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Designing a SETS-based biology teaching module: Efforts to enhance students' critical thinking and problem-solving skills

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ABSTRACT

Based on the problem analysis, 10th-grade students at SMAN 1 Talawi show low critical thinking and problem-solving skills. This research aims to determine the level of validity, practicality, and effectiveness of developing biology teaching modules based on the SETS model to enhance students' critical thinking and problem-solving abilities. The type of research used is research and development with the Plomp model. The research data were analyzed using a Likert scale and t-test. The research results show that the biology teaching module based on the Science, Environment, Technology, and Society (SETS) model has a validity score of 87.91%, with very valid criteria. The practicality assessment shows a score of 84.52% with a very practical criterion. The average score for the critical thinking ability test is 83.85, and the average score for the problem-solving ability test is 83.00. These scores indicate that the effectiveness assessment falls into the high criterion with a very effective interpretation. The results of the t-test show that the P-value < α, so the alternative hypothesis (H_1) is accepted. So, it can be concluded that the biology teaching module based on the SETS model that has been developed falls into the category of very valid, very practical, and very effective for enhancing the critical thinking and problem-solving abilities of tenth-grade students. The use of technology in this module is one of the novel aspects, where students are involved in exploring and analyzing issues about ecosystems and environmental changes through technology.

Keywords: Biology teaching module, critical thinking skills, problem-solving skills, SETS model

INTRODUCTION

The global education system must be capable of preparing students for a variety of fields of study that need complex thinking and creativity in order to meet the challenges and opportunities that are becoming increasingly prevalent. This goal is to prepare students to contribute to the world of work and everyday life. A concept has emerged with a focus on this profession, known as 21st century skills.

The term 21st-century skills refers to a set of knowledge, work habits, skills, and character that are very important for leading a good life, especially in academic and career contexts (Rahman, 2019). The first 21st-century skills framework focuses on critical learning and innovation skills: (1) critical thinking and problem-solving, (2) communication and collaboration, (3) creativity and innovation. Critical thinking and problem-solving are considered the new foundation of 21st-century learning (Trilling & Fadel, 2020). Thinking is a complex cognitive process used to seek answers, solve problems, and achieve desired goals. It encompasses critical thinking skills and problem-solving abilities (Kanphukiew & Nuangchalern, 2024).

Students who think critically and objectively are able to process both qualitative and quantitative information, establish connections between various pieces of information, analyze the information, evaluate it, and draw conclusions (Satria et al., 2022b). Students who think critically and objectively are

able to process both qualitative and quantitative information, establish connections between various pieces of information, analyze the information, evaluate it, and draw conclusions (Satria et al., 2022). According to Simanjuntak & Sudibjo (2019), stating that critical thinking is a skill acquired by managing various information from every source creatively and logically, then analyzing it to produce a conclusion.

The ability to think critically is highly needed by learners to solve problems because it can be addressed through exploratory actions towards a problem, accepting the problem as a response to situations and conditions by providing opinions (Puspita & Putri, 2020). The ability to think critically can enhance the quality of a person's thinking so that they can become skilled in analyzing, evaluating, and constructing something in their mind to solve problems, making it important to develop (Fauziah, 2022).

One of the most famous contributors to the development of the concept of critical thinking is Robert Ennis. Critical thinking is defined as reasonable and reflective thinking that focuses on decision-making about what to believe or do. Critical thinking aims to prove something, interpret the meaning of something, solve problems, but critical thinking can also be a collaborative effort (Facione & Gittens, 2013).

Indicators of critical thinking according to the concept proposed by Ennis-Weir include: (1) understanding the intent, (2) examining reasons and assumptions, (3) stating the intent, (4) considering other possibilities, and (5) responding. The indicator leads students to a critical thinking process when expressing ideas, accepting differing opinions, tolerating mistakes, and responding appropriately. Some important attitudes in the development of critical thinking skills are: clarity of thought, fair-mindedness, intellectual courage, self-confidence, insight, integrity, curiosity, humility, perseverance, and independence (Bradley & Price, 2016).

The process of critical thinking can be trained during problem-solving because finding a solution requires understanding the problem, analyzing information, and determining the solution, so these two abilities are interconnected with each other. Problem-solving ability is a set of procedures or strategies that enable a person to enhance their independence in thinking. Problem-solving is a process with various steps, where problem-solving must find the connection between past experiences (schemas) and the current problem being faced, and then take action to resolve it (Nurhasanah & Luritawaty, 2021).

Problem-solving is necessary for students when discussing concepts, relationships between concepts, and relationships between concepts and other fields. If we observe the type or characteristics of problem-solving questions, students need cognitive abilities up to the (analytical/C4) level to solve those questions. If students are not accustomed to solving problems, they do not have good problem-solving skills (Maulyda et al., 2019).

Problem-solving skills can train someone to think critically, logically, and creatively (Astuti et al., 2021). Problem-solving also provides direct experience for students, thereby enhancing their ability to construct, understand, and apply the concepts they have learned (Sumiantari, 2019). The work systematics that are built and used in problem-solving will encourage the dissemination of knowledge and the ability to analyze a problem (Fairley et al., 2021).

The ability to solve problems can be obtained through learning steps that guide students to think and seek solutions to problems. The steps of problem-solving according to Polya in Laia & Harefa, (2021) among others: a) understanding the problem; b) planning the problem-solving; c) implementing the problem-solving plan; d) reviewing the problem-solving results, so that in the end, with the problem-solving skills possessed by the students, the techniques in solving problems

become more structured and logical. Through problem-solving skills, students become active thinkers, receive information, communicate, search for and process data, and finally conclude (Palennari et al., 2021).

Considering the aforementioned explanations that it is important for students to have critical thinking skills and problem-solving abilities. To develop critical thinking skills and problem-solving abilities, students can achieve these skills in biology, which is one of the subjects taught in schools. The biology subject is designed to enhance student engagement in learning, thereby fostering the development of students' abilities (Nurwahidah, 2023). In biology lessons, students must analyze, search, discover, and conclude on their own what they have learned (Prasetyo & Zulela, 2021). In the process of learning biology, students often experience difficulties in studying terms and concepts. Additionally, the subject of biology requires students to have an integrated understanding from the microscopic to the macroscopic scale (Azizah & Alberida, 2021).

One of the biology subjects that requires critical thinking and problem-solving skills is the topic of ecosystems and environmental changes. The expected learning outcome is that students will have the ability to create solutions to problems based on local or global issues from their understanding of ecosystem components and the interactions between these components, as well as environmental changes. This Learning Achievement can be realized through the Learning Objectives Pathway (ATP) (Anggraena et al., 2022).

Based on the initial test results conducted on students in class X-7 at SMAN 1 Talawi, it was found that students' critical thinking skills and problem-solving abilities are still low. In the critical thinking skills test results, 19.40% fell into the "moderate" category and 80.60% into the "sufficient" category. Then, in the problem-solving skills test results, 2.78% fell into the "moderate" category, 86.10% into the "low" category, and 11.10% into the "very low" category. These test results were obtained because students lack the ability to analyze, understand the meaning, respond, and have not been trained in problem-solving.

Factors that cause low critical thinking and problem-solving skills among students, based on relevant research, are because they are not accustomed to engaging in problem-solving processes in daily learning (Suriati et al., 2021). Many classroom learning processes are still conventional, where the teacher plays a more prominent role as the main source of information, while the students only passively receive the information (Arif et al., 2020). This causes students to rarely encounter situations that require them to think analytically or solve problems independently (Fitriani et al., 2020). Problem-based learning that can encourage these skills is still minimally applied, so students are not accustomed to digging for information, analyzing situations, and seeking solutions in depth (Hidayat et al., 2022).

Based on the curriculum analysis results, information was obtained that the curriculum used is the Merdeka Curriculum. In phase E of the even semester, the learning material is about ecosystems and environmental changes. The expected learning outcomes are for students to have the ability to be responsive to local and global issues and to actively participate in problem-solving. Learning objectives are developed within the framework of learning objectives, where classroom learning will then follow this framework of learning objectives. Based on the results of the needs analysis for the development of biology teaching modules based on the SETS model, it shows a percentage of 80.55%, which falls into the very much needed category.

Based on these issues, it is necessary to develop teaching modules. The development of teaching modules is carried out because there are currently no teaching modules that align with the components of the teaching modules in the Merdeka Curriculum. Additionally, the development of teaching modules is conducted

because teaching modules provide a structured flow of material, from learning objectives, core material, exercises, to evaluation. This is in line with Kosasih (2021) that the teaching module developed can be used as a learning tool, a source of information, and a practice tool in mastering a specific learning program.

The development of the teaching module is structured to facilitate teachers in providing guidance and information to students to achieve learning objectives. The module, as a teaching material, has advantages compared to textbooks, as the module is systematically organized, including content, methods, and developed evaluation tools (Utomo, 2020).

The developed teaching module is a biology teaching module based on the Science, Environment, Technology, Society (SETS) model. The SETS Learning Model is a learning model that focuses on real-world problems, which include concepts and processes, and then students are invited to investigate, analyze, and apply concepts and processes in real situations (Rohmatun & Rasyid, 2022).

The SETS model is used as a basis in the development of biology teaching modules to integrate the concepts of science, technology, environment, and society, in order to form connections that enhance critical thinking and problem-solving skills. Learning with the SETS model will link science, technology, environment, and society reciprocally as a form of integrative connection (Suci et al., 2020). Then, according to Mayasari et al., (2023) The SETS model is one of the innovative learning approaches that essentially guides students to think and act globally and to solve everyday problems.

The biology teaching module developed based on the SETS Model is also designed to align with the material to be presented in the teaching module. The material includes ecosystems and environmental changes. In a comprehensive manner, the learning objectives are structured according to the SETS model syntax with the aim of broadening students' understanding of the nature of science, environment, technology, and society. The biology teaching module based on the SETS model is developed by addressing issues or problems currently emerging in society, which are certainly related to the study of ecosystems and environmental changes.

The biology teaching module is structured using the SETS model basis, which includes four components: Science, Environment, Technology, Society. The SETS components will be implemented through the SETS syntax itself, including: invitation, exploration, solution, application, and concept consolidation (Khasanah, 2015; Agus et al., 2022). The development of teaching modules based on the SETS model is expected to enable students to enhance their critical thinking and problem-solving skills because biology teaching modules based on the SETS model have the following characteristics: (1) the problems are local in nature, (2) the use of surrounding resources, (3) active student involvement to obtain information and solve problems, (4) problem-solving based on the abilities possessed, and (5) each student has the opportunity to solve problems in learning (Amanda et al., 2018).

The implementation of the teaching module based on the SETS model can train students to understand problems, think critically and systematically, observe, consider, formulate and execute plans, and draw conclusions. This research aims to develop a teaching module based on the Science, Environment, Technology, Society (SETS) model to enhance the critical thinking and problem-solving abilities of tenth-grade students. The novelty and originality of the development of the biology teaching module based on the SETS model are: 1) the application of the SETS model in learning about ecosystems and environmental changes, 2) the use of technology to support learning and investigation of ecosystem issues and environmental changes, and 3) project-based and reflective assessment.

METHOD

The type of research used is Research and Development (R&D). R&D is the process or steps taken to develop new products or improve existing products (Judijanto et al., 2024). R&D research is also research that produces certain products, and tests the effectiveness of existing products as well as develops and creates (Yuliani & Banjarnahor, 2021). The population in this study consists of tenth-grade students, and the research sample includes tenth-grade students from classes X-7 and X-3. The sampling was conducted using the simple random sampling technique. The research design used is a posttest-only control group design. The data in this study were obtained through the distribution of questionnaire instruments and test instruments. The development model used in this research is the Plomp model, which consists of three stages, namely (Plomp & Nieveen, 2013):

Prelimenary research phase

Preliminary research is conducted by analyzing problems and needs. This activity begins with analyzing students by administering a test. Next, material analysis, curriculum analysis, and needs analysis are conducted through the distribution of questionnaires given to teachers. In addition, at this stage, the researchers also conducted a literature review to identify issues based on previous studies related to critical thinking skills and problem-solving abilities.

Development phase

The stages of developing teaching modules based on the SETS model consist of:
1) Product development, 2) Product validation: the product validation stage includes self-evaluation and expert review. 3) Conducting Limited Scale Practicality Testing: limited scale practicality testing includes one-to-one evaluation and small group evaluation.

Assessment phase

The assessment stage of developing biology teaching modules based on the SETS model. The assessment stage involves two activities, namely: 1) Large-scale practicality test, 2) Effectiveness test: the effectiveness test of the biology teaching module is conducted in the experimental class. Implementation of the effectiveness test using critical thinking and problem-solving ability tests.

Data analysis techniques

Product validity data analysis

The validity results for all observed aspects are presented in the form of a table and analyzed using a Likert scale with points 1-4 with the criteria: 1 = disagree, 2 = somewhat disagree, 3 = agree, and 4 = strongly agree. The formula used to calculate the validity percentage of the product (teaching module) is as follows (Riduwan & Sunarto, 2012):

$$P = \frac{f}{N} \; x \; 100\%$$

Note:
P = Percentage figure
f = Score obtained
N = Total frequency or maximum score

The assessment data is then converted into the teaching module validity criteria as shown in Table 1.

Table 1. Validity criteria for SETS-based biology teaching modules

Validity Score (%)	Criteria
81-100	Very Valid
61- 80	Valid
41- 60	Fairly Valid
21- 40	Less Valid
0-20	Not Valid

(Source: Riduwan & Sunarto, 2012)

Product practicality data analysis

The instrument used is a questionnaire, and the practicality analysis is conducted using a Likert scale. The data from the practicality assessment sheets filled out by teachers and students are then analyzed by following these steps: 1) Score the answers using a scale of 1-4 with the criteria; 4= strongly agree, 3= agree,

2= disagree, 1= strongly disagree, 2) Determine the maximum score and total score, 3) Calculate the practicality value percentage using the formula (Putra et al., 2022).

$$\text{Practicality} = \frac{\text{total score}}{\text{maximum score}} \text{ x } 100\%$$

The obtained values are subsequently interpreted based on the practicality assessment interpretation table presented in Table 2.

Table 2. Interpretation of practicality values

Practicality Score (%)	Criteria
81-100	Very Practical
61- 80	Practical
41- 60	Fairly Practical
21- 40	Less Practical
0-20	Not Practical

(Source: Putra et al., 2022)

Analysis of Product Effectiveness Data

The acquisition of product effectiveness data is through the average scores of critical thinking and problem-solving ability tests in the experimental and control classes. Next, calculate the average scores of the students using the formula (Riduwan & Sunarto, 2012):

$$\dot{x} = \frac{\Sigma Xi}{n}$$

Note:
$\dot{x}$: Mean
ΣXi : Sum of each data
n : Number of data

Table 3. Categories and interpretations of the effectiveness of the biology teaching module

Average	Category	Interpretation
76-100	High	Very Effective
51-75	Medium	Effective
26-50	Low	Less Effective
0-25	Very Low	Not Effective

(Source: Riduwan & Sunarto, 2012)

The data were then analyzed using a t-test. Hypothesis testing was conducted using an independent two-sample t-test. Criteria for testing data analysis with a significance level (significant value α=0.05). The hypothesis in this study is as follows:

H_1: The Biology Teaching Module Based on the Science, Environment, Technology, Society (SETS) Model has a significant influence on the critical thinking skills and problem-solving abilities of 10th-grade students.

H_0: The Biology Teaching Module Based on the Science, Environment, Technology, Society (SETS) Model does not have a significant effect on the critical thinking skills and problem-solving abilities of 10th-grade students.

Conclusion of hypothesis test:

If P-value < α 5%, then H_1 is accepted.
If P-value > α 5%, then H_1 is rejected.

RESULTS AND DISCUSSION

Initial investigation stage

The findings from the analysis of students and the analysis of the material indicate several issues. The issue refers to the low level of critical thinking skills and the low level of problem-solving skills of the 10th-grade students at SMAN 1 Talawi. The results of the critical thinking ability test showed 19.40% in the high category and 80.60% in the sufficient category. Then, the results of the problem-solving ability test showed 2.78% in the "Medium" category, 86.10% in the low category, and 11.10% in the very low category. In addition, there are subtopics that are difficult to understand, such as waste management in the environmental change material.

Based on the curriculum analysis results, information was obtained that the curriculum used is the Merdeka Curriculum. In phase E of the even semester, the learning material is about ecosystems and environmental changes. The expected learning outcomes are for students to have the ability to be responsive to local and global issues and to actively participate in providing solutions to problems. Learning objectives are developed within the framework of learning objectives, where classroom learning will then follow this framework of learning objectives. Based on the needs analysis results from the development of

biology teaching modules based on the SETS model, which showed a percentage of 80.55%, falling into the very much needed category, it can be concluded that there is a need for the development of biology teaching modules to enhance critical thinking skills and problem-solving abilities in the material on ecosystems and environmental changes.

Product development stage

The entire content of the module has been adjusted to align with the teaching module components found in the independent curriculum. For more details, please scan the following barcode:

Figure 1. Barcode of the biology learning module based on the SETS model

The development of the teaching module begins with designing and validating the cover. The appearance of the module cover shown in Figure 2.

(a) (b)

Figure 2. Cover of the biology teaching module based on the SETS model: a) before b) after

Product validation

Self evaluation conducted by the researcher

The initial design results of the biology teaching module based on the SETS model were evaluated through self-evaluation. In this activity, parts of the teaching module that need improvement were identified, both in terms of content, language, and material concepts, resulting in an average self-evaluation score.

Table 4. Average self-evaluation scores

No	Aspect Being Assessed	Validity Value (%)	Criteria
1	Cover	91.67	Very Valid
2	Content Eligibility	93.75	Very Valid
3	Presentation of Content	90	Very Valid
4	Linguistics	93.75	Very Valid
	ΣX	369.17	Very Valid
	$\bar{x}$	92.2925	

Based on the analysis of the self-evaluation scores in Table 4, an average of 92.29% was obtained, categorized as very valid. However, there are several words or sentences that need to be revised to improve the biology teaching module based on the SETS model, and the points that need to be corrected can be seen in Table 5.

Table 5. Improvements and follow-up from self evaluation

No	Correction	Follow-up
1	Punctuation error	Revision of punctuation
2	*Typo*	Revise *typo*
3	There is an unorganized presentation of images	Organizing the presentation of image

Expert review

The assessment of the biology teaching module based on the SETS model through the Expert review activity obtained an average validity as shown in Table 6.

Table 6. Average validity scores of biology teaching modules based on the SETS model

No	Aspect Being Assessed	Validity Value (%)	Criteria
1	Cover	87.5	Very Valid
2	Content Eligibility	87.5	Very Valid
3	Presentation of Content	85	Very Valid
4	Linguistics	91.67	Very Valid
	ΣX	351.67	Sangat Valid
	$\bar{x}$	87.91	

The average validity score of the biology teaching module based on the SETS model is

87.94%, with a very valid criterion. Thus, the biology teaching module based on the SETS model to enhance critical thinking and problem-solving skills on ecosystem and environmental change materials that has been developed can be used for the next stage. The assessment conclusion on the biology teaching module based on the SETS model on ecosystem and environmental change materials can be used with minor revisions.

At this stage, several suggestions for improving the SETS-based biology teaching module that was developed were also received. The suggestions and feedback can be seen in Table 7.

Table 7. Revision suggestions of biology teaching modules based on the SETS model

Validator	Suggestions
Dr. Abdurahman, M.Pd	Pay attention to the punctuation at the end of the sentence.
Prof. Dr. Abdul Razak, M.Si	Pay attention to the wording of the questionnaire.
Dr. Zulyusri, M.P	Pay attention to writing, punctuation, and image citation methods. Use HD quality images. Differentiate the cover for each material. Pay attention to the spelling mistakes word by word. (typo). Add a learning approach. On the cover, display the SETS item. Change the color on the module as needed.

Limited scale practicality test

One to one evaluation

The assessment of teaching materials and student worksheets found in the biology teaching module based on the SETS model during the one-to-one evaluation activity can be seen in Table 8.

Table 8. Average one to one evaluation

No	Aspect Being Assessed	Average (%)	Criteria
1	Completeness of Teaching Materials and Student Worksheets	89.58	Very Practical
2	Linguistics	94.44	Very Practical
3	Presentation	79.17	Very Practical
	ΣX	263.19	Very Practical
	$\bar{x}$	87.73	

Small group evaluation

The assessment of teaching materials and LKPD found in the biology teaching module based on the SETS model during the small group evaluation activity can be seen in Table 9.

Table 9. Average scores of small group evaluation

No	Aspect Being Assessed	Average (%)	Criteria
1	Ease of Use	85.12	Very Practical
2	Learning Time Efficiency	83.33	Very Practical
3	Benefits obtained	86.9	Very Practical
	ΣX	255.35	Very Practical
	$\bar{x}$	85.11	

The results of the practicality test on a small group with an average score of 85.11% with very practical criteria. This shows that the biology teaching module based on the SETS model is very practical and can be used during the learning process, so it can be continued to the assessment stage by conducting large-scale trials.

Assessment phase

Wide-scale practicality test

The results at the assessment phase are data obtained from the wide-scale practicality test of the biology teaching module based on the SETS model for students and teachers. In addition to the wide-scale practicality test results, the assessment phase also provides effectiveness test data, including data from critical thinking ability tests and problem-solving ability tests. The analysis results of the wide-scale practicality test data of the biology teaching module based on the SETS model for students can be seen in Table 10.

Table 10. Average practicality test scores by students

No	Aspect Being Assessed	Average (%)	Criteria
1	Ease of Use	81,83	Very Practical

No	Aspect Being Assessed	Average (%)	Criteria
2	Learning Time Efficiency	81,42	Very Practical
3	Benefits obtained	84,48	Very Practical
	ΣX	247,73	Very
	x̄	82,58	Practical

The data in Table 10 shows that the average practicality test score of the biology teaching module based on the SETS model on a large scale conducted by students is 82.58%, categorized as very practical. Based on the assessment aspects of ease of use, learning time efficiency, and benefits obtained, the practicality of the biology teaching module based on the SETS model on a large scale is very practical to use. Furthermore, the results of the practicality test data analysis of the biology teaching module based on the SETS model conducted by teachers can be seen in Table 11.

Table 11. Average practicality test scores by teacher

No.	Aspect Being Assessed	Average (%)	Criteria
1	Attraction	100	Very Practical
2	Ease of Use	75	Practical
3	Benefits obtained	84.38	Very Practical
	ΣX	259.38	Very Practical
	x̄	86.46	

The average score of the practicality test of the biology teaching module based on the SETS model conducted by teachers is 86.46%, categorized as very practical. Based on the assessment aspects of attractiveness, ease of use, and benefits obtained, the practicality of the biology teaching module based on the SETS model is very practical to use. The results at the next evaluation stage were obtained from the analysis of effectiveness data.

Effectiveness test

Table 12. Average scores of critical thinking and problem-solving ability tests

No	Data	Experimental Class	Control Class
1	Critical Thinking Skills Test	83.85	69.86
2	Problem-Solving Ability Test	83	70.83

The assessment of critical thinking and problem-solving skills is obtained through a test in the form of essay questions. Each test consists of 5 questions. The test is administered to students in the experimental class and the control class. Assessment is used to evaluate the effectiveness of the biology teaching module based on the SETS model. The average scores of the critical thinking ability test and the problem-solving ability test can be seen in Table 12.

Based on Table 12, the average scores of critical thinking ability tests and problem-solving ability tests in the experimental class are higher than those in the control class. The average score of the critical thinking ability test in the experimental class is 83.85, while the average score of the critical thinking ability test in the control class is 69.86. Then, the average score of the problem-solving ability test in the experimental class is 83, and the average score of the problem-solving ability test in the control class is 70.83. The average scores of the critical thinking ability test and the problem-solving ability test indicate that the effectiveness of using the biology teaching module based on the SETS model in the experimental class falls into the high category with a very effective interpretation.

Next, the results of the normality test and homogeneity test were obtained as prerequisites for data analysis. After obtaining the results of the normality test and homogeneity test, the t-test analysis results were obtained to see the significant effect of using the SETS model-based biology teaching module to improve students' critical thinking and problem-solving abilities. The t-test analysis results can be seen in Table 13.

Table 13. Results of the t-test analysis

No	Data	P_{value}	Significance	
1	Critical Thinking Test	0.000	0.05	H_1 accepted

No	Data	P_{value}	Significance	
2	Problem-Solving Test	0.000	0.05	H_1 accepted

The results of the t-test analysis of critical thinking skills show a P-value of 0.000 and a significance level of 0.05. These values indicate that P-value < α 0.05, thus H1 is accepted. Subsequently, the results of the t-test analysis of problem-solving skills show a Thitung value of 0.000 and a significance level of 0.05. These values indicate that P-value < α 0.05, thus H1 is accepted. Thus, it can be interpreted that the biology teaching module based on the SETS model has a significant influence on the critical thinking and problem-solving abilities of tenth-grade students.

Module validity

Based on the assessment of the validity test (Self evaluation and expert review), the biology teaching module based on the SETS model is deemed suitable for use and further implementation because it has met the validity criteria. The aspects of validation for this teaching module include content suitability, content presentation, and language use. This is supported by research conducted (Santiani et al., 2023) that the aspects being validated include theory, assumptions, and the representation of the conceptual model. Additionally, the cover aspect is also evaluated, including the appearance of the images representing the concepts in the module, and this appearance is well-designed to make the module appealing to read. This is supported by (Utari et al., 2023) paying attention to the color and component harmony in the overall appearance of a product plays an important role in supporting its successful use. The right color can create a positive impression. Validity testing ensures that the module is not only aligned with the curriculum but also relevant to real-world contexts, which is the core of the SETS approach. In the context of the SETS model, validity encompasses how the module is able to integrate scientific concepts with environmental, technological, and societal issues.

Practicality of the module

The average practicality score is 84.52%, so the biology teaching module based on the SETS model is declared very practical. The criteria were obtained based on the assessment conducted by teachers and students. The percentage of practicality tests given by students is 82.58%. This percentage indicates that the teaching module falls into the very practical category. This criterion was achieved because the teaching module is easy to understand and easy to apply in learning activities. This is supported by Lubis et al., (2023) that the practicality of a product can make it easier for students to use. The high practicality score indicates that the students feel assisted by the designed teaching module.

Product effectiveness

Effectiveness testing is important to assess the impact of using teaching modules on the improvement of students' critical thinking and problem-solving skills. This is supported by Aliyah & Widiyatmoko, (2022) that the effectiveness test conducted by implementing the test aims to measure the improvement in students' abilities. The higher average test scores on both tests indicate that the use of the SETS model-based biology teaching module in the experimental class is very effective in enhancing students' critical thinking and problem-solving abilities. The t-test results show that the SETS model-based biology teaching module not only has an impact but also a significant effect on improving the critical thinking and problem-solving skills of tenth-grade students. This teaching module is capable of providing more effective learning, resulting in better improvements for students in the experimental class compared to those in the control class. This is in line with the research conducted by (Amanda et al., 2018) that the use of the SETS model by developing a problem-

based learning model can influence students' critical thinking skills. Then, based on the research conducted by Perdana & Rosana, (2023) that the development of the SETS virtual model on ecosystem material enhances problem-solving skills and environmental awareness.

Critical thinking is viewed as critical analysis and trained intellectual critique that combines study, understanding of historical context, and balanced judgment (Kumar et al., 2023). Critical thinkers must also reach a level of maturity in acquiring certain attitudes (Bunt & Gouws, 2020). Meanwhile, according to Walsh et al., (2023) problem-solving is the ability to reason the impact of hypotheses, evaluate, and make decisions.

The implementation of the development of biology teaching modules based on the SETS model not only enhances critical thinking skills and problem-solving abilities but also increases students' learning motivation. This motivation is evident from the active involvement of students in discussions, their enthusiasm in completing tasks, and their desire to delve deeper into the topics being discussed. The biology teaching module based on the SETS model presents relevant and real contexts, enhancing students' interest in biology, as they can see how biological concepts are integrated into daily life and contribute to problem-solving in society.

In addition, the biology teaching module based on the SETS model provides students with the opportunity to develop collaborative skills. Many activities in this module are designed to be done in groups, allowing students to collaborate in analyzing problems, sharing ideas, and finding solutions together. Through these collaborative activities, students also learn to appreciate differing opinions and strengthen their communication skills, which are essential elements in critical thinking and problem-solving. This collaboration encourages students to build a more comprehensive understanding through discussion and comparison of perspectives, enriching the overall learning process.

The findings of this research also underscore that the SETS approach helps students understand the relationship between biology and technological development. In this module, students are invited to observe how technology can be utilized in biological research or the application of biological sciences in industries, such as biotechnology. This understanding broadens students' insights into the role of technology in addressing global challenges, while also providing a new perspective on careers in the fields of science and technology. Thus, this module not only enhances academic competence but also equips students with knowledge relevant to the developments in the job market.

Based on these various findings, this research concludes that the biology teaching module based on the SETS model is an innovative and effective module for developing students' critical thinking skills, problem-solving abilities, collaboration, scientific literacy, and technological understanding. The application of this module is recommended to be expanded in other learning contexts, in order to create a generation of young people who are capable of thinking comprehensively and acting responsibly in facing future challenges.

CONCLUSION

The conclusion of this study shows that the biology teaching module based on Science, Environment, Technology, and Society (SETS) has a significant positive impact on improving critical thinking and problem-solving skills.

This SETS approach allows students to learn biological concepts in real-world contexts, which are not only relevant to everyday life but also contribute to understanding global issues related to the environment, technology, and society. Through integrated activities in the module, students experience an improvement in their analysis, evaluation, and critical decision-making skills in problem-solving.

SETS-based teaching modules have proven to be an effective learning strategy to prepare students for complex challenges in the future. This module not only enhances students' academic competencies but also fosters a sense of responsibility, environmental awareness, and the ability to think critically and solution-oriented. This research recommends the implementation of the SETS module in various other subjects to encourage comprehensive and applied learning, while also equipping students with the 21st-century skills needed to contribute positively to society.

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