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DEVELOPMENT OF TEACHING MODULES BASED ON SETS (SCIENCE, ENVIRONMENT, TECHNOLOGY, SOCIETY) TO IMPROVE STUDENTS CRITICAL THINKING SKILLS IN GREEN CHEMISTRY MATERIAL

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Abstract

This study aims to describe the feasibility of teaching modules based on SETS (Science, Environment, Technology, Society) to improve students' critical thinking skills in green chemistry material. This study uses Thiagarajan's 4D development research method with modifications from Ibrahim's 3D method, which includes the define, design, and develop stages. Feasibility was assessed based on three aspects: validity, practicality, and effectiveness. Validity was assessed in terms of content and construct validity. Overall, in terms of content and construct validity, the module received a mode of 3 and 4, which are categorized as good and very good. Furthermore, practicality was reviewed from the student response questionnaire, which obtained an average of 94.81% in the excellent category, supported by the results of student activity observations of 89.04%, which showed active involvement in each stage of learning, and learning implementation of 97.65%, which confirmed that the entire series of activities was carried out very well. Meanwhile, the effectiveness of the teaching module based on SETS (Science, Environment, Technology, Society) can be seen from the increase in the average critical thinking skills test score from 28.72 to 83.86 with an average N-gain of 0.7718, which is in the high category. The Wilcoxon test results showed that all students experienced a significant increase ($Z = -5.235$; Sig. $0.000 < 0.05$). Thus, the teaching module based on SETS was declared effective in improving students' critical thinking skills in green chemistry material.

Keywords: teaching module, SETS (Science, Environment, Technology, Society), project-based learning, critical thinking skills, green chemistry

INTRODUCTION

Education is an important aspect that every individual must undergo to improve their quality of life, because through education, a person can develop their potential, shape their character, and change their behavior and knowledge for the better [1]. The education system in Indonesia requires all citizens to undergo 12 years of education at several levels, one of which is senior high school. Students will be taught various fields of knowledge at the senior high school level, one of which is chemistry.

Chemistry is a branch of natural science that studies the structure and properties of matter (substances), changes in matter, and the energy that accompanies changes in matter [2]. Green chemistry is a new subject in chemistry in the merdeka curriculum. Green chemistry studies the process of manufacturing products by reducing or eliminating the use of hazardous chemicals through green chemistry principles, such as waste prevention, atom economy, minimizing hazardous chemicals, designing safe chemicals, using safe solvents and additives, energy efficiency, using renewable raw materials, reducing by-products, using catalysts, designing degradation, real-time analysis to prevent pollution and prevent potential accidents [3]. In other words, green chemistry aims to design chemical products and processes that are safe for the environment and human health [4].

The application of these concepts requires students to not only understand the concepts theoretically, but also to develop critical thinking skills in analyzing environmental problems caused by the use of chemicals and applying green chemistry principles to reduce the impact of chemicals on the surrounding environment [5]. Critical thinking skills are also one of the important skills that students must have in order to face the challenges of the 21st century. Therefore, critical thinking skills are an essential competency that must be developed in green chemistry learning. In fact, critical thinking skills are still not optimally integrated into green chemistry learning.

The results of a pre-research conducted in one of the tenth grade classes at a high school in Gresik in February of the 2024/2025 academic year showed that 75% of students stated that green chemistry lessons in class were often delivered using the lecture method. Delivering material using the lecture method makes students quickly bored and less interested in participating in lessons. The use of the lecture method also makes it difficult for teachers to detect the level of student understanding [6]. In addition, 80.5% of students stated that green chemistry learning in the classroom relies more on memorizing theory. Learning that relies solely on memorization makes students less likely to think critically and are at the Lower Order Thinking Skills level in Bloom's Taxonomy, namely remembering (C1) and understanding (C2). At this level, students only remember and understand basic information without developing the ability to analyze (C4), evaluate (C5), or create (C6). As a result, students experience difficulties when facing more complex problems that require higher-order thinking skills (HOTS) and easily forget material because the material is not processed in depth through higher cognitive processes [7].

Based on the results of teacher interviews, students were provided with learning support media such as Student Activity Sheets (SAS/LAPD) and teaching materials to help students understand green chemistry material. However, the SAS and teaching materials provided did not connect the aspects of science, technology, environment, and society, so students' analytical skills did not develop optimally. Supported by the results of the pre-research test of students' critical thinking skills, the average skills in the interpretation indicator were 43.05%, analysis 38.89%, evaluation 34.72%, explanation 41.11%, and inference 48.61%. This proves that the critical thinking skills possessed by students are still low. Therefore, improvements need to be made in the learning process so that students' critical thinking skills can improve. One improvement that can be made is to develop the learning media used.

One type of learning media that can be developed is teaching modules. Teaching modules are learning tools or learning designs that are compiled based on the applicable curriculum and applied with the aim of achieving the established competency standards [8]. In their compilation, teaching modules need to be adapted to the characteristics of the material being taught so that learning is effective and meaningful for students. The contextual and applicative characteristics of green chemistry material require a learning approach that can develop students' critical thinking skills, one of which is through the SETS (Science, Environment, Technology, Society) approach. The SETS approach is an effective method for helping students connect green chemistry concepts with problem solving in everyday life [9]. Approach SETS is an integrated approach designed to develop students' ability to understand a problem comprehensively by integrating four important components, namely science, technology, environment, and society in learning [10]. Through the SETS approach, students can analyze and solve actual issues in society caused by the impact of scientific and technological developments and their influence on society and the environment, thereby encouraging students to be more active, creative, and critical in providing solutions to issues in their surrounding environment [11].

Several studies show that the SETS approach can improve students' critical thinking skills. In a previous study conducted by Yevira [12] stated that SETS-based e-modules on environmental pollution can increase students' interest in learning and critical thinking skills. Furthermore, research by Asmuri [13] states that SETS-based Integrated Science modules can improve critical thinking skills. In addition, research by Wahyuni [14] also states that SETS (Science, Environment, Technology, Society) based Integrated Science modules on the subject of work and energy in junior high school can help students practice critical thinking skills.

In applying the SETS approach, learning is not centered on the teacher, so creativity is needed in planning a learner-centered learning process. The SETS approach can be enhanced by integrating it with the project-based learning model. In the developed teaching module, the SETS approach is applied through project activities involving the creation of ecoprint batik, lerak soap, and herbal drinks. The scientific aspect is reflected in the understanding of green chemistry concepts and the characteristics of natural materials used in each project. The environmental aspect is demonstrated through the use of natural materials and organic waste as an effort to reduce environmental pollution. The technological aspect is realized through the application of simple and environmentally friendly technologies in the product manufacturing process for each project. Meanwhile, the social aspect is reflected in the usefulness of the products produced in community life, both in terms of hygiene, health, and economic value development.The PjBL model provides ample space for the implementation of the SETS approach, as it allows students to analyze and resolve issues arising from the development of science and technology and their impact on society and the environment through a project as a real solution to environmental problems.

In addition, the SETS approach in green chemistry learning is suitable to be applied using the PjBL model because the syntax in the PjBL model fulfills all components in the SETS approach and both support each other in improving students' critical thinking skills. The syntax in the PjBL learning model includes determining fundamental questions, developing project plans, setting schedules, implementing projects with monitoring of activities and project progress, project reports and product presentations, as well as evaluation and learning experiences. Each PjBL syntax explicitly integrates SETS components, including facts, exploration, solutions, applications, and concept consolidation. Therefore, the application of the SETS approach combined with the PjBL model in green chemistry learning not only makes learning more contextual and meaningful, but also encourages students to think critically, creatively, and actively in finding solutions to problems in their surroundings.

Based on the description of the background of the problem mentioned above, it is considered important to develop a teaching module based on SETS (Science, Environment, Technology, Society) that is expected to be effective in improving students' critical thinking skills. This study aims to determine the feasibility of the developed teaching module based on the aspects of validity, practicality, and effectiveness.

METHOD

This type of research is research and development. This research uses Thiagarajan's 4D development research method with modifications from Ibrahim's 3D method, which includes the stages of define, design, and develop [15]. The feasibility of the developed teaching module is based on three aspects of feasibility namely validity, practicality, and effectiveness [16].

The research data sources came from the validation results and limited trial data. Limited trials were conducted on students in one of the 10th grade classes at SMA in Gresik Regency. The instruments used were review sheets, validation, response questionnaires, and observation of student activities, observation of learning implementation, as well as pretest and posttest questions on critical thinking skills. The review data was analyzed descriptively and qualitatively. The results of the review can be used as input to improve and refine the teaching module developed.

In the validation results, the data were analyzed descriptively and quantitatively. The assessment was carried out by giving scores to each statement item. Furthermore, the data were analyzed in each aspect of the statement using the mode. Scores were given on the validation sheet using the Likert scale presented in Table 1.

Table 1. Likert Scale Validation Sheet

Score	Assessment Criteria
4	Very good
3	Good
2	Not very good
1	Very poor

[17]

The developed teaching module can be considered valid if the most data (mode) is obtained ≥ 3.

The analysis of student response questionnaire data was conducted to determine the practicality of the teaching module, supported by observation sheets of student activities and the implementation of learning. The student response questionnaire contained 19 statements, consisting of 16 positive statements and 3 negative statements. The negative statements were numbers 4, 8, and 13, while the other statements were positive.

Table 2. Likert Scale for Response Questionnaire

Category	Statement Numbers
Understanding & Interest	1,5,6
Learning Motivation	2,3,4,8
Module Accessibility	9, 10, 11
Module Content Quality	12, 13, 14
Critical Thinking Skills	15, 16, 17, 18, 19

The data from student responses were analyzed descriptively and quantitatively and calculated based on the Likert scale presented in Table 3.

Table 3. Likert Scale for Response Questionnaire

Score	Assessment Criteria
4	Very Good
3	Good
2	Fairly Good
1	Poor
0	Not Suitable

[18]

The data obtained from the scores is then calculated using the following formula:

$$\text{Response (\%)} = \frac{\sum Y}{\sum PD} \times 100\%$$

Explanation:
Response (%) = Percentage of student response
$\sum Y$ = Total student scores
$\sum PD$ = Number of students

[19]

The percentage results of the response questionnaire were then interpreted into the assessment criteria presented in Table 4.

Table 4. Response Questionnaire Assessment Criteria

Percentage (%)	Assessment Criteria
0	Very Poor Not
21	Good Fair
41	Good
61-80	Very Good
81-100	

[20]

The teaching module developed can be considered practical if the assessment results are ≥61%.

Student activity data was obtained from observations of student activities during the learning process. Student activity data was analyzed descriptively and quantitatively and calculated based on the Likert scale presented in Table 2. Furthermore, the student activity data obtained was calculated using the following formula:

Student activity (%) =

$$\frac{\sum scores\ of\ present\ students}{\sum total\ scores\ of\ all\ students} \times 100\%$$

The student activity percentage data was then interpreted using the assessment criteria presented in Table 3 and could be considered practical if the assessment result percentage was ≥61%.

The learning implementation data was obtained from observations of learning activities, starting from the opening activities, determining basic questions, preparing project plans, preparing schedules, implementing projects & monitoring student project progress, product presentations, evaluations and learning

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experiences, as well as closing activities. The data from the observation of learning implementation was analyzed descriptively and quantitatively. Scores were given on the learning implementation observation sheet using the Likert scale presented in Table 2. Furthermore, the data from the observation of learning implementation was analyzed for each aspect of the statement using the mode. Learning activities can be said to be good if the mode obtained is ≥ 3.

The effectiveness of this study was based on the results of critical thinking skills tests administered to students through pre-tests and post-tests. The tests were administered to describe the improvement in students' critical thinking skills in learning using SETS-based teaching modules and to describe the effectiveness of the teaching modules developed. The tests administered consisted of 10 essay questions that had been compiled based on critical thinking skills test indicators.

After the pretest and posttest were conducted, the test scores were calculated using the following formula:

$$\text{Test score} = \frac{\text{score obtained}}{\text{maximum score}} \times 100$$

Next, the test results data were statistically tested using a normality test. The normality test was conducted to determine whether the data obtained was normally distributed or not. In this study, the Shapiro Wilk test (number of data <50) was used. Decisions were based on the significance value, namely if the significance value was > 0.05, the data was declared to be normally distributed (H_0) and a t-test was performed. If the significance value was < 0.05, the data was declared to be non- normally distributed (H_1) and a Wilcoxon Signed Rank test was performed.

In the t-test, the hypothesis proposed is H_0 if there is no significant difference between the pretest and posttest scores of the students and H_1 if there is a significant difference between the pretest and posttest scores of the students. The decision is based on the significance probability value, namely if the significance probability value is > 0.05, then $H_0$is accepted. If the significance probability value is < 0.05, then $H_0$is rejected.

In the Wilcoxon Signed Rank Test, the hypothesis proposed is H_0 if there is no significant difference between the pretest and posttest scores of students and H_1 if there is a significant difference between the pretest and posttest scores of students. The decision is based on the significance probability value, namely if the significance probability value is > 0.05, then $H_0$is accepted. If the significance probability value is < 0.05, then H_0 is rejected.

The final test, the N-Gain test, is used to determine the increase in students' critical thinking skills in green chemistry. The following is the N- gain formula used:

$$g = \frac{\text{Sposttest} - \text{Spretest}}{\text{Smaks} - \text{Spretest}}$$

The N-gain score obtained is then interpreted into the assessment criteria in Table 5.

Table 5. N-gain Score Criteria

Nilai <g>	**Kriteria Penilaian**
N-gain ≥ 0,7	High
0,7 > N-gain ≥ 0,3	Medium
N-gain < 0,3	Low

[21]

RESULTS AND DISCUSSION

Based on the research conducted, the following data was obtained.

Define Stage

This stage aims to gather various information related to the teaching module product to be developed, as well as to determine and define the items needed in the learning process so that the resulting teaching module is truly in line with the needs of students and curriculum requirements. This stage consists of five steps of analysis, namely front-end analysis, learner analysis, concept analysis, task analysis, and formulating learning objectives [22].

Front-end analysis is the first step in the definition stage. Front-end analysis is conducted to identify the problems faced by students and teachers during the learning process. In the front-end analysis, data was obtained from the results of a pre-research questionnaire and interviews. The questionnaire results showed that 75% of students stated that classroom learning was still dominated by lecture methods; 86.11% of students stated that green chemistry learning focused on theory, making it less interesting; 80.56% of students stated that green chemistry instruction remained focused on memorization; and 55.56% of students stated that is analytical skills were not adequately taught. Furthermore, the results of interviews with teachers showed that students had been provided with learning support media such as Student Activity Sheets (SAS) and teaching materials, but these did not integrate the aspects of Science, Environment, Technology, and Society (SETS), so that the analytical skills of students had not developed optimally. Learning media is an important component that needs to be continuously developed in order to provide educational services that encourage students to learn independently [23]. Therefore, it is necessary to develop learning media that integrates the SETS approach to support the improvement of students' analytical and critical thinking skills.

Next, an analysis of students was conducted to obtain information about their characteristics so that the teaching modules developed would be tailored to their needs. The analysis results showed that students' academic abilities still needed to be improved, particularly in critical and analytical thinking. Meanwhile, in terms of students' age and development, green chemistry material in the merdeka curriculum is taught in 10th grade chemistry (Phase E). Students in 10th grade are aged 15–16 years. Based on Piaget's cognitive development theory, students at this age are generally in the formal operational stage, which is the stage where individuals are capable of abstract, logical, and systematic thinking [24]. However, observations conducted on students in Grade X IPA 3 at SMA observations of students in class X IPA 3 at a high school in Gresik showed that their cognitive development was not yet optimal. Most students still showed passive responses in the learning process.

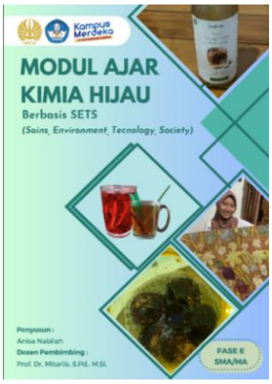
Next, a concept analysis was conducted to examine green chemistry concepts based on the learning outcomes and learning objectives that had been compiled so that they could be used in the development of teaching modules. This stage included the identification and detailing of relevant key concepts, particularly green chemistry concepts and their relationship to SETS (Science, Environment, Technology, Society) elements. These concepts include the definition of green chemistry, the 12 principles of green chemistry, the application of these principles in chemical processes, and their impact on the environment, technology, and society.

Task analysis is carried out to identify the main tasks that must be completed by students. Tasks are designed in accordance with the material, learning outcomes and learning objectives. In the teaching module developed, tasks are presented in Student Activity Sheet based on SETS using the Project Based Learning model for green chemistry material. Students are directed to observe phenomena, formulate project questions, develop project plans, create schedules, monitor or implement projects, present project results in front of the class, and evaluate their experiences during the project. Through these activities, students can actively discuss and collaborate to find solutions to environmental problems by considering various arguments, thereby improving their critical thinking skills [25].

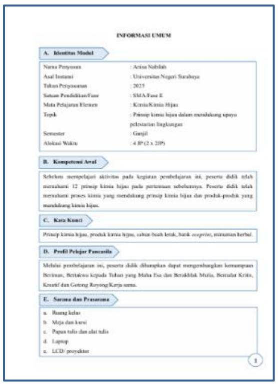
The formulation of learning objectives aims to determine the achievement indicators that students will attain in accordance with the learning outcomes in the Merdeka Curriculum. The learning objectives used in the development of the SETS (Science, Environment, Technology, Society)- based teaching module are as follows: through the project activity's, students can explain the application of green chemistry principles in daily life as a solution to address environmental issues effectively and sustainably.

Design Stage

The Design stage is carried out with the aim of compiling the initial design of the SETS-based green chemistry teaching module. This stage includes test compilation, media selection, format selection, and initial design compilation, all of which are designed to support the improvement of students' critical thinking skills in accordance with the teaching module provisions in the Merdeka Curriculum. The teaching module consists of three main components, namely general information, core components, and attachments. The general information component includes the identity of the teaching module, initial competencies, keywords, Pancasila learner profiles, facilities and infrastructure, number and target of students, learning models, as well as the media, teaching materials, tools, and materials used. The core component includes learning outcomes, learning objectives, learning objective flow, sparking questions, learning preparation, learning activities, assessment, enrichment and remedial, and teacher reflection. The appendix contains a summary of green chemistry material, Student Activity Sheets (SAS), cognitive, skill, and attitude assessment instruments, as well as a glossary and bibliography. The teaching module based on SETS is presented in Figure 1.



(a)



(b)

(c)

(d)

Figure 1. (a) Cover Display of Teaching Module
(b) General Information Display
(c) Core Competency Display
(d) Appendix Components

The teaching module appendix contains Student Activity Sheets (SAS/LAPD). The Student Activity Sheets (SAS) in this teaching module consist of 3 SAS, namely SAS 1 for the ecoprint batik making project, SAS 2 for the lerak soap making project, and SAS 3 for the herbal drink making project. The SAS display is shown in Figure 2

(a)

(b)

(c)

Figure 2. (a) SAS Batik Ecoprint Project
(b) SAS Lerak Soap Project
(c) SAS Herbal Drink Project

All three projects apply green chemistry principles in accordance with the characteristics of the materials, work processes, and objectives of the products produced. Green chemistry principles are applied, including principle number (1) waste prevention, (5) use of safe solvents, (7) use of renewable raw materials, (10) design of easily degradable products, and (12) prevention of poten tial accidents.

Development Stage (Development)

There are three steps in the development stage aimed at testing the feasibility of the LAPD: validity, practicality, and effectiveness.

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Validity

Validity was conducted through open module validation by two chemistry lecturers and one chemistry teacher. Data validity was assessed using content validity and construct validity criteria. Validity includes the completeness of the learning module components in the independent curriculum, the appropriateness of the learning module to the learning content, the integration of SETS components with the PjBL learning model, and the support for the development of critical thinking skills. The assessment results from the third validator on content and construct validity aspects showed that the developed SETS-based learning module received mode scores of 3 and 4, respectively, in the good and very good categories, respectively. Therefore, the developed learning module can be declared valid.

Practicality

In this study, practicality was assessed through student questionnaire responses, supported by observations of student activities and learning implementation. The following graph shows the results of student responses, presented in Figure 3.

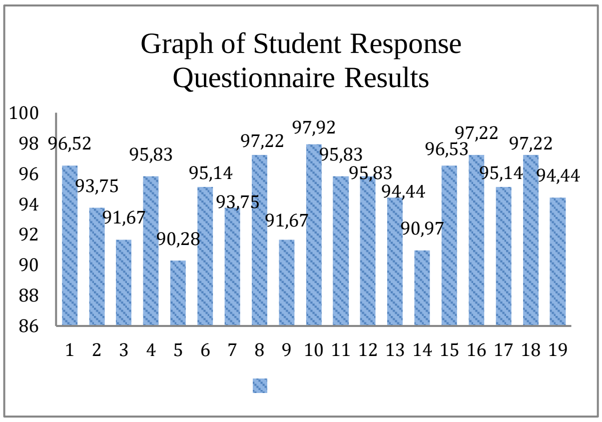

Figure 3. Graph of Student Response Questionnaire Results

Based on the figure above, the overall average percentage of the student response questionnaire questions was 94.81% with a very good category. This shows that the developed teaching module can be declared practical in improving students' critical thinking skills.

Supported by the results of observations of student activity, a percentage of 89.04% was obtained, indicating active involvement in each stage of learning, as well as a learning implementation rate of 97.65%, confirming that the entire series of activities was carried out very well. Thus, the SETS-based teaching module that was developed can be said to be practical and suitable for use in learning to support the improvement of students' critical thinking skills. This is in line with the opinion of Kurnianto and Sarwono, who stated that the practicality of teaching modules includes ease of understanding, ease of application, and usefulness for both teachers and students, so that modules that meet these criteria can be used effectively in learning [26].

Effectiveness

The achievement of effectiveness in this study was based on the results of the critical thinking skills test of the students through the completion of a pretest and posttest. After the pretest and posttest were conducted, a graph of the increase in student skills was obtained, as shown in Figure 4.

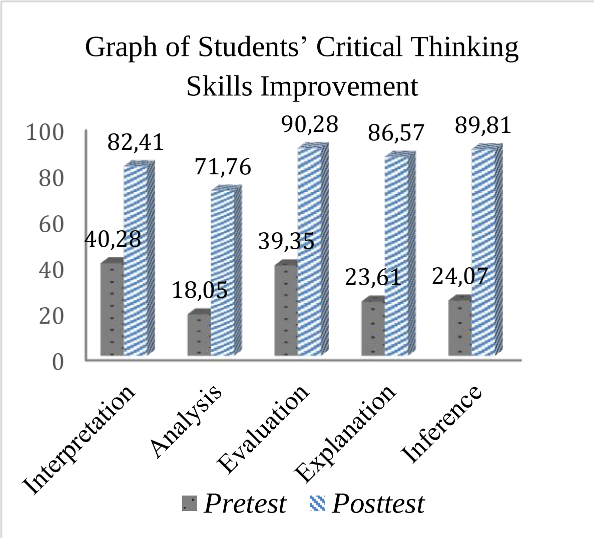

Figure 4. Graph of Students' Critical Thinking Skills Improvement

Based on Figure 4, there was an increase in the pretest and posttest scores of students on each critical thinking skill indicator. On the interpretation indicator, the pretest score was 40,28 and the score increased to 82,41 on the posttest. In the analysis indicator, the score increased from 18,05 to 71,76. Furthermore, in the evaluation indicator, the score increased from 39,35 to 90,28. In the explanation indicator, the score increased from 23,61 to 86,57, and in the inference indicator, the score increased from

24,07 to 89,81. After obtaining the pretest and posttest scores, all data were analyzed using n-gain to determine the extent of improvement in the critical thinking skills of students. Based on the calculation results, the N-gain scores of students are shown in Figure 5.

N-gain Analysis on Each Critical Thinking Skill Indicator

Critical Thinking Skills Indicators	Pretest	Posttest	N-gain	% N-gain
Interpretation	40,28	82,41	0,70	70,54
Analysis	18,05	71,76	0,65	65,54
Evaluation	39,35	90,28	0,83	83,97
Explanation	23,61	86,57	0,82	82,42
Inference	24,07	89,81	0,86	86,58

Figure 5. Results of N-gain Analysis

Furthermore, the pretest and posttest data obtained were tested for normality using SPSS to determine whether the data obtained were normally distributed or not. The results obtained from the SPSS normality test are presented in Figure 6.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest	.086	36	.200*	.981	36	.790
posttest	.161	36	.018	.886	36	.001

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 6. Normality Test Results

The figure above shows the results of the Shapiro-Wilk test for the normality of the pretest and posttest data for critical thinking skills. Based on the test results, the pretest data obtained a significance value of 0.790 (Sig. > 0.05), indicating a normal distribution. Conversely, the *posttest* data had a significance value of 0.001 (Sig. < 0.05), indicating that it was not normally distributed. Thus, because one of the data sets was not normally distributed, the analysis was continued using the non-parametric Wilcoxon Signed Rank Test. The results of the Wilcoxon test are presented in Figure7.

Ranks

		N	Mean Rank	Sum of Ranks
posttest - pretest	Negative Ranks	0[a]	.00	.00
	Positive Ranks	36[b]	18.50	666.00
	Ties	0[c]		
	Total	36		

a. posttest < pretest

b. posttest > pretest

c. posttest = pretest

Test Statistics[a]

	posttest - pretest
Z	-5.235[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Figure 7. Wilcoxon Signed Rank Test Results

The Wilcoxon Signed Rank Test is used to determine significant differences between pretest and posttest values if the data is not normally distributed. The results of the Wilcoxon Signed Rank Test are shown in Figure 6. Based on the Ranks table, the number of Negative Ranks (posttest < pretest) is 0, Positive Ranks (posttest > pretest) is 36, and Ties (posttest = pretest) is 0. This indicates that all students (100%) experienced an increase in posttest scores compared to pretest scores. Furthermore, based on the Test Statistics table, a Z value of –5.235 was obtained with a significance of Asymp. Sig. (2-tailed) = 0.000. Because the significance value of 0.000 < 0.05, it can be concluded that there is a significant difference between the pretest and posttest scores for students' critical thinking skills.

Improvements in students' critical thinking skills can be achieved through the application of the SETS approach because through this approach, students not only understand concepts theoretically, but are also asked to analyze and solve actual issues in society comprehensively by integrating four important components, namely science, technology, environment, and society in learning, so that this can encourage students to be more active, creative, and critical thinkers [11]. Supported by several previous studies showing that the SETS approach can improve students' critical thinking skills, one of which is a study conducted by Asmuri et al. [13] stating that SETS-based integrated science modules can improve critical thinking skills. Thus, the use of SETS-based teaching modules in green chemistry material is effective in improving students' critical thinking skills.

CONCLUSION

The validity of the developed teaching module was reviewed in terms of content and construct validity, with the assessment results from the three validators obtaining a mode score of 3 and 4 in the good and very good categories, so that the developed teaching module can be declared valid. The practicality of the teaching module developed was reviewed from the student response questionnaire, supported by the results of observations of student activities and learning implementation. The average student response reached 94.81, which is categorized as excellent. Student activity obtained a percentage of 89.04%, and learning implementation was 97.65%. This shows that the developed teaching module is practical, easy to use, and able to encourage active student involvement. The effectiveness of the teaching module developed was reviewed based on the increase in the average critical thinking skills test score, which was initially 28.72 to 83.86 with an average N-gain of 0.7718 (high category). Thus, the SETS-based teaching module proved to be effective in improving students' critical thinking skills in green chemistry material.

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