



## The Effectiveness of Socioscientific Issue-Based Petroleum Materials Integrated with The Elsmawar Website on Students' Scientific Literacy

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**Abstract:** This study aims to determine the effectiveness of Socioscientific Issue (SSI)-based petroleum materials integrated with the eLSMAWAR website on students' scientific literacy during the COVID-19 Pandemic. However, it still targets the achievement of 21st-century skills, namely scientific literacy competencies. Scientific literacy is needed as a skill that can answer the demands of the 21st-century era, as a problem solver that is competitive, innovative, creative, collaborative, and has character. This research method uses Research and Development (R & D), which refers to Borg and Gall's development model. The instrument used in this study was an expert validation sheet filled in by a validator which was useful for knowing whether it was feasible or not to develop. Students are given ten descriptive questions on a 1-4 Likert scale to determine the effect of teaching materials on scientific literacy. The data obtained were analyzed by descriptive quantitative. Expert validation resulted in an average percentage of 87% on material, presentation, language, and legibility aspects. For the validation of chemistry educators, the mean score of CVI for the language aspect and legibility is 0.80; the material aspect is 0.86; for the presentation, aspect is 0.84. This means that based on chemistry experts and educators, the criteria for SSI-based petroleum materials integrated with the eLSMAWAR website are appropriate/valid and very suitable for use. The scientific literacy test results obtained an N-Gain of 0.66, which means that the SSI-based teaching materials integrated with the eLSMAWAR website are quite effective in improving students' scientific literacy. The research concludes that the teaching material based on Socioscientific Issue (SSI) integrated with the eLSMAWAR website on students' scientific literacy with three indicators of scientific literacy is following the demands of the implementation of 21st-century skills.

**Keywords:** petroleum, socioscientific issue, scientific literacy

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### INTRODUCTION

During the COVID-19 pandemic conditions and the increasing rate of spread of the virus in various regions, the Ministry of Education and Culture decided to change learning in schools from face-to-face to distance learning. Face-to-face learning, replaced with online learning, can limit interactions between students and educators and students and lecturers (Masrul et al., 2020; Wijaya et al., 2020). Indirectly, the COVID-19 pandemic requires someone to be literate about technology (Chawla, 2020; Wiederhold, 2020), especially information technology, which contributes significantly to the learning process during a pandemic situation (Astini, 2020), the use of technology in online learning as well can provide new knowledge that is useful for students (Rahayu et al., 2020; Santhalia et al., 2020).

In the millennial era like today, there are several types of e-learning that we usually find in learning, namely Web-based learning and M-Learning (Mobile Learning). Web-based learning is a way of delivering and accessing teaching materials carried out through electronic media by using a web server to deliver course material. Online learning activities can be controlled remotely through various examples of e-learning, for example, web learning such as Google Classroom, Moodle, Edmodo, Schoology, and the educational institution's web. E-learning with its characteristics and usefulness is not new in learning innovation which is an alternative for learning continuity and effectiveness (Jamaludin et al., 2020; Purnamasari et al., 2020). Learning does not always have to be carried out in the classroom as a delivery room, but one solution considered capable of making learning can be carried out anywhere and anytime (Kustandi & Darmawan, 2020).

The application of M-learning is usually called mobile learning. Learning using mobile systems and devices, after this, is known as mobile learning. This mobile-based e-learning technology is the latest generation (Ismayani, 2018). This is supported by Sudarsana et al. (2020) that cellular such as smartphones and tablets is one of the communication media used in learning. Examples of M-learning between via Whatsapp, Telegram, or Line. The benefits of mobile learning include 1) convenience: information is easily accessible and is not limited

by place or time; 2) engaging: content interaction can be personalized to facilitate motivation and engagement; 3) collaboration: students can communicate through online communities, such as forums and chats; 4) accessible: classrooms are everywhere, and educators are scattered to allow for a wider reach; and 5) cost-effective: existing content can be used and reused later. Computer devices' size is now easier to carry everywhere than previous computer equipment (Personal, 2017). This means that computer equipment can be taken anywhere and anytime. Learning using practical computer devices such as tablets, laptops, and smartphones is now standard and commonly used.

Educator creativity in designing online learning for students also plays an important role. Even though learning activities are accessed from home, they must still target the achievement of 21st-century skills that combine knowledge, skills, behavior, and scientific literacy, which includes digital, media, culture (Frydenberg & Andone, 2011). According to Redhana (2019), the challenges of the 4.0 industrial revolution in education must produce human resources who have 21st-century skills, namely 4C (Creative, Critical thinking & problem solving, Collaboration, and Communication). 21st-century skills in the 2013 curriculum are integrated with scientific literacy and strengthening character education in the teaching and learning process. Having scientific literacy skills provides opportunities to answer the times' challenges as a problem solver who is competitive, innovative, creative, collaborative, and has character. Some experts view that scientific literacy leads to functional literacy, which is the literacy needed to carry out work and life functions. Therefore, they provide another term, scientific literacy, namely functional literacy. In line with 21st-century skills, functional science literacy is very much needed in life and the development of times that are full of complexity (Pelch & McConnell, 2017; Bossér et al., 2015).

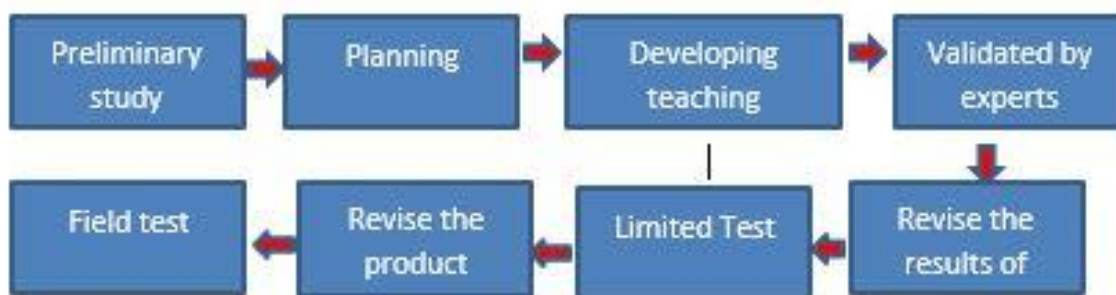
PISA 2018 announced that the value of students' scientific literacy level in Indonesia is 396. This shows that it is further below the OECD average and has decreased significantly, from 403 to 396 (Schleicher, 2018). This shows that Indonesian students still find it difficult to link science and scientific facts in everyday life. Although the PISA study was conducted on junior high school students, these results' weaknesses should receive attention in learning at the high school level. Learning in high school needs to ensure that the scientific literacy weaknesses of junior high school students can be overcome in learning in senior high school. Scientific literacy needs serious attention and is addressed as soon as possible to improve Indonesia's quality of education.

Learning needs to be supported by the availability of teaching materials that are following the criteria of 21st-century teaching materials, which include dimensions of scientific literacy such as content, procedures, and scientific behavior in real-life environments (Naezak et al., 2021; Fauzia & Kelana, 2020; Wardani, 2020; Kelana & Pratama, 2019). Scientific literacy is multifaceted, which includes understanding scientific experience with High-Order Thinking Skill (HOTS) to solve challenges that exist in the real environment (Purnami et al., 2020; Winata et al., 2018). The current teaching material only emphasizes the content, without any process and behavior, so that it is predicted to be the cause of students' scientific literacy levels below average. For this reason, it is necessary to have alternative teaching materials based on Socioscientific Issue (SSI) integrated with the eLSMAWAR website for students' scientific literacy.

This study aims to interpret the specifications of petroleum teaching materials based on the Socioscientific Issue (SSI) integrated with the eLSMAWAR website on the students' scientific literacy during the COVID-19 Pandemic. This scientific literacy is limited to petroleum material with indicators of the ability to describe scientific phenomena, the ability to relate chemical concepts to real-life phenomena, and the ability to analyze data and scientific evidence. SSI in this research is in the form of learning resources which are issues in electronic media about petroleum. The reason for the importance of scientific literacy competency indicators for students to have is the ability to apply to understand scientific facts with science, technology, and society so that they can solve increasingly complex problems in environmental changes in real-life.

## **METHODS**

This research develops SSI-based teaching materials. The development model used by Borg and Gall (1989) is used to analyze the specifications of SSI-based teaching materials that are integrated with the eLSMAWAR website in terms of benefits, feasibility, and efficiency of use. In this study, eight out of ten stages were carried out according to Borg and Gall (see Figure 1). The development procedure in this research includes observation, making plans, teaching material development, validity test by experts, improvement of expert validation, limited test, revision of limited test results, field test. Teaching material development activities begin with conducting a preliminary study and then planning the development of teaching materials based on the findings. The results of the development of teaching materials are then validated by experts in the form of a score of the validity of the teaching material and also suggestions for improving further teaching materials. Teaching materials that have been validated and improved are then tested in a small community, namely six 6<sup>th</sup> grade students with heterogeneous abilities selected based on the educators).



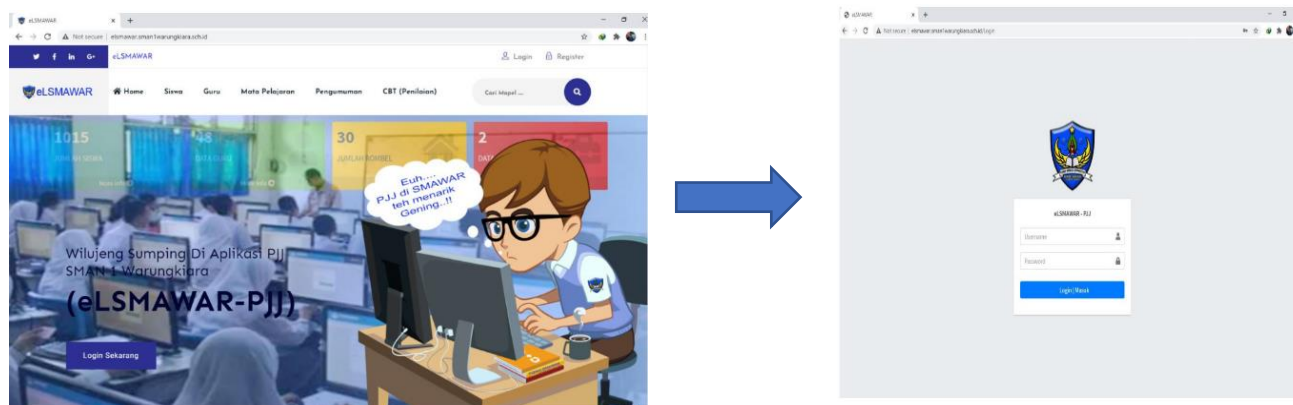
**Figure 1.** Research Framework

The small community test looked at the quality of the teaching materials developed. Teaching materials that were developed again were improved based on suggestions and input from educators and students. The improvements were tested on research subjects in the field test as many as 72 students consisting of 23 men and 49 women in class XI MIPA SMAN 1 Warung Kiara, Sukabumi Regency. This study's target participants have devices in cellphones and laptops that can be used to browse information or electronic learning resources. Field testing determines the quality and effectiveness of the teaching material being developed. The quality of teaching material is obtained from the average percent of expert and educator observations, while effectiveness is shown by the difference in the average pretest and posttest results. The data analysis technique used quantitative descriptive analysis and qualitative descriptive analysis. Quantitative descriptive analysis analyzes data in the form of scores obtained from validation questionnaires and students' scientific literacy tests. Qualitative descriptive analysis analyzes descriptive data in the form of suggestions and responses from the validator.

Teaching material data is validated by experts using the Google Form application. The data is analyzed by calculating the average score for each aspect then characterizing it. Students' scientific literacy was measured using a written test using the google form. There are three aspects of competency indicators measured, namely the ability to explain chemical concepts, the ability to connect chemical concepts to everyday phenomena, interpret scientific data and evidence. The concept of petroleum being tested consists of processing petroleum into its fractions, the quality of gasoline, and the impact of burning petroleum fuels. Scientific literacy data in numerical values were then analyzed by determining the average and analyzed descriptively quantitatively.

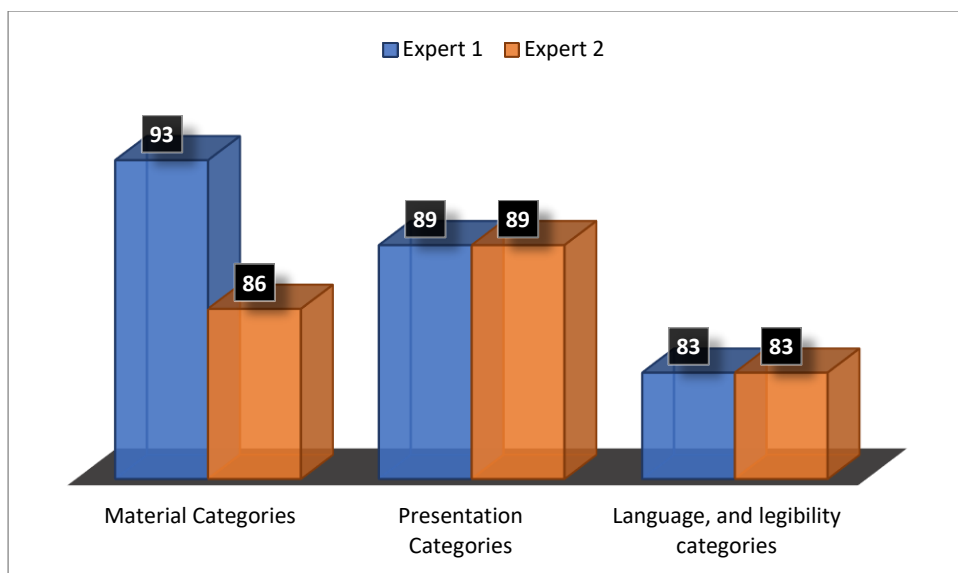
## RESULT AND DISCUSSION

The SSI-based petroleum teaching materials are integrated with the eLSMAWAR website with a link <http://elsmawar.sman1warungkiara.sch.id/Login> (see picture 2) and to enter learning about petroleum with a link <https://forms.gle/wEVzaND9LMmr5P7NA>.



**Figure 2.** The appearance of the eLSMAWAR website

After the teaching materials developed are following the components and characters, it is necessary to validate the teaching materials. The validation results by two expert lecturers obtained language and legibility aspects of 89,5%, the material aspect of 89%, and the presentation aspect of 83%. According to experts, SSI-based teaching materials developed are categorized as very suitable for the material, presentation, language, and legibility aspects to be suitable for use in learning. It can be seen in Figure 2.



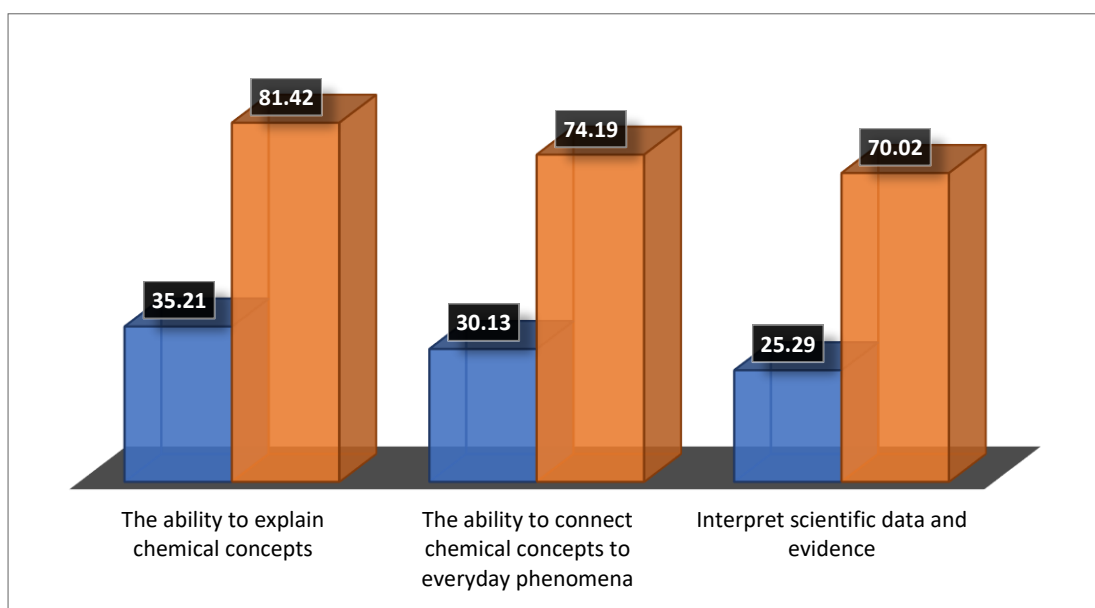
**Figure 3.** Percentage of Expert Validation

The assessment of 20 high school chemistry educators with CVR values for all categories, including presentation, material, language, and legibility categories, is 0.80. This shows that the teaching material is considered feasible/valid. The average CVI is 0.86 for material, and 0.84 for presentation, and 0.80 for language and legibility. This means that SSI-based Petroleum teaching materials developed in material, presentation, language, and legibility follow the SSI stages that are integrated into scientific literacy. The material presented is up-to-date, contextual, according to the scope and accuracy of the material, has the appropriate techniques, support, and presentation completeness. The language aspect is following the development of students, can be understood, follows the rules of the Indonesian language, and has consistency in the use of symbols and the accuracy of writing scientific names. It can be seen in [Table 1](#).

**Table 1.** Product Specifications

Category	Product Specifications
Material	Current, contextual, accurate, and following its scope
Presentation	Techniques, support, and completeness are appropriate
Language and legibility	The language is clear, light, understandable, and according to the spelling that is refined in Indonesian, both symbols and writing the scientific name

The results of the scientific literacy pretest-posttest analysis carried out on 72 high school students of class XI MIPA with three indicators can be seen in [Figure 3](#).



**Figure 4.** Scientific Literacy Pretest Posttest

Based on [Figure 4](#), it is found that before learning is carried out using SSI-based petroleum teaching materials integrated with the eLSMAWAR website, each indicator's mean score is below 40 percent. After learning using SSI-based petroleum teaching materials integrated with the website, each indicator's mean score reaches 70.02 to 81.42. Furthermore, the Kolmogorov Smirnov normality test using SPSS version 26.0 was carried out in the data analysis process so that the data were not normally distributed with the Asymp. Sig. (2-tailed) of  $0.000 < 0.05$ . In the Kolmogorov Smirnov test, if the significance of the p-value  $< \alpha = 0.05$ , the data to be tested has a significant difference with standard normal data, this means that the data is not normally distributed. If the significance of the p-value  $> \alpha = 0.05$ , it means that there is no significant difference between the data to be tested and the standard normal data. This shows that the data obtained from the pretest and posttest are normally distributed data. The data analysis process was then carried out by the Wilcoxon test and produced a value of  $0.000 < 0.05$  so that it could be concluded that there was a significant difference between the results of the pretest and posttest scores so that there was an effect of using petroleum teaching materials based on socioscientific issues integrated with the eLSMAWAR website on students' scientific literacy.

Furthermore, the research data will be studied by calculating the average value and making a percentage, and then the N-Gain is calculated to be 0.66. It can be seen in [Table 2](#). This means that the N-Gain acquisition belongs to the medium category, which refers to [Hake \(1999\)](#).

**Table 2.** Data analysis results in pretest and posttest

Implementation Data	Pretest	Posttest
Number of students	60	60
Lowest score	0	40
Highest score	75	100
Average score	30,21	75,21
% N-Gain	66	Moderate category

[Table 2](#) above proves that learning using SSI-based teaching materials integrated with the eLSMAWAR website can improve students' scientific literacy in petroleum material. The data is strengthened by the Wilcoxon test of 0.000, which means that this teaching material is very significant in increasing scientific literacy. The development in this teaching material is made using the Socioscientific Issues (SSI) based learning approach. SSI determines social dilemma problems related to science in terms of concepts, procedures, and technology. The use of SSI in science education is the main way to encourage scientific literacy ([Sibic & Topcu, 2020](#)). This approach encourages students to familiarize themselves with scientific behavior, develop the capacity of students to evaluate information, make decisions about socioscientific problems, and participate in debates and discussions about the sociotechnical controversies that are happening around students ([Genisa et al., 2020](#); [Dawson & Carson, 2018](#)). SSI is an appropriate context to support students to transfer knowledge of scientific thinking with acting skills in their lives in the modern era ([Imaduddin et al., 2018](#); [Nava & Prasetyo, 2018](#); [Yuliastini et al., 2016](#)). The distinctive feature of the teaching material is that it includes the SSI context in the form of issues in the media used as sources of information.

The research findings confirm that SSI-based petroleum teaching materials integrated with the website can educate scientific literacy and make it easier for students to acquire scientific literacy competencies ([Jufrida et al., 2019](#); [Majetic & Pellegrino, 2018](#); [Ismail et al., 2016](#)). Issues in the learning process, such as issues in the students' environment and are related to real-life to encourage students to explain scientific concepts obtained with scientific facts. [Choerunnisa et al. \(2017\)](#) state humans in this era of globalization are required to have scientific insight and scientific literacy to overcome complex life challenges. This complex problem results from advances in science and technology, and the low achievement of students' scientific literacy on content abilities indicates that students are not fully able to apply knowledge. Students must have scientific literacy to live that is relevant to the surrounding environment to create a peaceful environment ([Imansari et al., 2018](#); [Rostikawati et al., 2016](#)).

According to [Prastiwi et al. \(2017\)](#), chemical literacy skills include facts, understanding, and analysis. In this study, students describe facts using chemical theory, understand chemical theories, models, and concepts. With a broad and deep scope of application to overcome challenges in everyday life, as a user of new products and new technology, in deciding and participating in social debates on issues related to chemistry. Understand how chemistry and chemistry-based technology relate to one another. Chemistry seeks to construct an explanation of nature, whereas chemical technology seeks to replace the world itself. The models and concepts created by the two fields have a strong involvement in influencing each other. Analyzing is a strategy and benefits of chemical applications to understand the relationship between innovation in chemical processes and social life (the importance of applications such as pharmaceuticals, fertilizers, and polymers). Understanding the nature of existing chemical phenomena will translate into a better phenomenon by changing the world we see from a different perspective.

Scientific literacy is the development of life skills because scientific literacy is defined as the use of scientific concepts when a person makes decisions on issues or situations related to science, and these issues have an impact on society, especially unstructured issues (ill-structured), can be debated (debatable) and contains a moral component (Spitzer & Fraser, 2020; Pelch & McConnell 2017; Bossér et al., 2015; Zeidler & Sadler, 2011). To support the importance of ICT Literacy, the Ministry of Education and Culture, in collaboration with the Ministry of Information carry out activities frequently that can improve ICT Literacy in society, such as digital literacy activities (Pratama et al., 2019). Digital literacy is interpreted as a skill and technological knowledge for individuals in developing long-term learning activities and having a good contribution to society (Çam & Kiyici, 2017; Sarwinda et al., 2020). Furthermore, digital literacy is also interpreted as personal skills in applying functional abilities to digital systems by creating creative, critical, and collaborative information data (Setiaji et al., 2020; Zulkarnain et al., 2020).

## CONCLUSION

After researching the teaching material used, the validation results obtained an average percentage of 87% on the material, presentation, language, and legibility. For the validation of chemistry educators, the average value of CVI for language and legibility aspects is 0.80; for the material aspect 0.86; for the presentation aspect 0.84. This means that based on chemistry experts and educators, the Socioscientific Issue (SSI)-based Petroleum teaching material integrated with the eLSMAWAR website has the criteria of being feasible/valid and very suitable for use. The scientific literacy test results obtained an N-Gain of 0.66, which means that the SSI teaching material integrated with the eLSMAWAR website is effective enough to improve scientific literacy in students. The research concludes that the teaching material based on the Socioscientific Issue (SSI) integrated with the eLSMAWAR website on students' scientific literacy has three indicators of scientific literacy following the demands of the 21st-century skill implementation.

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