

Use of Socio-Scientific Issues in Chemistry Learning

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Abstract: *Socio-Scientific Issues* is a learning approach that involves social conflict that is closely related to science that has developed in society so that it requires scientific thinking in the presentation of science. The purpose of this research is to find out how effective the SSI approach in teaching chemistry in the high school environment. The method used search using Scopus to get 18 articles to be reviewed. The information is arranged in the following order: type of research, purpose of using the SSI approach, data collection, chemical materials used and field of use of the SSI approach. It is hoped that this discussion can provide guidance for education using the SSI approach in the classroom learning process. The result obtained from the literature review are that SSI can be used in chemistry learning with any material so that it attract the attention of students.

Keywords: Chemistry; Scopus; Socio-Scientific Issues

Introduction

Education is an important aspect of an individual's life. Everyone has the right to it and must continue to develop it. The development of education today goes hand in hand with changes in the culture of life. These changes are very important to improve education in modern times (Wati et al., 2022). In the era of modern information technology, students with scientific literacy skills are expected to be able to think critically, identify scientific phenomena, and participate in public discussions. This point of view emphasizes the cultivation of scientific literacy as the goal of science education, where the focus of learning is developing students' abilities to actively participate in learning (Hofstein et al., 2011)

Using learning topics related to everyday life allows students to recognize the importance of science and be motivated to learn science in understanding scientific phenomena and problems in the development of science and technology (Bybee & McCrae, 2011). However, students generally see science as irrelevant to them (Zeidler, 2016). One thing that can be used to make

science relevant for students is to use socio-scientific issues (SSI) in learning (Owens et al., 2019, Hancock et al., 2019; Sadler et al., 2016).

Socio Scientific Issues is a problem-oriented approach that is related to issues that explain social scientific issues that occur in society (Sadler et al., 2017). SSI aims to link intellect, ethics and morals, as well as understanding the relationship between social life and science (Subiantoro et al., 2013). SSI can be used to engage students during the science process to provide a more meaningful learning experience by integrating real life problems (Fita et al., 2021). However, learning using SSI is still rarely used by teachers, because they view science teaching as only conveying facts and theories. This can also be caused by many teachers still not knowing about SSI, lack of teacher expertise and understanding, lack of required student competencies, inadequate facilities and lack of time for preparation and implementation of lessons (Febriani et al., 2022; Nida et al., 2020). The application of SSI makes it easier for students to contextualize and increase their participation in learning science, improve high-level thinking and reasoning skills, improve science process skills, students'

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skills in argumentation and making decisions regarding the issues or problems they face.

A number of investigations illustrate the positive impact of SSI use on the development of argumentation skills (Effendi-Hasibuan et al., 2020; Atabey & Arslan, 2020), motivation (Slovinsky et al., 2021), environmental awareness (Susilawati et al., 2021) and think critically (Merchan & Maatarredona, 2016). However, this effect does not necessarily come from specific learning content but rather comes from the methodology that uses SSI as a support. This ambiguity was also reported by (Bell et al., 2010), which details that explicit teaching of scientific learning content is as effective as teaching that integrates learning content based on SSI, indicating the need to produce new studies in this area. The purpose of this research is to find out how effective the SSI approach in teaching chemistry in the high school environment. This research was carried out because there are still very few users of the SSI approach in schools, the update carried out is to provide references is suitable for use in schools.

Method

According to (Arksey & O'Malley, 2007) proposes a five-stage framework used to conduct a systematic review to ascertain obstacles to the findings. In the first stage, identify the research question. Research questions can provide direction and limitations in the review discussion. Some research questions are as follows:

- Q1 What types of research using the SSI approach are often used?
- Q2 What is the purpose of using the SSI approach?
- Q3 What data collection is often used in research using the SSI approach?
- Q4 What materials are used in chemistry learning using the SSI approach?
- Q5 How is SSI used in various fields?

In the second stage, identify relevant studies related to Socio-Scientific Issues. The search uses an academic database, namely Scopus. The Scopus database was crawled with several terms using the combination: "socio-scientific issues" "Socio-Scientific Issues in Chemistry". These search terms using English language literature produced 678 search results.

In stage 3, relevant studies are evaluated and selected from the search results obtained. OnThe database used obtained 678 search results. Through filtering using the criteria "Socio-Scientific Issues",

"Science Education" titles and abstracts, the number of articles obtained was 329. A total of 349 were less relevant because they did not match the criteria used. Then there was a reduction due to the selection of article and journal criteria to 256 articles. A total of 73 were removed because they did not meet the article criteria. By tracing the open access criteria, 118 articles were removed because they were not relevant and became 138 articles with open access criteria.

Other more detailed inquisition criteria were established. Firstly, the selection of all the articles provides a clear picture of the instructions from SSI in chemistry education. Second, the article must clearly explain the picturethe type of research used, the purpose of the research, the data collection tools used, the materials used and the use of SSI in various fields. These criteria resulted in a total of 18 articles being used. In Stage 4, all data obtained is mapped to make it easier to obtain the results. Data is mapped in such a way as to provide answers to predetermined research questions. Finally, in Stage 5, the results obtained through charting are compiled, summarized, and reported in an appropriate manner

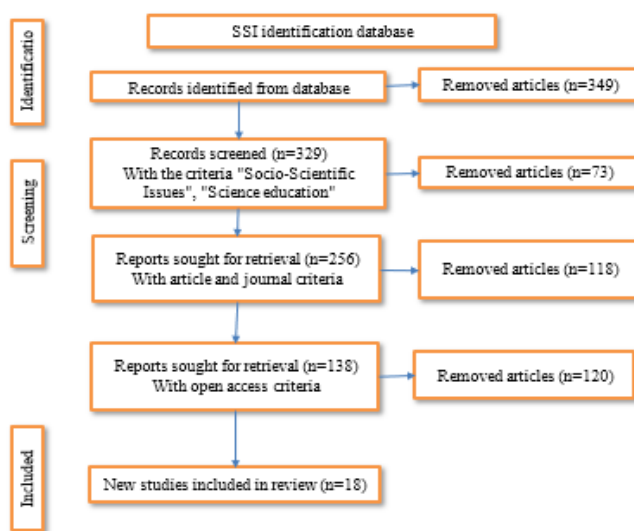


Figure 1. Literature search procedures according to guideline

Result and Discussion

Table 1 can provide information from 18 selected articles regarding the use of SSI in the world of education to answer questions 1, 2, 3, 4 and 5. These articles can be categorized by author, research method used, research objectives, variables used. as well as frequently used chemicals.

Table 1. Utilization of SSI in education

Author and year of writing	Research methods	Objective	Data collection tools	Material	Dimensions
(Calik & Wiyarsi, 2021)	Systematic Reviews	To thematically synthesize the research papers on chemistry-focused socio scientific issues (SSI) from 2008 to 2020 and inferentially evaluate them in terms of the relevance model of chemistry education	Research papers	Macromolecules and inorganic compounds, organic compounds, solubility	Technological, ethical, political, religious, societal, environmental, economic, health
(Su, 2021)	Mixed Method	To verify the confluent application of concept mapping (CM) and socioscientific issues (SSI) according to the value-laden and moral dilemma orientation to construct problem solving performance	Quantitative: open ended pretest post test questions and questionnaire. Qualitative: interviews	Chemical reactions, organic compounds	Health, culture, ethics, society, environment, morals
(Pratiwi, Rahayu, & Fajaroh, 2016)	Quasi Experiment	To investigate the differences in students' critical thinking which learn cooperatively using different learning contexts.	Multiple choice questions based on critical thinking indicators, post test	Reaction rates	Law, social, health
(Cha, Kan, Chia, & Chia, 2022)	Qualitative	To analyze data and make decisions use of the Chemical SWOT Methodology to Enable Students in the context of socioscientific issues related to the use of parabens and triclosan, which are chemicals with potential adverse effects that are widely used in everyday products	Essays	Organic compounds, benzenes	Health, environment
(Saija, Rahayu, Fajaroh, & Sumari, 2022)	Quasi Experiment	To assess inquiry based OE3C learning methodologies that incorporate local socioscientific issues (SSI) to improve students' scientific literacy	Questionnaire, pretest and posttest, interview	Thermochemistry and rate reactions	Cultural, environmental, moral and ethical
(Zidny, Laraswati, & Eilks, 2021)	Case study	To explore students' application of chemical concepts and their use of arguments in an educational research framework to incorporate and reconstruct indigenous science in chemistry education	Worksheet questionnaire	Organic compounds	Culture, environment, socio-economic, ethical, ecological,
(Bayram-Jacobs, Wieske, & Henze, 2019)	Qualitative	To explore how the design of this chemistry lesson for citizenship influences students' use of different perspectives in decision-making about 'the use and sale of laughing gas' with the To instructional approach, and activating pedagogical methods and tools (ie, group discussions, reading the information cards, taking notes, watching instructional videos)	Worksheets and questionnaires	Gases Compounds	Health, economy, society
(Nida, Rahayu, Eilks, & Survey of	Mixed Method	To explore Indonesian science teachers' experience and perceptions toward science	Questionnaires, surveys, interviews	Environmental chemistry, food chemistry	Environment, social

Author and year of writing	Research methods	Objective	Data collection tools	Material	Dimensions
Indonesian Science Teachers' Experience and Perceptions toward Socio-Scientific Issues-Based Science Education, 2020)		teaching that is based on socio-scientific issues (SSI)			
(Wiyarsi, Prodjosanto, & Nugraheni, 2021)	Quasi Experiment	To investigate students' scientific habits of mind (SHOM) and chemical literacy using the Context of Socio-Scientific Issues on the Inquiry Learning	Chemical literacy test, argumentative questions, SHOM scale	Acid-base	Society, economy, health, religion
(Eilks, Marks, & Stuckey, 2018)	Qualitative	To present a curriculum model for using socio-scientific issues as contexts for science education in general and chemistry education in particular	Lesson plans	Aromatic compounds	society, health, religion, ethics
(Fadly, Rahayu, Dasna, & Yahmin, 2021)	Quasi Experiment	To examine the effectiveness of SOIE (Strengthening, Orientation, Investigation, and Evaluation) innovative learning strategies on students' chemical literacy.	Pretest posttest chemical literacy test and learning achievement tests	Stoichiometry, solutions, acid bases	Moral, ethical, environmental, economic, political, social
(Pitiporntapin, Yutakom, & Sadler, 2016)	Mixed Method	To explore PSTs' use of SSIs in their teaching during practicum, their problems with SSI-based teaching, and their professional development needs related to SSI-based teaching	Interview Protocol Classroom observation form	Organic compounds and inorganic compounds	Environment, ethical
(Ke, Sadler, Zangori, & Friedrichsen, 2021)	Hypothetical study/theoretical study	To develop and use multiple models as part of their science learning experiences in general, and how the practice benefits students in the context of SSI in particular to promote scientific literacy	Research papers	Biochemistry	Health, society
(Morris, 2014)	Hypothetical study/theoretical study	To explore how SSIs have been interpreted in an important and innovative science course for students aged 14-16 in England, entitled Twenty First Century Science and analyzes the Twenty First Century Science textbooks	Research papers	Benzopyrene (aromatic) as dye Colloidal Surfactant	Ethical, moral, society, environment, technology
(Reis, Tinoca, Baptista, & Linhares, 2020)	Quantitative	To involve teachers, students, and the public in the discussion on Responsible Research and Innovation (RRI), promoting both the construction of knowledge on cutting-edge (and controversial) research topics and the discussion about the criteria that these research/innovation processes should respect in order to be	Pre and posttest questionnaire	Polymers, macromolecules	Society, technology, environment, economics, ethics, politics

Author and year of writing	Research methods	Objective	Data collection tools	Material	Dimensions
(Nida, Marsuki, & Eilks, 2021)	Qualitative (case study)	considered as responsible about the RRI dimensions of cutting-edge research topics (socioscientific issues)-on students' perceptions regarding their scientific competences and the science classes To examine the current controversial issue of palm oil production for manufacturing biodiesel in Indonesia and it is used as a context to teach chemistry at the undergraduate level	Questionnaires and interviews	Organic compounds, carboxylic acids, esters, transesterfication	Society, politics, environment
(Nida, Pratiwi, & Eilks, 2021)	Case Studies	To ea case study looking at the use of daily life contexts and socio-scientific issues by pre-service science teachers (PSTs) in Indonesia during their final year teaching internship	Questionnaires and interviews	Chemical reactions	Environmental, society, morals, economy, technology, ethics
(Erman, Pare, Susiyawati, Martini, & Subekti, 2022)	Quantitative	To develop a scaffolding set to help students have sufficient prior knowledge of biochemistry relevant to SSI, connect with biochemistry ideas and societal concerns of SSI	rubrics, a questionnaire, and an observation sheet, pre post test	Carbohydrate metabolism	Health, social

Q1. What types of research using the SSI approach are often used?

On Table 2 provides data on the research design used in several studies listed in table 1. In several cases

the studies included in each study used more than just one type of research. The most widely used research design is the research design carried out with

Table 2. Types of research used in research

Theme	Code	Frequency
Method	Quantitative	Quasi Experiment Other
	Qualitative	Case study Other
	Combine Research	Mixed Methods Systematic review
Total		18

Q2 What is the purpose of using the SSI approach?

The use of SSI has its own objectives from several studies which are listed in Table 1.

Table 3. Objectives of the SSI approach to chemistry learning

Theme	Code	F
Objective	Investigating the effects of any models/methods /strategies/tools in chemistry learning based on SSI on dependent variables	2,3,5,6,7,8,9,11,12,13,18
	Analyzing textbooks how SSI has been presented	14
	Using the context of SSI in chemistry learning to explore competence	4,15,16,17
	Presenting curriculum model in chemistry learning based on SSI	10
	Evaluating chemistry based SSI in terms of the relevance model of chemistry education	1
Total		18

As presented in table 2, the aim theme consisted of five different codes. The first code has the highest frequency of all the aim codes. The first code is investigating the effects of any models/ methods/ strategies/ tools in chemistry learning based on SSI on dependent variables. This shows that many studies have investigated the effect of any models/ methods/ strategies/ tools in chemistry learning based on SSI on dependent variables like inquiry-based OE3C learning that incorporates local socioscientific issues (SSI) to improve students' scientific literacy (Saija, Rahayu, Fajaroh, & Sumari, 2022) and investigate students' scientific habits of mind (SHOM) and chemical literacy using the Context of Socio-Scientific Issues on the Inquiry Learning (Wiyarsi, Prodjosantoso, & Nugraheni, 2021). The results of this study showed that chemistry

learning based on SSI has an effect on the dependent variable. The second code is analyzing textbooks how SSI has been presented (Morris, 2014). These papers analyze the Twenty First Century Science textbooks how SSIs have been interpreted in science courses. The third code is using the context of SSI in chemistry learning to explore competencies such as professional development related to SSI-based teaching (Pitiporntapin et al., 2016). The fourth code is presenting curriculum model in chemistry learning based on SSI. The last code is evaluating chemistry-based SSI in terms of the relevance model of chemistry education

Q3 What data collection is often used in research using the SSI approach?

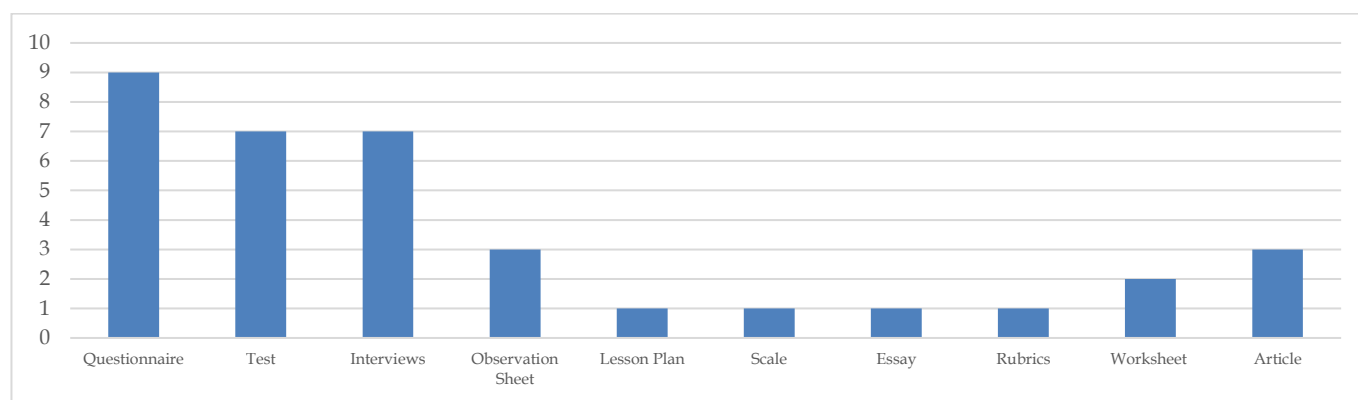


Figure 2. Data collection tools in SSI chemistry learning

Data collection is the procedure of collecting, measuring and analyzing accurate insights for research using standard validated techniques. Based on table 3, data collecting tools theme consisted of 10 codes. They are mostly 9 questionnaires. Most of the questionnaire in quantitative and qualitative research, this may become the right tool for collecting data in chemistry learning based on SSI because the most aim of research is investigating the effects of any models/methods /strategies/tools in chemistry learning based on SSI on dependent variables and using the context of SSI in chemistry learning to explore competence. Participants can answer the question and researchers collect information from the questionnaire. The other data collecting tools are 7 tests from quantitative research, 1 textbook, 3 observation sheets from quantitative and mixed method, 1 lesson plan, 1 scale, 1 essay, 1 rubric, 2 worksheets, 3 articles

Q4 What materials are used in chemistry learning using the SSI approach?

Table 4. Material used in chemistry learning using the SSI approach

Theme	Code	F
Chemistry	Thermochemistry	5
Concept	Reaction Rates	3, 5
	Organic Compunds	1, 2, 4, 6, 12, 16
	Inorganic Compunds	1, 12
	Biochemical Process	13
	Macromolecules	1, 15
	Solubility	1
	Acid Base	9, 11
	Chemical Bonds	17
	Polymers	15
	Chemical Reactions	2
	Stociometry	11
	Total	23

One of the criteria in this literature research is that the topic of SSI must be integrated to chemistry concepts. Based on table 4, the research papers used chemistry concepts such as thermochemistry, reaction rates, organic compounds, inorganic compounds, macromolecules, etc. The majority of them focused on the organic compounds (eg, carboxylic acid, ester, etc)

through the relevant SSI. Organic compounds are mostly used in daily products, the use of organic compounds might be viewed as easily applicable for chemistry learning based on SSI

Q5 How is SSI used in various fields?

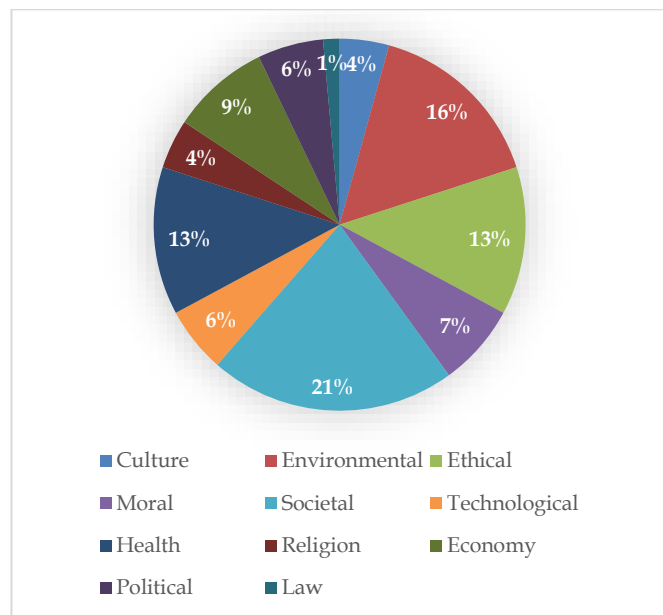


Figure. 3 Use of SSI in Various Fields

Students collect and/or analyze scientific data related to the issue being considered, and negotiation of social (eg, political and economic) dimensions of the issue is expected. Based on table 5, 11 codes appear for dimensions of SSI theme. It can be concluded that the papers mostly associate their SSIs topics with societal dimensions. Furthermore, there are culture, environmental, ethical, moral, technological, health, religion, economy, political and legal dimensions used in papers.

The research was conducted with the aim of framing and highlighting several contributors (articles, types of research, research objectives, data collection tools, chemical materials and the use of SSI in various fields). The concept of SSI has evolved and incorporates more potential areas in which SSI can play a role in enabling students to achieve science education goals. This article provides an overview of various aspects and dimensions of SSI which can conclude that SSI has a social context but has scientific considerations, requiring several considerations such as moral, ethical, cultural, traditional, economic, political to provide benefits for students in making decisions, increasing literacy science, as well as enabling intellectual growth, moral development and community engagement in local, social and global contexts.

Conclusion

The use of SSI in science education can improve students' skills, such as argumentation, motivation, environmental awareness, and critical thinking. The research results highlight the success of SSI in chemistry learning, covering various topics such as macromolecules, organic compounds, solubility, chemical reactions, dangerous compounds, and environmental chemistry. The article also emphasizes the positive role of SSI in achieving science education goals, including students' scientific literacy, argument-based learning, and the development of critical thinking skills through the study of reaction kinetics, providing a comprehensive view in the context of chemistry learning

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Author Contributions

Author one is the main author who put forward the research idea and designed the research. The second author was tasked with translating Indonesian into English. Meanwhile, the third and fourth authors are lecturers who are tasked with revising articles before submission.

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Conflict of Interest

This research was carried out in order to obtain a Master's degree at graduation. then for hobby purposes because I have a hobby of writing in any form.

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