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Exploring students' and teachers' responses to a socio-scientific issues-based learning module

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Abstract: This paper aims to determine the readability and practicability percentages of a socio-scientific issues-based chemistry learning module as assessed by students and teachers. The research method used was Research and Development (R&D) following the 4D model by Thiagarajan. The instruments used in this research were students' response questionnaires and teachers' response questionnaires. Data were collected from a sample of grade XI students (n=30) and 5 teachers. The data were analyzed using quantitative descriptive analysis techniques. Readability was calculated as the percentage of the total scores given by students divided by the maximum score. Practicability was determined based on the percentage of the total scores given by teachers divided by the maximum score. The SSI-based chemistry learning module developed in this study showed a 'good' readability level with a percentage of 84.17% and was considered as 'very practical' to use with a practicability percentage of 86.5%.
Keywords: development, readability, practicability, module, socio-scientific issues

Introduction

In developing countries such as Indonesia, people face numerous socio-scientific issues (SSI) in their day-to-day lives, such as environmental pollution(Genisa, Subali, Djukri, Agussalim, & Habibi, 2020). SSI in society requires students to make appropriate decisions to avoid being easily swayed by fake news or science-related issues (Leung, 2022). The community typically receives SSI through various media channels, including newspapers, television, radio, and the internet (Ratcliffe & Grace, 2005). Contextual and real-world problems in every chemistry lesson, as seen in SSI-based learning, are essential for developing students' scientific literacy skills, transferable skills, and interest in science (Rahayu, 2019). Integrated learning with SSI can also improve students' decision-making skills related to environmental issues (Hsu & Lin, 2017). However, in Indonesia, there are limited opportunities in learning where socially contextualized problems are discussed in class, such as investigating and using relevant knowledge, evidence, and information to solve everyday life problems (Subiantoro, 2017). Socioscientific issues-based instruction fosters meaningful learning by promoting active participation, problem-centered, and student-centered approaches, but a lack of adequate background knowledge among teachers is seen as a barrier to its effective implementation in science classrooms (Yapıcıoğlu, 2018). Organic compounds are topics that are widely used by teachers in SSI-based chemistry learning, as are topics related to environmental problems, and Çalık & Wiyarsi (2021) suggested that teachers need training on how to integrate chemistry-focused SSI and relevance models into school chemistry.

Implementation of SSI-based learning in Indonesia is still rare and difficult for teachers. According to pre-interviews, several teachers stated that they had started including SSI in their teaching, but they still faced difficulties, and it was not yet effective. The

interviews revealed that several teachers tried to compile their own learning materials to relate them to real-world problems. However, compiling learning materials or media is not an easy task. There are several obstacles faced by teachers in developing learning media, including time limitations, difficulty in using new applications, difficulty in visualizing abstract chemistry materials, the common media used being mostly PowerPoint, and difficulty in considering the relevance to students' abilities (Maradona & Ikhsan, 2020).

In pre-observation research, five secondary schools in Bantul district were examined to determine the accessibility of teaching materials. Based on the results, it was found that learning materials such as textbooks, enrichment books, reference books and other learning materials such as newspapers, magazines and internet access are already available. However, the availability of socio-scientific issues-based learning modules as study material is not yet available. Modules are learning materials that aim to teach specific subjects and enable students to develop particular skills, unlike books (Depdiknas, 2008). Modules are learning materials that offer students the opportunity to learn at their own pace (Sofiana & Wibowo, 2019). Using the module provides several results, such as improved learning outcomes, improved representation skills, improved conceptual skills, improved activities, improved process skills and increased students' interest (Yuliani, Wiji & Mulyani, 2021).

Literature Review

The 4D model is a learning development model that consists of four phases, which are: define, design, develop, and disseminate (Thiagarajan, Semmel, & Semmel, 1974). A 4D model requires less complexity, resulting in shorter steps(Maydiantoro, 2021). 4D model is the most popular model in scientific development in Indonesia (Rahardjanto & Husamah, 2022). One of the reasons the 4D model was chosen in development research was because the steps were arranged systematically (Wardani, Degeng, & Cholid, 2019). Compared to other development models, such as Borg & Gall, which has 10 steps, the 4D model has less complex stages, no need a long time for the development process (Maydiantoro, 2021). The Develop stage in the 4D model incorporates formative evaluation through expert appraisal and development testing, allowing for revisions based on feedback before final dissemination (Hariyanto *et al.*, 2022).

Socio-scientific issues (SSI) are social issues related to science that are controversial and unethical, where there is more than one possible solution so that the solution requires moral and ethical judgment(Zeidler, Walker, Ackett, & Simmons, 2002). One of the characteristics of socio-scientific issues is that there is controversy over science which produces conflict in society (Levinson, 2006). In solving socio-scientific issues, you must consider the social and scientific aspects of the problem so that it can be solved objectively (Cian, 2020).

Modules are educational materials that feature learning objectives, instructional materials, and exams designed to assist students in achieving their intended learning goals. During module development, the features that should be taken into account are self-instructional, self-contained, stand-alone, adaptive, and user friendly (Rahdiyanta, 2016). To encourage students to learn, a learning module must incorporate graphic elements such as module size/shape, cover image, content design, paper quality, printing quality and binding quality (Ramadhani & Mahardika, 2015). Socioscientific issue-based learning promotes active participation, problem-solving, and a student-focused approach, but insufficient teacher knowledge is seen as a barrier to its implementation in science classrooms (Yapıcıoğlu, 2018). This is one of the challenges in developing the SSI-based learning module, as the module must be designed to help both teachers and students in achieving learning objectives and overcoming potential obstacles.

In order to develop a socio-scientific issues-based learning module that suitable in the context of SSI in Indonesia, it is necessary to explore students' and teachers' responses to the developed learning module. Therefore, this research aims to determine the readability and practicability percentage of socio-scientific issues-based chemistry learning module through students' and teachers' responses

Methodology

Research Design

The method used in this research was Research and Development (R&D) using the 4D model by Thiagarajan (1974). The instruments used in this research were students' response questionnaires and teachers' response questionnaires. Students' responses questionnaires were used to determine the readability of the learning module, while teachers' responses questionnaires were used to determine the practicality of the learning module.

Instrument Development

The questionnaire was a Likert scale 1 to 4. The readability aspect was synthesized, resulting in an instrument outline as presented in Table 1.

Table 1 Instrument outline of students' responses questionnaires

Aspect	Indicator	No. Item
1. Material (Faridah et al., 2022; Friantini *et al.*, 2020; Sari *et al.*, 2022)	Ease of understanding the material.	1
2. Design (Sari *et al.*, 2022)	a. Appealing module cover design.	2
	b. The design of the module contents is attractive.	3
3. Presentation (Faridah *et al.*, 2022; Sari *et al.*, 2022)	a. The letters used are easy to read.	4
	b. The illustrations presented are clear and attractive.	5
	c. Appealing writing layout	6
	d. Good paper quality.	7
	e. The quality of the printing and binding is good.	8
4. Language (Friantini *et al.*, 2020; Sari *et al.*, 2022)	a. The language used is easy to understand.	9
	b. The terms used are easy to understand	10
	Total	**10**

The practicality aspect was synthesized, resulting in an instrument outline as shown in Table 2.

Table 2 Instrument outline of teacher' responses questionnaires

Aspek	Indikator	No. Item
1. Material (Ailillah *et al.*, 2021; Irawan & Hakim, 2021)	Compatibility of the material presented with basic competencies.	1
2. Format (Irawan & Hakim, 2021)	The module size is appropriate, not too small or too big.	2
3. Appearance (Khalil *et al.*, 2020)	a. Appealing module cover design.	3
	b. The design of the module content is attractive.	4

		c. The letters used are easy to read.	5
4.	Language (Ailillah *et al.*, 2021; Irawan & Hakim, 2021)	a. The language used is easy to understand.	6
		b. The terms used are easy to understand.	7
5.	Advantage (Khalil *et al.*, 2020)	The module helps improve students' understanding of the material, through socio-scientific issues that exist in society.	8
6.	Quality (Ailillah *et al.*, 2021)	a. The type of paper used is of good quality.	9
		b. The quality of the printing and binding is good.	10
		Total	**10**

Before being used, the research instruments underwent content validity testing through expert judgment. This process involved two university lecturers serving as experts. The content validity coefficient can be determined using Aiken's V formula (Azwar (2021). The formula is as follows:

$$V = \frac{\Sigma s}{[n(c-1)]}$$

Where:
$s = r - l_0$
l_0 = the lowest score in the rating scale
c = the highest score in the rating scale
r = the score given by an expert for an item
n = the number of experts providing ratings.

The validity categories for Aiken's V can be interpreted as shown in Table 3 below (Nabil, Wulandari, Yamtinah, Ariani, & Ulfa, 2022).

Table 3 Validity categories for Aiken's V

Index	Category
≤ 0,4	Low Validity
0,4 – 0,8	Moderate Validity
> 0,8	High Validity

Sampling

The respondents were selected using random sampling. A total of 30 grade XI students and 5 chemistry teachers were involved in the data collection.

Data Collection

The questionnaire was distributed printed forms to the students for students' responses questionnaires and to the teachers for teacher' responses questionnaires.

Data Analysis

The collected data were analyzed using descriptive statistics. The students' response questionnaire was using Likert scale 1 to 4 so for a total of 10 items, the maximum score on the students' response questionnaire was 40. The readability of the learning module can be categorized according to Table 4.

Table 4 Product readability categories based on students' responses

No.	Score range	Category
1.	$\overline{M} > 34$	Very Good
2.	$28 < \overline{M} \leq 34$	Good
3.	$22 < \overline{M} \leq 28$	Acceptable
4.	$16 < \overline{M} \leq 22$	Poor
5.	$\overline{M} \leq 16$	Very Poor

The maximum score on the teachers' response questionnaire was 40 so that the practicability of the learning module can be categorized according to Table 5.

Table 5 Product readability categories based on teachers' responses

No.	Score range	Category
1.	$\overline{M} > 34$	Very Practical
2.	$28 < \overline{M} \leq 34$	Practical
3.	$22 < \overline{M} \leq 28$	Quite Practical
4.	$16 < \overline{M} \leq 22$	Less Practical
5.	$\overline{M} \leq 16$	Not Practical

The readability and practicability percentage of the learning module were calculated using the following formula:

$$\text{Percentage (\%)} = \frac{\text{Total Score Obtained}}{\text{Maximum Score}}$$

Results

In this study, a research and development (R&D) method was used to develop a "chemistry learning module based on socio-scientific issues (SSI) for colloid topic". This method employed the 4D model by Thiagarajan, which consists of four stages: define, design, develop, and disseminate. In the Define stage, an initial analysis was conducted to identify the problems encountered in learning. This involved observing schools and interviewing teachers. In the Design stage, the selection of learning media, media format, and initial design were carried out. In the Develop stage, expert judgement and development trials were conducted. Finally, in the Disseminate stage, the module, which had been revised based on expert feedback and trial results, was printed and distributed.

In this research, a development trial was conducted by testing the SSI-based chemistry learning module on students with the aim of determining the readability percentage and practicability percentage of the learning module. Before being used, the instruments were assessed for validity of the instrument. Content validity was evaluated through expert judgement by two lecturers. The content validity coefficient was calculated using the Aiken's V formula. The validation results of students' responses instrument were then calculated to find the Aiken's V value, yielding data as shown in Table 6 while the validation results of teachers' responses instrument shown in Table 7.

Table 6 The content validity of students' responses instrument

No. Item	Validator' score		V	Validity	No. Item	Validator' score		V	Validity
	1	2				1	2		
1	4	4	1	High Validity	6	4	4	1	High Validity
2	4	4	1	High Validity	7	4	4	1	High Validity
3	4	4	1	High Validity	8	4	4	1	High Validity
4	4	4	1	High Validity	9	4	4	1	High Validity
5	4	4	1	High Validity	10	4	4	1	High Validity

Table 7 The Content Validity of Teachers' Responses Instrument

No. Item	Validator' score		V	Validity	No. Item	Validator' score		V	Validity
	1	2				1	2		
1	4	4	1	High Validity	6	4	4	1	High Validity
2	4	4	1	High Validity	7	4	4	1	High Validity
3	4	4	1	High Validity	8	4	4	1	High Validity
4	4	4	1	High Validity	9	4	4	1	High Validity
5	4	4	1	High Validity	10	4	4	1	High Validity

Product trials were carried out on 30 students to asses readability and 5 teachers to asses practicability. Student response data was analyzed to obtain the percentage of student readability of a socio-scientific issues-based chemistry learning module. The aspect and indicator used in students' response questionnaires was shown in Tabel 8 while the aspect and indicator used in teachers' response questionnaires shown in Tabel 9.

Table 8 The aspects and indicators of learning module readability

Aspect	Indicator
Material	1. Ease of understanding the material.
Design	2. Appealing module cover design.
	3. The design of the module contents is attractive.
Presentation	4. The letters used are easy to read.
	5. The illustrations presented are clear and attractive.
	6. Appealing writing layout
	7. Good paper quality.
	8. The quality of the printing and binding is good.
Language	9. The language used is easy to understand.
	10. The terms used are easy to understand

Table 9 The aspects and indicators of learning module practicability

Aspect	Indicators
Material	1. Compatibility of the material presented with basic competencies.
Format	2. The module size is appropriate, not too small or too big.
Appearance	3. Appealing module cover design.
	4. The design of the module content is attractive.
	5. The letters used are easy to read.
Language	6. The language used is easy to understand.
	7. The terms used are easy to understand.
Advantage	8. The module helps improve students' understanding of the material, through socio-scientific issues that exist in society.
Quality	9. The type of paper used is of good quality.
	10. The quality of the printing and binding is good.

The students' responses data is presented in Table 8. From the students' responses data, the average score was 33.67 with a maximum score of 40 so learning module consider has a "good" readability. The readability percentage of the SSI-based chemistry learning module developed was 84.17%. The highest readability aspect was the presentation, with 87.33%, while the lowest aspect was the material of the module, with 78.33%

The teachers' responses data was presented in Table 9. From the teachers' responses data, an average score was obtained, namely 34.60 with a maximum score of 40 so that the learning module was categorized as "very practical". The percent practicality of the SSI-based chemistry learning module developed was 86.50%. The aspect with the highest percentage was the advantage of the module, with 95%, while the lowest was the format, with 75.00%.

Table 10 The result of students' response

Aspect	Score obtained	Maximum score	Percentage
Material	3,13	4	78,33%
Design	6,67	8	83,33%
Presentation	17,47	20	87,33%
Language	6,40	8	80,00%
Total Score	33,67	40	84,17%

Table 11 The result of teacher' response

Aspect	Score obtained	Maximum score	Percentage
Material	3,4	4	85,00%
Format	3	4	75,00%
Appearance	10,6	12	88,33%
Language	6,6	8	82,50%
Advantage	3,8	4	95,00%
Quality	7,2	8	90,00%
Total Score	34,6	40	86,50%

Teachers also provide suggestions for improving the chemistry learning module. Suggestions given by teachers are shown in Table 10.

Table 12 The result of teacher' response

No.	Suggestions
1.	In socio-scientific issue activities, it is necessary to convey the methods used.
2.	Learning materials need to be further complemented on topics of daily life application.

Discussion

Before developing the socio-scientific issue (SSI)-based chemistry learning module, an initial analysis was conducted. The initial analysis aimed to identify problems encountered in the learning process. At this stage, school observations and teacher interviews were conducted. From the teacher interviews, one teacher stated that in chemistry lessons, various teaching models had been used; however, for the topic of colloids, assignments were typically limited to creating presentation slides.

> *"The teaching models used are varied, but for colloid material, assignments are usually given to students to create presentations."*

Regarding the use of the SSI approach in chemistry learning, its application has not been optimal. Some teachers stated that implementing SSI-based learning is hindered by the lack of learning resources, which they have to compile themselves.

> *"However, SSI learning resources still need to be compiled independently from the internet and then adjusted to the students' environment."*
>
> *"The learning resources are still self-compiled."*
>
> *"The resources are created independently."*
>
> *"It has been tried but has not been fully optimized."*

Observations at the school also revealed that there are already sufficient learning resources, such as textbooks, enrichment books, reference books, and other learning materials like newspapers, magazines, and internet access. However, SSI-based learning modules as teaching materials are still unavailable. From this initial analysis, it was concluded that there is a need to develop an SSI-based chemistry learning module for the topic of colloids.

The objectives of this study are to determine the readability and practicability percentage of socio-scientific issues-based chemistry learning module through students' and teachers' responses. The instruments used in this research were students' response questionnaires and teachers' response questionnaires. There are 4 aspects used in the students' response instrument, namely material, language, design, and presentation (Faridah, Rahayu, & Dewi, 2022; Friantini, Winata, & Permata, 2020; Sari, Fajarianingtyas, & Anekawati, 2022). On the other hand, the 6 aspects used in the teacher' response instrument are material, format, appearance, language, advantage and quality (Ailillah, Junaidi, Hakim, & Hadisaputra, 2021; Irawan & Hakim, 2021; Khalil, Amin, & Lukiati, 2020)

The content used SSI-based chemistry learning module was Colloids. Colloids contains concepts of applied chemistry, making SSI-based learning helpful for students in developing both knowledge and competence (Nurmilawati, Agung, & Murniati, 2021). In the developed learning module, socio-scientific issues activities are integrated, featuring an article from national news that highlights problems relevant to the students' surroundings. Below the article, questions are provided about colloid topics connected to the news article.

In one of the socio-scientific issues activities, an article about the eruption of Mount Merapi is presented. Mount Merapi is an active stratovolcano located on the border between the province of Central Java and the Special Region of Yogyakarta, Indonesia. During the eruption of Mount Merapi, it emits hot clouds commonly referred to as "Wedhus Gembel," which literally means a goat with thick hair. Generally, the composition of "Wedhus Gembel," scientifically known as pyroclastic density flow, consists of solid substances (volcanic ash) and gases (CO_2, sulfur, chlorine, water vapor, and others) mixed with air. "Wedhus Gembel" is an example of a colloid found near the students' environment. By presenting issues familiar to the students, it is expected that they will better understand chemistry concepts.

SSI-based modules are modules produced using the SSI method by integrating them with topics or news (Pursitasari, Alfitriyani, & Kurniasih, 2022). Through SSI integrated learning, students can gain rational, intuitive, and emotional insight by considering scientific topics (Powell, 2020). Through SSI, students can gain valuable insights and remember the various contexts of what you are learning (Wong, Wan, & Cheng, 2011). Information selection in the process of decision making can be facilitated by the SSI context (Bader, Ahearn, Allen, Anand, Coppens, & Aikens, 2023). SSI discussion can make students' decision-making ability and position on environmental issues more supportive of environmental protection and sustainability (Wang, Hong, Liu, & Lin, 2018).

Modules are developed through development testing, which involves collecting responses from students and teachers. The ease of use and practicality of the product, as well as the attractiveness of the product, can be seen from the responses of students and teachers (Khasanah & Saputri, 2022). The readability percentage of the resulting module was 84.17% and the module was classified as "good". The practicality percentage of the resulting module was 86.50% and the module was classified as "very practical". Nevertheless, there are some suggestions from the teachers for the development of this learning module that have not been implemented. Regarding the suggestion, *"In socio-scientific issue activities, it is necessary to convey the methods used,"* we did not implement it due to the adaptive characteristic of the module. It was feared that specifying a particular method would limit teachers to using only that approach, so we chose not to incorporate this suggestion into the module's improvement. Similarly, the suggestion *"learning materials need to be further complemented with topics on daily life applications"* has not been implemented due to limitations from the researcher. However, it is reassuring to know that the module has already been validated by experts. In the Develop stage, expert judgment was conducted on this learning module, and the validation results from the material and media experts rated it as "very good" (Utami & Prodjosantoso, 2024). For further development suggestions, such as the need for the development of an SSI-based learning module for other chemistry topics as well as other subjects, and the need for a module that includes socio-scientific issues relevant to different regions.

Implementation

The learning module based on socio-scientific issues has shown positive results as indicated by student and teacher responses, namely the module has "good" readability and was categorized as "very practical". The chemistry learning module based on socio-scientific issues that has been developed can be used in schools and other educational institutions, especially high schools in the Bantul district, Yogyakarta, Indonesia while still paying attention to the characteristics of the students.

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