F. (2023). Analysis of Students' Argumentation skill towards Socio-Scientific Issues in Chemistry Learning. *ACM International Conference Proceeding Series*, 159–163. https://doi.org/10.1145/3631991.3632015

Freani, R. D. (2024). Model RADEC Berbasis Socio-Scientific Issue (SSI) sebagai Alternatif Meningkatkan Higher Order Thinking Skills pada Pembelajaran IPA Abad 21. *Proceeding Seminar Nasional IPA*, 265–272.

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).

Hajijah, A., Nasution, M., Hasibuan, N. A. P., Hilda, L., & Baroud, N. Y. (2025). Fostering Critical Thinking through Socio-Scientific Issue-Based Problem-Based Learning in Stoichiometry Instruction. *JTK (Jurnal Tadris Kimiya)*, *10*(1), 35–44. https://doi.org/10.15575/jtk.v10i1.43992

Hardianti, H., Copriady, J., & Haryati, S. (2020). Pengembangan Perangkat Pembelajaran IPA SMP Berbasis Discovery Learning Berorientasi Meningkatkan Kemampuan Berpikir Kritis dan Hasil Belajar Peserta Didik. *Chemistry Education Review (CER)*, *3*(2), 109.

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://e-journal.lp3kamandanu.com/index.php/panthera

Hastjarjo, T. D. (2019). Rancangan Eksperimen-Kuasi. *Buletin Psikologi*, *27*(2), 187.

Jariah, S. A., & Aminatun, T. (2022). Implementation of the Socio-scientific Issues Approach with the Investigative Group Learning Model to Improve Students' Critical Thinking Skills on Environmental Change Materials. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1042–1048. https://doi.org/10.29303/jppipa.v8i3.1197

Khusmawardani, E., Muntholib, & Yahmin. (2022). Impact of Explicit Scientific Inquiry Instruction Hybrid Mode With Socioscientific Issue Context on Students' Critical Thinking Skills in Chemical Kinetics. *Journal of Chemistry Education Research*, *6*(2), 131–137.

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), 64–73.

López-Fernández, M. del M., González-García, F., & Franco-Mariscal, A. J. (2022). How Can Socio-scientific Issues Help Develop Critical Thinking in Chemistry Education? A Reflection on the Problem of Plastics. *Journal of Chemical Education*, *99*(10), 3435–3442.

Musa, W. J. A., Mantuli, M. A., Tangio, J. S., Iyabu, H., Kilo, J. La, & Kilo, A. K. (2023). Identifikasi Pemahaman Konsep Tingkat Representasi Makroskopik, Mikroskopik, dan Simbolik pada Materi Ikatan Kimia. *Jambura Journal of Educational Chemistry*, *5*(1), 52–59.

Nurfikri, M., Sapinatul Bahriah, E., & Suryaningsih, S. (2025). Pengembangan Buku Pengayaan Elekrokimia Berbasis Socio Scientific Issues Terintegrasi STEAM (SSI-STEAM). *Prosiding Seminar Nasional FITK UIN Syarif Hidayatullah Jakarta*, *2*(1).

Nurhayati, H. M., Rahayu, S., & Yahmin. (2016). Pengaruh-Pembelajaran-Kimia-Kelarutan-dengan-LC-5E-Berkonteks-SSI-terhadap-Keterampilan-Berpikir-Kritis-Siswa-SMA. *Jurnal Pendidikan Sains*, *4*(4), 137–143.

Okpatrioka. (2023). Research And Development (R&D) Penelitian Yang Inovatif Dalam Pendidikan. *Dharma Acariya Nusantara : Jurnal Pendidikan, Bahasa dan Budaya*, *1*(1), 86–100.

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*, *372*, 1–8.

Pandela, Y. S., Sunyono, & Rudibyani, R. B. (2019). Pengaruh Isu Sosio-Saintifk dalam Meningkatkan Kemampuan Berpikir Kritis pada Materi Larutan Elektrolit dan Non-Elektrolit. *Jurnal Pendidikan Dan Pembelajaran Kimia*, *8*(2), 296–307. https://jurnal.fkip.unila.ac.id/

Purwanto, A., Rahmawati, Y., Rahmayanti, N., Mardiah, A., & Amalia, R. (2022). Socio-critical and problem-oriented approach in environmental issues for students' critical thinking skills development in chemistry learning. *Journal of Technology and Science Education*, *12*(1), 50–67. https://doi.org/10.3926/jotse.1341

Rasyih, H., Noer, A. M., & Rasmiwetti, R. (2024). Development of an E-Module Based on Social Scientific Issues (SSI) to Improve Critical Thinking and Environmental Care Skills on Green Chemistry Material Using the Fliphtml5 application. *Jurnal Penelitian Pendidikan IPA*, *10*(8), 6059–6069.

Ratnawati, E., Rahayu, S., & Fajaroh, F. (2016). Pengaruh Learning Cycle-5E Berkonteks SSI Terhadap Pemahaman Hakikat Sains Pada Materi Larutan Penyangga Dan Hidrolisis Garam Siswa SMA. *Jurnal Pendidikan Sains*, *4*(1), 25–35. http://journal.um.ac.id/index.php/jps/

Redhana, I. W., Sudria, I. B. N., Suardana, I. N., Suja, I. W., & Handayani, N. K. N. (2018). Identification of chemistry teaching problems of a prospective teacher: A case study on chemistry teaching. *Journal of Physics: Conference Series*, *1040*(1). https://doi.org/10.1088/1742-6596/1040/1/012022

Redhana, W. (2019). Mengembangkan Keterampilan Abad ke-21 dalam Pembelajaran Kimia. *Jurnal Inovasi Pendidikan Kimia*, *13*(1), 2239–2253.

Sadler, T. D., Romine, W. L., & Topçu, M. S. (2016). Learning science content through socio-scientific issues-based instruction: A multi-level assessment study. *International Journal of Science Education*, *38*(10), 1622–1635.

Selamat, I. N., & Priyanka, L. M. (2024). Integrating Local Wisdom and Socio-Scientific Issues: The Impact of the Ethno-SSI Module on Students' Problem-Solving Skills. *Thinking Skills and Creativity Journal*, *7*(2), 182–188.

Sevian, H., & Talanquer, V. (2014). Rethinking chemistry: A learning progression on chemical thinking. *Chemistry Education Research and Practice*, *15*(1), 10–23. https://doi.org/10.1039/c3rp00111c

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339.

Suardana, I. N., Redhana, I. W., & Selamet, K. (2025). Socio Scientific Issues-Based Science Learning to Improve Critical Thinking Skills: A Systematic Literature Review. *AIP Conference Proceedings*, *3206*(1), 08004.

Subagia, I. W., & Wiratma, I. G. L. (2020). The effectiveness of chemistry learning strategy in improving students' learning process and achievement. *Journal of Physics: Conference Series*, *1567*(4). https://doi.org/10.1088/1742-6596/1567/4/042039

Sudiana, I. K., Suja, I. W., & Mulyani, I. (2019). Analisis Kesulitan Belajar Kimia Siswa pada Materi Kelarutan dan Hasil Kali Kelarutan. *Jurnal Pendidikan Kimia Indonesia*, *3*(1), 7–16. https://ejournal.undiksha.ac.id/index.php/JPK/index

Sudria; I, I. B. N., Lanang, G., Lysa, W. ;, & Sembiring, K. B. (2019). Pengembangan Perangkat Pembelajaran Saintifik dengan Model Problem Based Learning melalui Penalaran Induktif pada Topik Laju Reaksi. *Jurnal Pendidikan Kimia Indonesia*, *3*(1), 32–45. https://ejournal.undiksha.ac.id/index.php/JPK/index

Sugrah, N., Suyanta, & Wiyarsi, A. (2023). Promoting students' critical thinking and scientific attitudes through socio-scientific issues-based flipped classroom. *LUMAT*, *11*(1), 140–165.

Widad, S., Rahayu*, S., & Munzil, M. (2025). Persepsi Guru Kimia di Kalimantan Barat Terhadap Penggunaan Socio Scientific Issues (SSI) Dalam Pembelajaran Kimia. *Jurnal Visi Ilmu Pendidikan*, *16*(3), 419–430.

Wildan, S., & Siahaan, J. (2016). *Pengaruh pembelajaran berbasis sociocientific issue (SSI) terhadap hasil belajar kimia materi pokok larutan penyangga siswa kelas X1 IPA SMAN 1 Bayan tahun pelajaran 2016/2017*.

Wiraspanggi, E. (2025). Systematic Literature Review Dengan Metode Prisma: Integritas Fungsi Manajemen Sumber Daya Manusia Sebagai Instrumen Pengambilan Keputusan Organisasi Yang Efektif. *Journal of Science Education and Management Business*, *4*(3), 819–836.