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Developing a Local Socio Scientific Issues-Based Biology Module Using the RQA Approach for Environmental Change

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ABSTRACT

Purpose: This study was conducted to design a Biology module grounded in local Socio Scientific Issues (SSI) and integrated with (RQA) approach for environmental change topics. It also aimed to evaluate the module's validity, practicality, and effectiveness in facilitating Biology learning at the senior high school level. **Methods**: This research employed a Research and Development (R&D) design adapted from the Borg and Gall development model. The study was conducted at UPT SMA Negeri 2 Sinjai with 59 tenth-grade students and two Biology teachers. Data collection was carried out using expert validation instruments, practicality questionnaires completed by teachers and students, and learning achievement tests administered through pretest and posttest. The collected data were then analyzed using Gregory's content validity coefficient to determine validity, percentage analysis to assess practicality, and N-Gain analysis to measure the increase in students' learning outcomes. **Findings**: The developed module achieved a Content Validity coefficient of 1.00, which reflects a very high level of validity. This result was supported by the strong ratings given by both validators across all 35 assessed indicators. In terms of practicality, the module received an average score of 94% from teachers and 89% from students, placing both results in the highly practical category. Furthermore, the effectiveness evaluation produced an average N-Gain score of 0.77, which falls within the high category, with 73% of students demonstrating a high level of learning improvement. **Research Implications**: The module can be used as an alternative contextual teaching material that supports active learning and improves students' understanding of environmental change. **Originality**: This study offers a locally contextualized Biology module that uniquely integrates SSI with the RQA approach to connect biological concepts with real environmental issues.

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INTRODUCTION

Learning is a process through which knowledge is delivered, shared, and exchanged between teachers and students. Meanwhile, learning materials, objectives, and instructional media serve as essential components of the learning system in education (Kurniati, 2021). Learning can also be understood as a deliberate effort made by educators to guide students so that they are able to learn in accordance with their needs and interests (Daniyati et al., 2023). Within Biology education, learning activities should not be limited to the acquisition of theoretical knowledge, but should also relate the concepts being studied to real phenomena found in the surrounding environment. One problem that frequently occurs in learning, including Biology learning, is that the learning process tends to focus heavily on theoretical understanding. As a result, students' knowledge is often not well connected to real life situations (Indah & Fadilah, 2024). Students also often experience difficulties in understanding, remembering, and applying previously learned material in new learning contexts (Kaminske et al., 2020).

Conceptual understanding is highly important because Biology contains various fundamental concepts about life that require students to actively collect, process, and organize information based on their understanding of the concepts being studied (N. Azizah & Alberida, 2021). Nevertheless, several Biology concepts are characterized by abstract and complex content, which often makes them challenging for students to comprehend. Therefore, instructional materials that are well planned, systematically organized, and able to help students construct meaningful understanding are needed. One learning tool that can support this process is a module. A learning module is a learning design developed

based on the curriculum to achieve predetermined competency standards (Nurhayati et al., 2025). Without proper module planning, the delivery of learning materials to students may become less structured, and learning interaction may become less balanced (Maulida, 2022). A well designed module should incorporate varied, innovative, and accessible elements, enabling students to understand the material more effectively while supporting the overall success of the learning process (Arifin et al., 2024). One instructional material innovation that is relevant to the needs of Biology learning modules is a module based on Socio Scientific Issues (SSI). The SSI approach is important in education because it is able to bring real life contexts into the learning process (Putri & Miterianifa, 2023). Many social and environmental phenomena are closely related to biological concepts; therefore, the use of socio scientific issues can help students connect learning materials with problems that occur in their surrounding environment (Azizah et al., 2022). The use of SSI based instructional materials can also support independent learning, as students may become more interested in studying Biology outside school hours when the material is linked to real issues around them (Septiningrum et al., 2021). SSI topics are often reported through various media, including traditional media and social media platforms. Therefore, SSI based learning should provide opportunities for students to develop relevant learning skills (Lesnefsky et al., 2023).

Nevertheless, learning that focuses only on SSI is not yet fully sufficient to optimally develop students' 21st century thinking skills (Laksono & Wibowo, 2022). Based on this rationale, the Reading, Questioning, and Answering (RQA) strategy may be integrated into instruction to foster students' ability to read critically, generate questions, and identify meaningful answers. The RQA framework comprises three sequential activities: reading, questioning, and answering. During the reading stage, students access, examine, and gather information relevant to the learning content under discussion (Leasa et al., 2023). The implementation of the RQA strategy can increase students' active engagement in the learning process by involving them in constructing responses and developing questions independently. Previous studies have reported that learning modules incorporating SSI and RQA principles may contribute to improving the quality of Biology learning. Sitanggang et al (2024), found that a socio scientific issue based e-module was feasible for use in Biology learning and effective in increasing students' learning interest. Hardin et al. (2025), another study also found that an SSI based e-module produced a positive impact on student learning outcomes. This was reflected in the average N-Gain score of the experimental class, which reached 0.33 and exceeded the control class score of 0.22. In a related study Ummah et al (2021), developed an RQA-based Biology module on virus material and reported a material expert validation score of 92.18%, placing it in the highly feasible category. The module also received a student response score of 93%, which was classified as very good.

Nurvia & Mellisa (2023), previous research has further shown that an RQA-based module was considered feasible, achieving an average score of 87.03%. The module was also reported to support students in reading, comprehending the material, identifying essential information, and developing creative thinking, teamwork, and collaboration skills.. Previous research has mostly examined the development of SSI based modules and RQA based modules separately. However, the development of a learning module that combines local Socio-Scientific Issues (SSI) with the Reading, Questioning, and Answering (RQA) approach on environmental change topics remains an area that needs further exploration. This gap is important because Biology learning does not only require instructional materials that are generally feasible, but also materials that are contextual, raise local environmental issues, and provide a sequence of learning activities that encourage students to read, ask questions, answer, and connect biological concepts with real phenomena in their surroundings. The urgency of developing this module is further supported by the results of the needs analysis conducted at SMAN 2 Sinjai. Students showed an interest in learning Biology topics related to environmental issues in their surroundings, as learning was considered more meaningful when connected to real experiences and problems closely related to everyday life.

However, the instructional materials used so far are still dominated by lengthy texts, printed books, PowerPoint presentations, and student worksheets prepared by teachers. Consequently, the learning process often becomes teacher-centered and provides limited opportunities for students to participate actively. Interviews with Biology teachers further revealed that tenth-grade students' conceptual understanding was still relatively low, mainly due to limited active participation, interest, and learning motivation during the learning process. Teachers also emphasized the need for learning modules with more attractive and creative designs to encourage students to read, develop curiosity, and become more interested in understanding the material. Based on these problems, this study aims to develop a Biology module based on local Socio Scientific Issues integrated with the Reading, Questioning, and Answering approach on the topic of environmental change for senior high school students. Specifically, this study seeks to evaluate the module's validity, determine its practicality, and examine its effectiveness in enhancing students' learning comprehension.

METHOD

A. Research Design

This study employed a Research and Development (R&D) design referring to the Borg and Gall development model. The research was conducted at UPT SMA Negeri 2 Sinjai in the 2025/2026 academic year over a period of four weeks. The research subjects consisted of 59 tenth-grade students and two Biology teachers. The Borg and Gall development stages were simplified into eight main stages (Jamaludin & Henderi, 2024) , namely: (1) identification of potential and problems accompanied by a needs analysis, (2) data collection through analysis of materials and student characteristics, (3) product design, (4) product validation by experts, (5) design revision based on validator feedback, (6) product testing, (7) product revision based on test results, and (8) field testing. During the implementation stage, a practicality test was conducted by teachers and students to assess the ease of use of the developed product. The field trial was conducted to examine teachers' and students' responses regarding the practicality of the module, as well as to evaluate the effectiveness of the developed module after its implementation in the learning process.The research procedure in Figure 1 below.

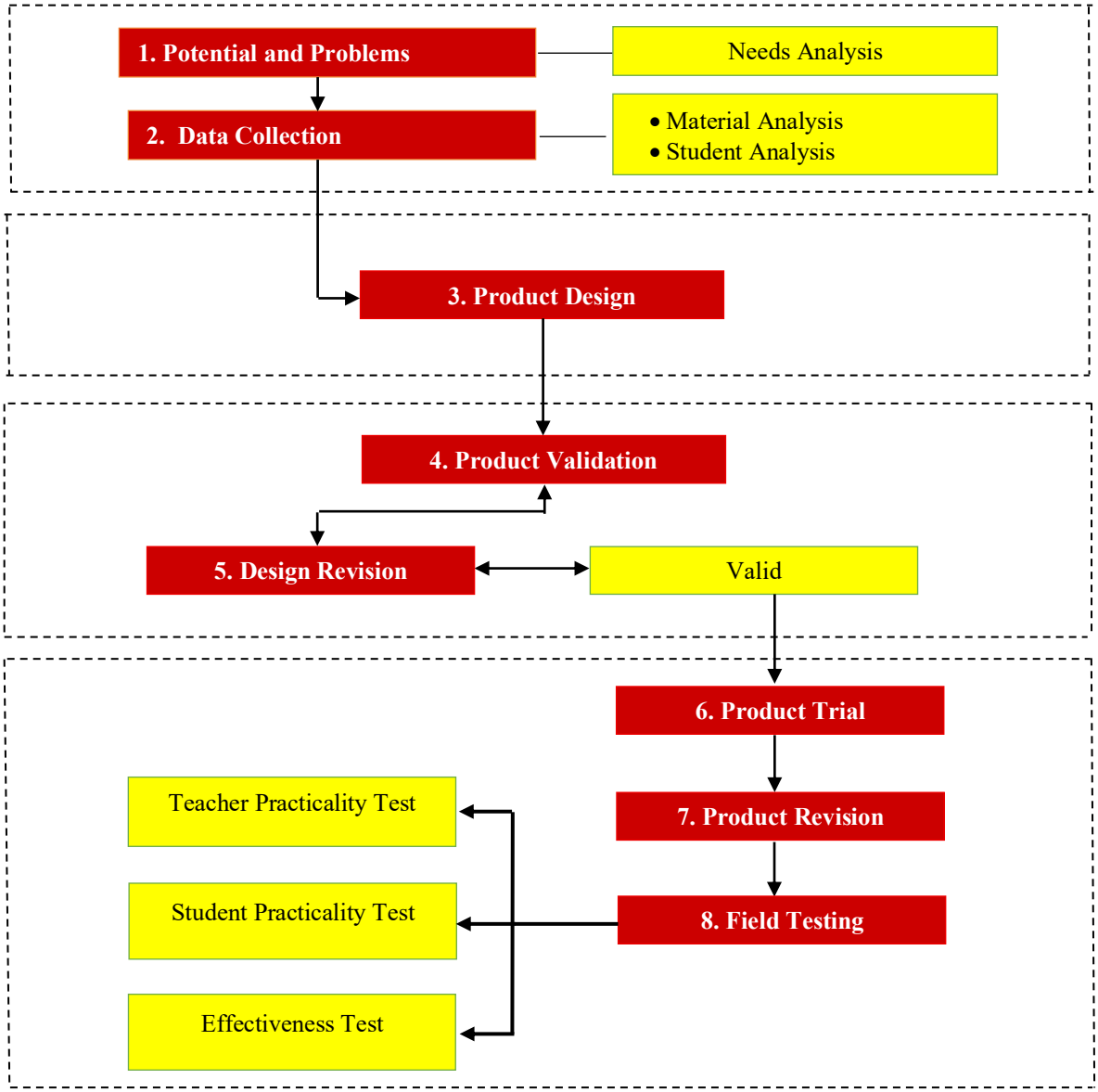


Figure 1. Research Procedure for Developing the Biology Module.

B. Research Instruments

Research instruments refer to the tools used to obtain data that align with the objectives of a study. In this research, the instruments included a module validation sheet, teacher and student response questionnaires, as well as pretest and posttest items. The validation sheet was employed by experts to assess the feasibility of the module based on content, presentation, language, and graphical aspects. Meanwhile, the response questionnaires were used to evaluate the practicality of the module during its implementation in the learning process. The pretest and posttest items were administered to measure students' conceptual understanding before and after using the module, thereby providing evidence of the effectiveness of the developed learning material.

C. Data Collection Techniques

Data collection in this study was conducted to obtain valid and relevant information through several techniques, namely interviews, expert validation, practicality assessment, and learning achievement tests. Interviews were carried out directly with Biology teachers at UPT SMAN 2 Sinjai to gather preliminary information regarding the instructional materials used, the learning process, and students' level of understanding. Expert validation was conducted by lecturers from State University of Makassar using a module validation sheet to determine the validity level of the developed module. The practicality assessment was administered through teacher and student response questionnaires after the module had been used in the learning process. Learning achievement was assessed using pretest and posttest instruments to measure the increase in students' understanding after the module was implemented. Each correct response was assigned a score of 1, while each incorrect response was given a score of 0.

D. Data Analysis Techniques

The data analysis techniques applied in this study are described as follows.

1. Validity Data Analysis

The validation data from Validator I and Validator II were analyzed using quantitative descriptive methods by calculating the content validity coefficient or Gregory index using the Gregory formula. The determination of the Gregory index began with the identification of strong or weak levels of relevance based on the assessment results of the two validators using the following contingency table in Table 1 below.

Table 1. Reference Contingency Table for Calculating the Gregory Index

2x2 Matrix		Validator I	
		Low (1–2)	Strong (3–4)
Validator II	Low (1–2)	A	B
	Strong (3–4)	C	D

Source : (Mirnawati et al., 2022)

The contingency table shows four categories of agreement: Category A (Low-Low) when both validators assign a score of 1–2 to the same item; Category B (Strong-Low) when the first validator assigns a score of 3–4 and the second validator assigns a score of 1–2; category C (Low–Strong) if the first validator assigns a score of 1–2 and the second validator assigns a score of 3–4, and category D (Strong–Strong) if both validators assign a score of 3–4 to the same item. The next step is to calculate the content validity coefficient based on the contingency matrix using the Gregory formula. The formula is shown below.

$$\mathbf{CV} = \frac{\boldsymbol{D}}{\boldsymbol{A+B+C+D}}$$

The validity coefficient was then interpreted into five categories, presented as an inter-validator agreement index in Table 2 below.

Table 2. Inter-Validator Agreement Index

Index	Validity Level
0.91 – 1.00	Very High
0.71 – 0.90	High
0.41 – 0.70	Moderate
0.21 – 0.40	Low
0.00 – 0.20	Very Low

The instrument is considered appropriate for use when the validity coefficient falls within the strong category, indicated by a content validity value greater than 0.71. This value indicates that the experts' assessments have met the established

validity criteria. If the product is still classified as having low validity, revisions should be made based on the validators' suggestions and comments until it meets the feasibility requirements to proceed to the practicality and effectiveness testing stages.

2. Reliability Data Analysis

The instrument reliability test was carried out to determine the consistency of the research instruments, ensuring that they were capable of producing stable and dependable results throughout the data collection process. The analysis was performed by calculating the index of agreement for each item using the following formula.

$$\textbf{Agreement Index} = 1 - \left(\frac{A - B}{A + B}\right)$$

The variables used in the reliability data tabulation are described as follows:

A : The score given by Validator 1 (V1).
B : The score given by Validator 2 (V2).
A - B : The absolute difference between the scores assigned by the validators.
A + B : The total score obtained from both validators.

Furthermore, the interpretation of the overall reliability index or coefficient refers to the criteria according to Table 3 below.

Table 3. Reliability Interpretation

Correlation Coefficient	Criteria
0.90 < r < 1.00	Very High
0.70 < r < 0.90	High
0.40 < r < 0.70	Moderate
0.20 < r < 0.40	Low
r < 0.20	Very Low

Source : (Rachmawati & Pradana, 2025)

3. Practicality Response Data Analysis

The practicality of the module was analyzed using questionnaire response data measured with a Likert scale. The questionnaire consisted of several statements completed by students and subject teachers by selecting one of the available response categories, The questionnaire employed a five-point Likert scale, comprising Strongly Agree (SA = 5), Agree (A = 4), Neutral (N = 3), Disagree (D = 2), and Strongly Disagree (SD = 1). The formula used to test the practicality of the module is as follows:

$$\boldsymbol{P} = \frac{\sum \mathrm{F}}{(N \; x \; I \; x \; R)} \text{ x } 100\ \%$$

Notes:

P = Percentage
∑ F = Total score of all respondents
N = Number of respondents
I = Maximum score
R = Number of indicators

Based on these percentage results, the data can be categorized according to Table 4 below.

Tabel 4. Practicality Criteria

Interval	Category
80.01% - 100 %	Highly Practical
60.01 % - 80.00 %	Practical
40.01 % - 60.00 %	Less Practical
20.01 % - 40.00 %	Impractical
00.00 % - 20.00 %	Highly Impractical

Source : (Meliana et al., 2022).

4. Effectiveness Data Analysis

Module effectiveness was measured through classroom learning tests by comparing students' pretest and posttest scores. The pretest was administered before the module was used, whereas the posttest was conducted after the learning process using the developed module. The learning outcome data were analyzed quantitatively using descriptive statistical calculations, referring to the scoring criteria presented in Table 5 below.

Tabel 5. Practicality Criteria

Item Number	Score per Item
1-25	4
Maximum Total Score	25 X 4 = 100

Source : (Amin et al., 2021)

The learning outcome data were analyzed by calculating the difference between the pretest and posttest scores using the following gain test formula below.

$$G = \text{Posttest Score} - \text{Pretest Score}$$

The normalized gain (N-Gain) was then computed to identify the degree of improvement in students' cognitive learning outcomes following the use of the module. This analysis was employed to determine the extent of students' learning progress, based on the following formula:

$$\textbf{N – gain (g)} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Ideal Score} - \text{Pretest Score}} \text{ x } 100$$

After the N-Gain value was obtained, the learning outcomes were then categorized based on the criteria presented in Table 6.

Tabel 6. Categories of N-Gain Level

Interval	Category
N-gain ≥ 0.7	High
0.3 ≤ N-gain< 0.7	Moderate
N-gain< 0.3	Low

Source : (Amin et al., 2021)

Students' learning outcome data were analyzed by comparing their pretest and posttest scores. The gain score was first calculated to identify the difference between students' achievement before and after using the module. Furthermore, the normalized gain (N-Gain) was computed to determine the level of improvement in students' cognitive learning outcomes, using the following formula:

Tabel 7. Interpretation Categories of N-Gain Effectiveness

Percentage (%)	Interpretation
< 40	Ineffective
40 - 55	Less Effective
56 - 75	Moderately Effective
> 76	Effective

Source : (Rahmi et al., 2021)

According to the classification criteria, an N-Gain percentage below 40% is interpreted as ineffective, 40–55% as less effective, 56–75% as moderately effective, and above 76% as effective. These criteria were used to determine the effectiveness of the SSI-based Biology module integrated with the RQA approach on environmental change material in enhancing students' learning outcomes.

RESULTS

This research and development (R&D) project resulted in a Biology module based on local Socio Scientific Issues (SSI) that is integrated with the Reading, Questioning, and Answering (RQA) model. The development process was carried out through eight research stages.

A. Potential and Problems

The initial stage of this development research was carried out by analyzing the potential and problems through a needs assessment involving students. This activity was intended to identify the challenges encountered by students during Biology learning in the classroom. The needs analysis was carried out at the preliminary observation stage by administering questionnaires to 29 tenth-grade students at the senior high school level. The results of the student needs analysis are presented in Table 3.1 below.

Tabel 8. Results of Students' Needs Analysis

Nu	Statement	Percentage (%)
1	Students are interested in Biology topics related to the environment.	84%
2	Students need a module to support their understanding of the learning material.	80%
3	Students have difficulty understanding the material without real-life examples.	79%
4	Students find it easier to understand material that is connected to local issues.	78%
5	Students need instructional materials that are varied and contextual.	90%
6	Connecting the material with environmental problems in the surrounding area can increase students' learning motivation.	84%
7	Students need engaging reading materials to improve their reading interest and deepen their understanding of the material.	80%
8	Students need guiding questions to stimulate critical thinking.	76%
9	The reading, questioning, and answering approach helps students understand the material gradually.	78%
10	Students need opportunities to practice solving environmental problems that are relevant to everyday life.	80%
11	Discussions on environmental issues can help develop students' communication skills.	84%
12	Students need clear learning steps.	84%
13	Students need explanations that are easy to understand.	85%
14	Students need visualizations of environmental data.	79%
15	Students need clear summaries of the learning material..	83%
16	Students need instructional materials that are relevant to everyday life.	84%
17	Students need learning media that are engaging, challenging, and able to increase their learning enthusiasm.	88%
18	Students need a module that supports independent learning through reading, formulating questions, and answering questions.	72%
19	Students need feedback during the learning process.	78%
20	Students need encouragement to seek additional information.	79%
	Average	**81%**

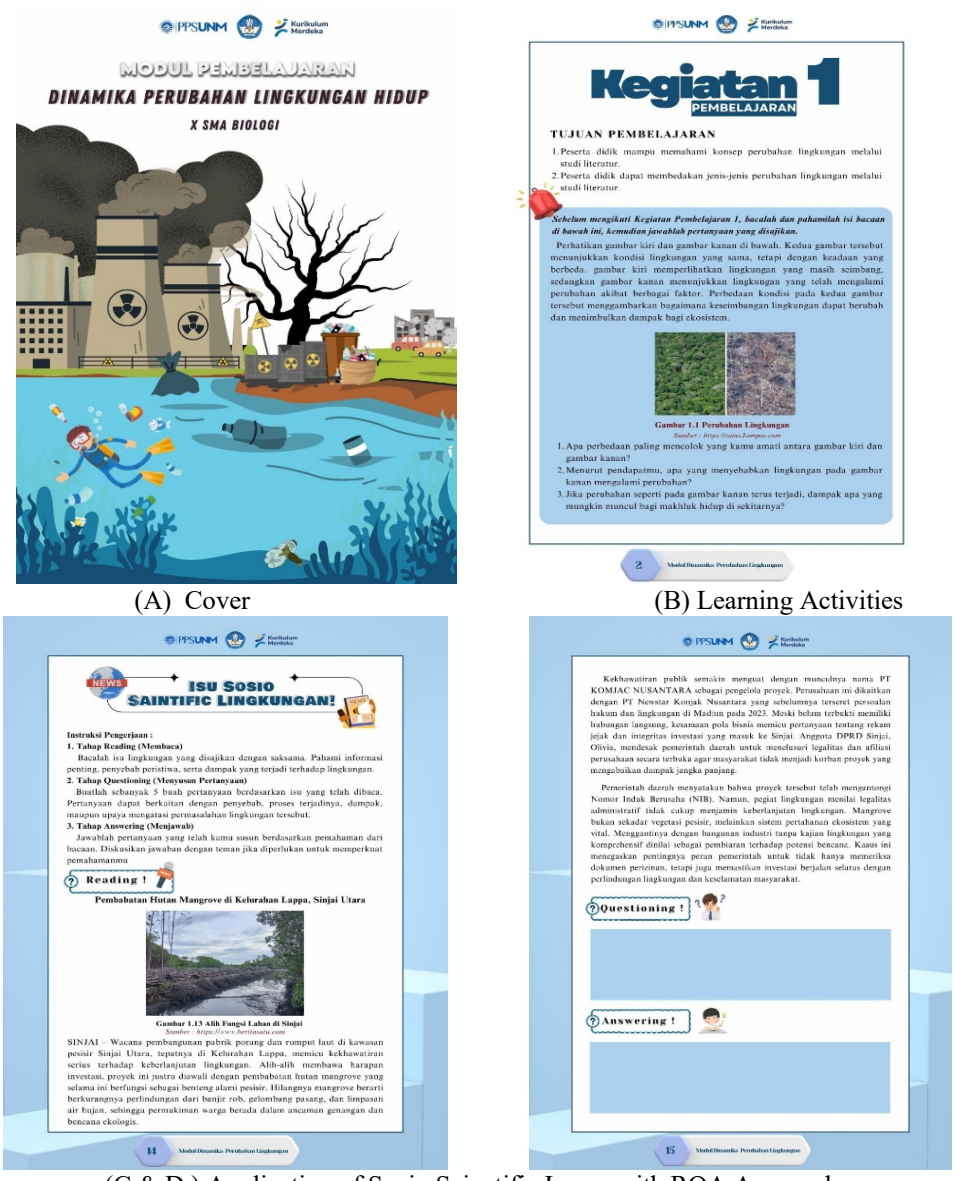
The needs analysis results showed that many students continued to face difficulties in relating abstract Biology concepts to real phenomena found in their immediate environment. This condition becomes a significant concern because it indicates a mismatch between the competencies targeted in the curriculum and students' current level of scientific literacy. However, the students demonstrated considerable interest in environmental issues within their local context. Therefore, the development of a Biology learning module based on local environmental issues is needed to support students in understanding the connection between biological concepts and real-life situations, while also promoting reading, questioning, and answering activities throughout the learning process.

B. Data Collection

Data were obtained through interviews with Biology teachers. The interview results provided information on the number of students involved as research participants, consisting of 59 students from two separate classes.The teachers reported several learning difficulties, including students' tendency to read the material only briefly and forget it quickly. As a result, when asked to explain the concepts again, students often had difficulty recalling the material. In addition, students also experienced difficulties in analyzing problems, indicating the need for a module that could help improve these aspects. The information obtained also included students' need for more contextual instructional materials that could connect Biology concepts with real problems in their surrounding environment. The interview data were then collected and used as the basis for designing a learning module that was aligned with students' needs and the learning conditions at school.

C. Product Design

The design phase began by gathering various references, including books, journals, and information sources related to socio scientific issues relevant to environmental change. Next, a storyboard was developed as a guide for module design, incorporating key components such as the cover, user guide, concept map, learning activities, assessment, glossary, and bibliography. At this stage, various research instruments are also developed, including validation instruments, practicality instruments for teachers and students, and effectiveness instruments in the form of learning outcome tests. Once the design and instruments are finalized, the module design development process is carried out using the Canva application. The product design of the Biology learning module is presented in Figure 2 below.



(A) Cover (B) Learning Activities

(C & D) Application of Socio Scientific Issues with RQA Approach.

Figure 2. Product Design of the Developed Module (a, b, c, d)

D. Product Validation

The product validation stage is conducted to assess the feasibility of the learning modules and all research instruments that have been developed. The validation process involves expert validators who provide evaluations and feedback on content, presentation, language, graphics, and the research instruments used. The validation results are then analyzed

and used as the basis for making improvements and refinements to the product before it is pilot-tested. The results of the content feasibility validation of the module, calculated using Gregory's formula, are presented in Table 9.

Table 9. Analysis of Validation Results for the Module Content Feasibility Aspect

Nu.	Indicator	Assessment		
		Validator		Relevance Category
		I	II	
1	Alignment of content with learning outcomes	4	4	D
2	Understanding the impacts of environmental change.	4	3	D
3	Understanding cause-and-effect relationships.	3	4	D
4	Use of supporting data and facts.	4	4	D
5	Accuracy of biological concepts.	3	4	D
6	Relevance to the local environment.	4	4	D
7	Integration of scientific and social aspects.	4	4	D
8	Appropriateness of the depth of content.	3	3	D
9	Science-based decision-making.	4	4	D
10	Development of critical thinking skills.	4	3	D

The validation conducted by two experts showed that each aspect of content validity obtained a CV score of 1, classified as "highly relevant" with a high level of agreement; thus, the module was found to have excellent content validity and to align with standards for subject matter, scientific concepts, and learning outcomes. Furthermore, the results regarding presentation validity are presented in Table 10 below.

Table 10. Analysis of Validation Results for the Module Presentation Feasibility Aspect

Nu.	Indicator	Assessment		
		Validator		Relevance Category
		I	II	
1	Presentation of material from simple to complex.	3	4	D
2	Alignment of activities with the RQA stages.	3	4	D
3	Sufficient information during the reading stage.	3	4	D
4	Relevance of reading materials to environmental issues.	4	4	D
5	Questions that stimulate curiosity.	4	3	D
6	Questions that guide problem analysis.	4	4	D
7	Answers that reinforce conceptual understanding.	4	4	D
8	Discussions that support decision-making.	3	4	D
9	Assignments that utilize scientific evidence.	3	4	D
10	Clear and measurable learning objectives.	3	4	D

The results of the two validators' assessment of the presentation's suitability showed a CV of 1, indicating a "highly relevant" category and a high level of agreement; thus, the module was deemed valid, systematically organized, conducive to student engagement, and consistent with the RQA approach. Furthermore, the results of the linguistic suitability assessment are presented in Table 10 below.

Table 10. Analysis of Validation Results for the Module Language Feasibility Aspect

Nu.	Indicator	Assessment		
		Validator		Relevance Category
		I	II	
1	The language is easy for high school students to understand.	3	4	D
2	The language is communicative and conversational.	4	4	D
3	Sentences are effective and straightforward.	4	4	D
4	The words used are unambiguous.	3	4	D
5	Scientific terms are explained in simple terms.	4	4	D

Nu.	Indicator	Assessment		
		Validator		Relevance Category
		I	II	
6	Activity instructions are clear and actionable.	4	4	D
7	Spelling and punctuation follow standard rules.	4	4	D
8	The writing style encourages student engagement.	3	4	D

The results of the two validators' assessment of linguistic appropriateness showed a CV of 1, indicating a "highly relevant" category and a high level of agreement; thus, the module was deemed linguistically valid, easy to understand, communicative, clear, and supportive of learning effectiveness and learner engagement. Furthermore, the results of the graphical appropriateness assessment are presented in Table 11 below.

Table 11. Analysis of Validation Results for the Module Graphical Feasibility Aspect

Nu.	Indicator	Assessment		
		Validator		Relevance Category
		I	II	
1	The layout is neat and consistent.	4	3	D
2	The font size is easy to read.	4	4	D
3	The font is easy on the eyes.	4	4	D
4	The illustrations are relevant to the material.	4	4	D
5	The images and diagrams clarify the concepts.	3	4	D
6	The colors do not interfere with readability.	3	4	D
7	The design is attractive and motivates learning.	3	4	D

The results of the two validators' assessment of the module's graphic design showed a CV of 1, indicating a "highly relevant" category and a high level of agreement. Consequently, the module was deemed valid in terms of graphic design, featuring a neat layout, clear typography, appropriate illustrations, and a visual design that supports both comfort and learning effectiveness. The calculation of the overall module validation coefficient using the Gregory formula is presented in Table 12 below.

Table 12. Calculation of the Gregory Validation Coefficient

2 x 2 Matrix		Validator I	
		Low (1–2)	High (3–4)
Validator II	Low (1–2)	A	B
		0	0
	High (3–4)	C	D
		0	35

$$\text{CV} = \frac{D}{A+B+C+D} = \longrightarrow \text{CV} = \frac{35}{0+0+0+35} = \frac{35}{35} = 1$$

The validation instrument for the learning module, which integrates local Socio-Scientific Issues (SSI) with the Reading, Questioning, and Answering (RQA) approach, was assessed by expert validators across four evaluation aspects and achieved an overall average score of 1. As shown in Table 3.6, none of the indicators fell into the Weak-Weak, Weak-Strong, or Strong-Weak categories. Instead, all 35 validated indicators were rated as Strong-Strong by both validators. Therefore, based on the calculation using Gregory's formula, a validity coefficient of 1.00 was obtained, indicating a very high validity category. Furthermore, the calculation results of the instrument reliability test analysis using the agreement formula are presented in Table 13 below.

Table 13. Calculation of the Inter-Rater Agreement Reliability Test

Agreement Index *(Rater Agreement)*	Number of Items|
0,86 (86,48%)	35

Based on the calculation results, the inter-rater reliability index was 0.86 or 86.48%. Referring to the interpretation criteria of reliability coefficients, this value falls within the range of 0.81–1.00, which is categorized as very high. The high reliability value indicates a very good level of agreement and consistency between the two validators in assessing

the research instrument. Therefore, the instrument used in this study can be considered to have a high level of reliability and is thus appropriate to be used as a data collection tool in this research.

E. Design Revision

The design revision stage was conducted after the module was evaluated by expert validators and improvements were deemed necessary. In this stage, various suggestions, comments, and recommendations from the validators were used as the basis for improving and refining the module, covering aspects of content, presentation, language, and visual design. The design before revision can be seen in Figure 3 below.

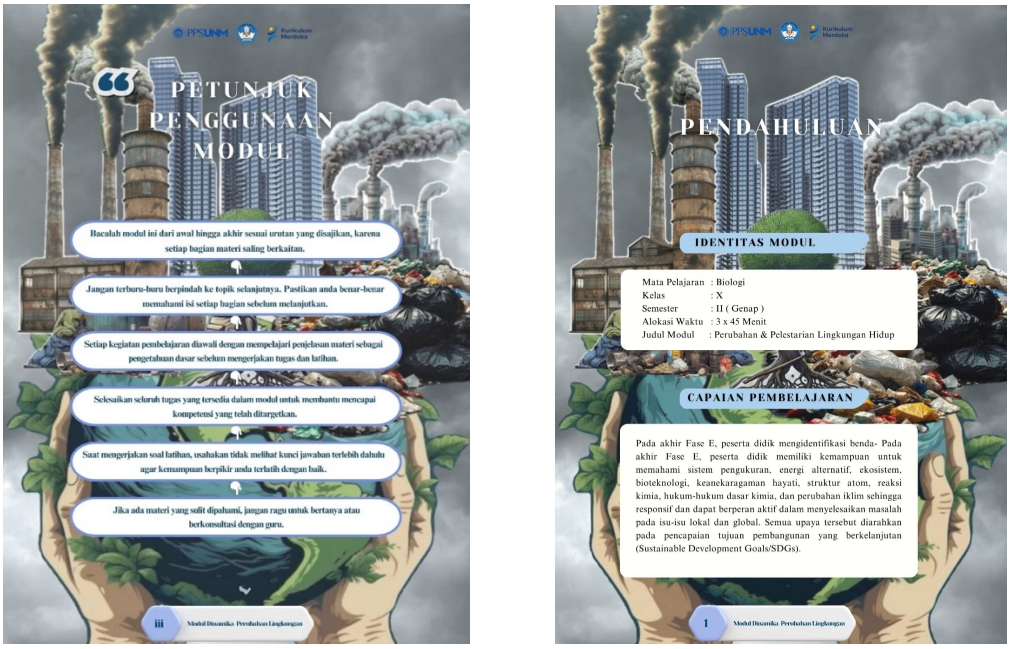


Figure 3. Product Design Before Revision Module.

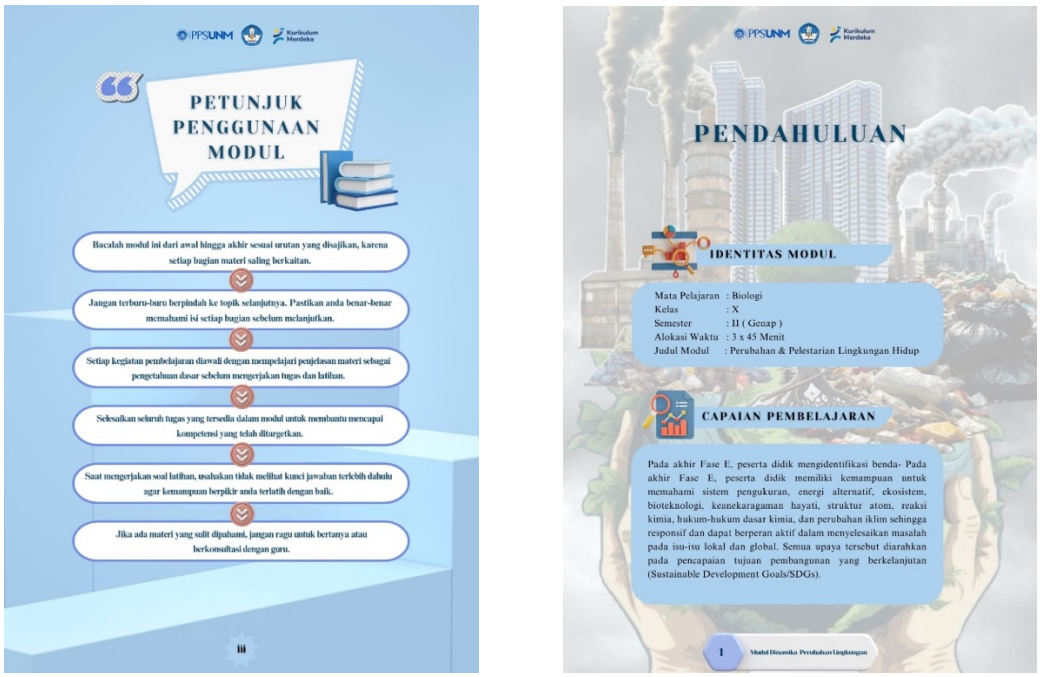


Figure 4. Product Design After Revision Module

One of the revised design elements was the background image. Before the revision, the background image appeared too prominent, making the module's appearance look crowded and potentially distracting students from the written content. After the revision, the intensity of the background image was reduced, resulting in a simpler and more balanced appearance. This change makes the text easier to read and helps students focus their attention on the presented material. After all components, including the module and other instruments, had been revised and declared valid, the next step was to conduct a product trial with students to obtain user responses and identify parts that still required improvement.

F. Product Trial

The product trial was conducted with students who were not included as research subjects. This stage aimed to identify various shortcomings that still existed in the learning module so that revisions could be made before the product was implemented with the research subjects in the field testing stage. Through this trial, students used the learning module and then provided assessments and responses to the module by completing the practicality questionnaire that had been provided. A total of 29 students from one class participated in the module trial.The assessment results, comments, and suggestions obtained from the students were then used as consideration in the product refinement process. The percentage of the practicality of module use during the trial stage can be seen in Table 3.8 below.

Table 14. Analysis of the Practicality Questionnaire Results at the Product Trial Stage

Nu.	Aspect	Percentage (%)	Category
1	Product Quality	79%	Practical
2	Appearance	82%	Highly Practical
3	Material Presentation	76%	Practical
4	Benefits	78%	Practical
	Average	**79%**	**Practical**

The overall results of the practicality questionnaire at the trial stage showed that the learning module achieved an average score of 79%, placing it in the practical category. This finding indicates that the developed module has an adequate level of practicality and is suitable for use by students during the learning process. Nevertheless, there were still several parts that required minor revisions based on students' comments and suggestions, particularly to improve the appearance, material presentation, and ease of use of the module. These revisions were carried out to make the module clearer, more attractive, and more suitable for students' needs.

G. Product Revision

Product revisions were made based on the results of pilot testing and feedback from students and biology teachers. The improvements included correcting typographical errors, adding scientific terms to the glossary to facilitate student understanding, and refining several module components, such as content, learning objectives, and assessment. The revised version was then finalized as the final product used in the field testing phase

H. Field Testing

The field testing involved 59 students from two 10th grade classes who participated in learning using a locally developed Biology module based on Socio Scientific Issues (SSI) integrated with the Reading, Questioning, Answering (RQA) approach. During the learning process, students read socio scientific issues related to the content, then formulated questions and answered them by connecting them to concepts they had learned. This activity was followed by peer discussions, during which students provided feedback, input, or counterarguments regarding the questions and answers presented. Through these learning activities, students were given opportunities to develop a deeper understanding of the material and relate biological concepts to real-life problems in their surrounding environment. At the end of the lesson, practicality questionnaires were distributed to students and Biology teachers to obtain feedback on the use of the developed module. Students' cognitive achievement was then measured through a posttest to determine their learning outcomes after participating in instruction using the module. The results of the practicality analysis, based on student and teacher evaluations, together with the findings of the module effectiveness analysis, are presented in the following section.

Teacher Practicality

An analysis of teachers' perceptions was conducted to determine the level of practicality in using the developed learning module. Data were collected through a questionnaire distributed to two biology teachers at UPT SMA Negeri 2 Sinjai. The assessment of the module's practicality covered four aspects: design, language, content, and benefits. The analysis of the accumulated results of teachers' perceptions regarding all aspects of the Socio-Scientific Issue

(SSI) based Biology module using the Reading, Questioning, Answering (RQA) approach is presented in Table 15 below.

Table 15. Analysis of the Accumulated Results of the Module Practicality Questionnaire

Nu.	Aspect	Percentage (%)	Category
1	Design	94%	Highly Practical
2	Language	95%	Highly Practical
3	Material	92%	Highly Practical
4	Benefits	94%	Highly Practical
Average		**94%**	**Highly Practical**

Based on teachers' perceptions, the local Socio Scientific Issue (SSI) based Biology module integrated with the Reading, Questioning, Answering (RQA) approach received an average score of 94%, falling into the "very practical" category. These results indicate that the module is easy to use, aligns with learning needs, and is suitable for implementation in the teaching-learning process.

Practicality for Students

Student perception analysis was carried out to evaluate the practicality and ease of use of the Biology module based on local Socio-Scientific Issues (SSI) and integrated with the Reading, Questioning, and Answering (RQA) approach. The data were collected through practicality questionnaires administered to 59 students from two classes after the module had been implemented in the learning process. The accumulated results of students' perceptions across all assessed aspects of the SSI-based Biology module integrated with the RQA approach are presented in Table 16.

Table 16. Accumulated Analysis of the Module Practicality Questionnaire Results

Nu	Aspect	Percentage (%)	Category
1	Product Quality	89%	Highly Practical
2	Appearance	90%	Highly Practical
3	Material Presentation	87%	Highly Practical
4	Benefits	88%	Highly Practical
Average		**89%**	**Highly Practical**

Based on student feedback, the Biology module based on local Socio Scientific Issues (SSI) and integrated with the Reading, Questioning, Answering (RQA) approach received an average score of 89% and was rated as "very practical." These results indicate that the module is easy to use, has an appealing design, presents the material systematically, and helps students understand the material and increases their engagement in the learning process.

The Effectiveness of the Module

The effectiveness of the learning module was evaluated using a cognitive achievement test consisting of 25 items. The data were obtained from pretest and posttest scores administered to 59 students from two different classes, before and after the implementation of the module in the learning process. A comparison of students' pretest and posttest results is presented in the following diagram, while the detailed data on students' learning outcomes are shown in Table 17.

Table 17. Students' Learning Achievement Test Data

Nu	Variable	Score
1	Number of Students	59
2	Mean Score	86,03
3	Maximum Score	100
4	Skor Minimum Minimum Score	44
5	Number of Students Who Passed	53
6	Number of Students Who Did Not Pass	6

The analysis of cognitive learning achievement data showed that, out of 59 students who participated in learning the environmental change material using the learning module, 53 students were declared to have passed, while 6 students did not pass. N-Gain analysis was employed to identify the improvement in students' learning outcomes and to evaluate the effectiveness of the developed module based on the comparison between pretest and posttest scores. The students' average pretest and posttest scores are shown in Table 17.

Table 17. Analysis of Students' Average Learning Achievement Data

Average Score		Difference	N-Gain Score	Category
Pretest	Postest			
44,33	86,03	41,7	0,77	High

The average N-Gain score obtained from the pretest and posttest was 0.77, which is categorized as high. Furthermore, the results of the students' N-Gain analysis can be seen in Table 18. below.

Tabel 18. Analysis of Students' N-Gain Scores in Learning Outcomes

Nu	Category	N-gain Skor	
		Frequency	Percentage (%)
1	High	43	73%
2	Moderate	13	22%
3	Low	3	5%
Total		**59**	**100%**

The N-Gain analysis indicated that students' learning outcomes improved after the implementation of the learning module. The results showed that 43 students (73%) were classified in the high improvement category, 13 students (22%) in the moderate category, and 3 students (5%) in the low category. The large proportion of students in the high category suggests that the module made a meaningful contribution to enhancing students' understanding of environmental change material. In total, 95% of students achieved moderate to high improvement, indicating that most students experienced positive learning gains after participating in instruction using the developed module. Based on the N-Gain effectiveness criteria and the data presented in Table 3.13, the module can be considered effective for use in the learning process.

DISCUSSION

Validation was conducted to determine whether the developed module had met the predetermined quality standards. In this study, the validation process involved two expert validators who assessed several research instruments. During the initial validation stage, the developed learning module received a number of comments and recommendations for improvement from the validators. These suggestions covered several aspects, including design, content, language use, and writing systematics. All comments and recommendations were then used as the basis for revising and refining the module before proceeding to the next validation stage. After the revision process was completed, the product and its supporting instruments were re-examined and assessed using the prepared validation sheets. The module was declared valid because it fulfilled the assessment criteria across several aspects, particularly content feasibility, presentation feasibility, language feasibility, and graphical feasibility. A total of 35 assessment indicators across these aspects were consistently rated in the "strong" category by both validators.

Based on these results, the calculation using Gregory's formula produced a validity coefficient of 1.00, which falls into the category of very high validity. This result indicates that all indicators in the module demonstrated a very high level of suitability according to both validators. Thus, the module may be regarded as a valid and feasible instructional material for implementation in the learning process. This indicates that the developed product has fulfilled the necessary quality criteria and is appropriate for classroom use.. This finding is in line with (Lestari et al., 2025), who explained that content feasibility validation is conducted to evaluate the accuracy and relevance of the material, ensuring that it corresponds to learning needs and instructional objectives. A similar view was expressed by Wiryawan & Jayanti (2025), who explained that teaching materials that have undergone revision and have been declared feasible can then be systematically arranged and packaged for the dissemination stage. This stage allows the teaching materials to be used more broadly by teachers and students in learning activities.

The assessment of the learning materials involved educational practitioners, namely teachers and students. The involvement of practitioners in evaluating the practicality of the product is essential to ensure that the developed module is aligned with the actual needs and conditions of classroom teaching and learning practices (Sari & Rakhmawati, 2025). Based on the teachers' assessment, the Biology module was categorized as highly practical for use in learning activities. This is reflected in all practicality aspects, which obtained a highly practical category, including design (94%), language (95%), content (92%), and usefulness (94%). In terms of design, teachers gave high ratings to the attractive appearance of the module, the readability of the font size and type, and the use of images that were relevant to the topic of environmental change. In the language aspect, the presentation of the material using

communicative language, effective sentence structure, and appropriate Indonesian language conventions also received excellent evaluations. Furthermore, in the content aspect, the suitability of the material with the intended learning outcomes, the presentation of relevant local environmental issues, and the implementation of the RQA approach were among the indicators that received the highest scores. In terms of usefulness, teachers considered that the module was able to support the delivery of learning material, encourage students' participation, and was appropriate for use in Biology learning at the senior high school level.

Based on the students' assessment, the Biology module was also classified as highly practical for classroom implementation. This was indicated by the practicality scores obtained across all assessed aspects, namely learning objectives (89%), appearance (90%), material presentation (87%), and usefulness (88%). In the aspect of learning objectives, students stated that the objectives presented in the module were clear. In terms of appearance, the font size and type were considered easy to read, which helped students follow the learning process more effectively. In the material presentation aspect, the activity instructions in the module were regarded as easy to understand, enabling students to carry out each learning activity properly. Meanwhile, in the usefulness aspect, students perceived the material in the module as beneficial and applicable to everyday life. The analysis of teacher perceptions of the module's practicality, including design, language, content, and usefulness aspects, produced an average score of 94%. This result indicates that the module meets teachers' instructional needs and can be implemented effectively in teaching and learning activities. Student perceptions also showed a positive result, with an average practicality score of 89% across aspects of product quality, visual appearance, material presentation, and usefulness. These findings suggest that the developed module supports students in understanding the material, provides an appealing design, presents content in an organized manner, and contributes to improving students' comprehension and engagement during learning. Furthermore, the module facilitates teachers in preparing and delivering instructional materials.

The results of this study are in accordance with the findings of previous research by Firanti & Kurniawati (2025), which found that a PBL-based module incorporating Socio-Scientific Issues was considered valid and demonstrated a very high level of practicality. In their study, the practicality of the module reached 92.92% based on teachers' assessment and 87.45% based on students' assessment. Another supporting study was conducted by Usamah et al (2025), who found that the Socio Scientific Issues TL based Climate Change e-module had a high level of practicality and was therefore suitable for use as a Biology learning medium. This level of practicality indicates that the e-module is easy to use, engaging, and able to support students in understanding climate change material through interactive learning activities. Similarly, Lasih et al (2025), reported that a teaching module based on local potential obtained a practicality score of 78%, which was classified as practical. This finding shows that the module was feasible and easy to use in learning biodiversity material. In addition, the study conducted by Nasution & Anas (2025), reported that a Biology e-module on environmental change integrated with Wahdatul Ulum was classified as highly practical. The practicality assessment showed scores of 80% based on educators' responses and 78% based on students' responses. The effectiveness test was conducted to determine the extent to which the developed module on environmental change was effective after being used by students in the learning process. The effectiveness of the module was examined through the N-Gain score obtained from students' learning outcomes after using the module, in order to identify their level of mastery of the material. This level of mastery was assessed following the implementation of the Biology module based on Socio Scientific Issues (SSI) and integrated with the Reading, Questioning, and Answering (RQA) approach in classroom instruction.

The N-Gain analysis presented in Table 4.24 showed that, out of 59 students who participated in learning using the module, 73% were in the high category, 22% were in the moderate category, and 5% were in the low category. These results indicate that the use of the module on environmental change was able to improve students' learning outcomes. The stages of Reading, Questioning, and Answering (RQA) in the implementation of socio-scientific issues within the topic of environmental change trained students to identify important information, formulate questions, and construct answers based on the material they had studied. In addition, the module provided various exercises that focused on the analysis of environmental issues, allowing students to become accustomed to connecting biological concepts with real life problems. The learning process contributed to strengthening students' critical and analytical thinking skills, allowing them to interpret test items more clearly and answer the posttest questions more effectively. This finding is consistent with Amalia & Manalu (2025), who reported that a Socio-Scientific Issues-based e-module was effective in enhancing students' critical thinking skills on human reproductive system material. The effectiveness was reflected in an N-Gain score of 0.80, which was classified in the high category. These results indicate that presenting learning content through socio-scientific issues can encourage students to examine problems more critically, contextually, and comprehensively.

Saragih & Pratama (2026), also found that an augmented reality-assisted e-module based on Socio-Scientific Issues was effective in improving students' health literacy and critical reasoning skills. The improvement in health literacy was reflected in an N-Gain score of 0.41, which was classified as moderate, while critical reasoning achieved an N-Gain score of 0.70, placing it in the high category. This indicates that the integration of AR and SSI makes learning about the circulatory system more interactive, contextual, and meaningful. According to Puspitarini et al (2025), modules based on Socio Scientific Issues (SSI) can increase students' involvement in scientific discussions related to real-life contexts while also developing critical thinking and evidence-based decision-making skills. The effectiveness of its implementation is influenced by its alignment with the curriculum, the readiness of teachers and students, and continuous module evaluation and development. Learning within the context of local SSI helps students achieve learning objectives while also understanding scientific concepts that are relevant to real-life situations. Moreover, this approach encourages the application of knowledge in daily life and supports the development of thinking skills Saija et al.,(2022); Kurniawan et al (2024).

Conceptually, Socio Scientific Issues are defined as scientific issues related to science and society (Altan et al., 2026). Through SSI based learning, students are given opportunities to explore various sources of information and collect relevant data to identify problems and draw conclusions based on evidence. These activities encourage students to apply their scientific knowledge and skills throughout the learning process. Therefore, students' scientific literacy can develop, particularly in explaining phenomena scientifically, which ultimately contributes to the improvement of their learning outcomes (Kurniawan et al., 2024). Previous research stated that applying the Socio-Scientific Issues approach can encourage students to build scientific attitudes resembling those practiced by scientists during learning. Through this approach, students are guided to address problems scientifically by constructing arguments based on relevant knowledge and evidence. This learning process can strengthen students' conceptual understanding and contribute to improved learning outcomes.

In the Questioning stage, students are guided to formulate questions based on their analysis of the reading material. This process activates their critical thinking skills and metacognitive awareness by encouraging them to identify concepts or issues that are not yet fully understood or require further exploration. In the Answering stage, students are asked to construct answers to the questions they have formulated by integrating relevant biological concepts. As a result, students are actively involved in elaborating, strengthening, and reconstructing their knowledge in a directed manner. Furthermore, the module contains various exercises and quizzes distributed throughout each learning activity. These exercises and quizzes do not merely function as evaluation tools, but also serve as a means of continuously reinforcing concepts so that students can internalize the material more optimally. The gradual and repeated provision of exercises in the learning module can help improve students' problem solving abilities, as they become accustomed to applying the concepts they have learned to different types of questions and learning situations.

CONCLUSION

Based on the findings of this research and development study, the Biology module based on local Socio Scientific Issues (SSI) and integrated with the Reading, Questioning, Answering (RQA) approach was found to bevalid, highly practical, and effective for use in learning environmental change material. The validation results showed that the module obtained a Content Validity coefficient of 1.00 based on Gregory's formula, which falls into the very high validity category. This result indicates that the module met the quality criteria in terms of content feasibility, presentation feasibility, language feasibility, and graphical feasibility, as reflected in the consistent "strong" ratings given by both expert validators across 35 assessment indicators. The practicality test also demonstrated positive results. Teachers' responses produced an average practicality score of 94%, while students' responses obtained an average score of 89%, both of which were categorized as highly practical. These findings show that the module was considered easy to use, visually appropriate, clearly organized, relevant to the learning objectives, and useful in supporting Biology learning at the senior high school level. The effectiveness test further showed that the module contributed to students' learning outcomes after its implementation in classroom learning. Based on the N-Gain analysis involving 59 students, 73% of students were in the high category, 22% were in the moderate category, and 5% were in the low category. These results indicate that the integration of local SSI with the RQA approach helped students understand environmental change material by encouraging them to read contextual issues, formulate questions, construct answers, and relate biological concepts to real-life environmental problems. Accordingly, the developed module may serve as an alternative Biology teaching material that promotes contextual, active, and meaningful learning. Future studies are suggested to evaluate the implementation of this module with a larger sample across different schools and learning contexts. Further investigation may also examine its impact on other learning outcomes, including scientific literacy, critical thinking skills, and students' long-term retention.

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