RESEARCH ARTICLE

Enhancing student conceptual understanding and critical thinking through SETS-based digital modules on environmental changes

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Abstract: The rapid advancements in science and technology have necessitated the adaptation of biology education to enhance students' understanding and critical thinking skills, aligning with the demands of the 21st century. The development of digital modules based on the Science, Environment, Technology, and Society (SETS) framework represents an innovative approach to facilitate students' learning by seamlessly integrating theories from science, environment, technology, and society. This research adopts the Research and Development methodology, employing the ADDIE development model. The digital module's development underwent validation by four experts, comprising two media experts and two material experts. The validation results yielded a 90% agreement from media experts and an 85% concurrence from material experts, indicating the suitability of the digital module on environmental change, grounded in the SETS framework, for educational use. The developed module was subjected to testing using a one-group pretest-posttest design, followed by the analysis of the obtained data through paired sample t-tests. The analysis results indicate a significant improvement in both conceptual understanding and critical thinking skills following the utilization of the module. Hence, this module is recommended for use in biology education, particularly in the context of environmental change materials.

Keywords: Digital modules, environmental change, SETS, thinking skills

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Introduction

The challenges of 21st-century learning necessitate students to acquire both learning abilities and life skills to confront future challenges (Geisinger, 2016; Soulé & Warrick, 2015). Meeting these demands necessitates that education equips and readies students with skills and competencies suitable for the global era (Kivunja, 2014a, 2014b). The development of the educational curriculum strives to enhance 21st-century skills, resulting in the cultivation of specific competencies. These competencies encompass communication, collaboration, critical, and creative thinking, collectively referred to as the 4Cs (Astuti et al., 2019; Soulé & Warrick, 2015). Attaining this competency is contingent upon their ability to grasp fundamental concepts. Understanding concepts related to the ability to explain the relationship between concepts, apply concepts and be precise in solving problems. Understanding concepts becomes a basis for gaining thinking skills.

One of the thinking skills that students must have is critical thinking (Chalkiadaki, 2018; Dwyer et al., 2014). Critical thinking can lead students to be able to analyze a phenomenon that occurs and requires students to continue to learn from everything that happens (Facione, 2015). Critical thinking has higher levels such as analysis, synthesis, evaluation, drawing conclusions and reflection that make students evaluate in class or life. Someone who has critical thinking skills will be able to solve problems from

various points of view more optimally (Ennis, 2015).

Unfortunately, many students have demonstrated a relatively low level of understanding of concepts and critical thinking (Elisanti et al., 2018; Fauzi, 2019; Fitriani et al., 2022). This deficiency is often attributed to the prevailing educational practices (Ramdiah et al., 2019), which tend to neglect students' ideas, concepts, and thinking capabilities. Biology education, in particular, is often characterized by rote memorization, note-taking, and imitation, which are deemed inadequate for achieving the intended learning outcomes (Lestari & Parmiti, 2020). Therefore, there is a pressing need for solutions aimed at enhancing conceptual understanding and critical thinking among students.

The solution to improving students' understanding of concepts and critical thinking can be done by providing learning media so that students are able to understand concepts and develop their thinking skills optimally. Learning media that can be applied in learning and help students learn are modules. Modules can be described as structured learning resources using language that is easy for students to understand and learn independently. Modules have the main characteristics as learning resources which are their advantages, namely self-instructional, self-contained, adaptive and use friendly. Modules can be used as an alternative among other learning resources that can support students in learning.

The utilization of Science, Environment, Technology, and Society (SETS) as an instructional approach holds a significant role in the education, particularly in enhancing students' conceptual understanding and critical thinking skills (Usmeldi et al., 2017). Students' comprehension of complex scientific concepts and their ability to think critically are pivotal for their overall competencies. Traditional biology teaching methods that emphasize rote memorization and passive learning have proven inadequate in fostering these essential skills. On the other hand, SETS, as an interdisciplinary approach, offers a holistic perspective on science, emphasizing the interconnectedness of knowledge and its practical applications in real-world contexts. By adopting SETS-based strategies, teacher can empower students to explore, reason, and analyze scientific concepts in depth, encouraging them to become active participants in their own learning experience (Fitri & Anhar, 2019).

As science and technology advances, digital-based teaching materials are being developed. Digital modules as an innovation medium are prepared to support and make it easier for students to learn. Digital modules are also referred to as comprehensive independent learning resources with instructions for self-study (Kuncahyono, 2018). Digital media can accommodate students in optimizing understanding, providing interesting data, supporting data interpretation and obtaining information. In addition, digital media can cause the learning process to become active, thereby improving the quality of learning (Clark & Mayer, 2016; Lin et al., 2017).

The presence of SETS-based digital biology modules is expected to make it easier for students to master concepts and develop critical thinking processes with phenomena in life that are integrated through science, environment, technology and society. Students are able to study independently and explore information from the SETS-based biology module as a whole. The SETS approach can complement digital modules so that students can continue to be active and improve their understanding of learning. Critical thinking can also be improved by using the module (Selviani, 2019). Another study have also analyzed the impact of SETS on student thinking skills (Usmeldi et al., 2017). Other research endeavors have seen the development of SETS-based modules (Hayati et al., 2019; Rahma et al., 2017). However, research that packages SETS into digital modules and assesses its influence on conceptual understanding and critical thinking remains scarce. Hence, the objective of this study was to create digital modules incorporating the SETS approach within the context of environmental change materials with the aim of enhancing student conceptual understanding and critical thinking.

Method

Research design

This study uses research and development with the ADDIE (Analysis, Design, Development, Implementation and evaluation) development model. Product development in the form of SETS-based environmental change digital modules to improve students' conceptual understanding and critical thinking. This research involved 34 students of class X MIPA 2 SMA (Senior High School) Cahaya Fadilah Jakarta in the Even Semester of the 2022/2023 academic year which were selected by purposive sampling. The one-group pretest-posttest research design was implemented when the product was implemented.

Research instrument

The test instruments used are conceptual understanding instruments and critical thinking instruments. The instrument for understanding the concept is in the form of multiple choice questions for the pretest and posttest. The test instrument consists of 11 valid questions out of a total of 12 questions which refer to indicators of understanding the concept. The conceptual understanding test instrument grid can be seen in Table 1. The instrument will be tested for validity before testing the instrument. Calculation of

instrument validity with coefficients and validity criteria can be seen in Table 2. Next, critical thinking test instrument is in the essay form. The test instrument consists of 19 valid questions out of 24 the number of questions which refer to indicators of critical thinking can be seen in Table 3.

Table 1. Concept understanding test instrument grid

No	Concept Understanding Indicator	Question Item Number
1	Remember	1*, 2
2	Understand	3, 4
3	Apply	5, 6
4	Analyze	7, 8
5	Evaluate	9, 10
6	Create	11, 12

Table 2. Coefficients and validity criteria

Coefficient	Criteria	Question Item Number
0.81 – 1.00	Very high	-
0.61 – 0.80	High	12
0.41 – 0.60	Enough	2, 3, 4, 5, 6, 8, 9, 10, 11
0.21 – 0.40	Low	7
0.00 – 0.20	Very low	1*

Table 3. Critical thinking test instrument grid

No	Critical Thinking Indicator	Question Item Number
1	Focusing questions	1*, 2
2	Analyze questions	3*, 4
3	Ask and answer questions. explanation or challenge	5*, 6
4	Consider the criteria and the validity of the information	7*, 8
5	Observe and consider reports of observations	9, 10
6	Deduce and consider the results of the deduction	11, 12
7	Induce and consider the results of induction	13, 14
8	Make and determine the results of the consideration	15, 16
9	Defining terms and definitions of consideration	17, 18
10	Identify assumptions	19, 20*
11	Define action	21, 22
12	Interact with others	23, 24

Note: *) Invalid item

Then, the instrument was tested for validity before testing the instrument. Calculation of instrument validity with coefficients and validity criteria can be seen in Table 4. Next, the reliability test will be carried out on the instrument. Calculation of reliability with reliability test can be seen in Table 5.

Table 4. Coefficients and validity criteria

Coefficient	Criteria	Question Item Number
0,81 – 1,00	Very high	-
0,61 – 0,80	High	9, 16, 21
0,41 – 0,60	Enough	3*, 5, 10, 11, 12, 13, 14, 15, 17, 22, 23, 24
0,21 – 0,40	Low	1*, 2*, 4, 6, 7*, 8, 18, 19, 20*
0,00 – 0,20	Very low	-

Note: *) Invalid item

Table 5. Reliability test interpretation

Reliability coefficient	Interpretation
$0,81 < r \leq 1,00$	Very good
$0,61 < r \leq 0,80$	Good
$0,41 < r \leq 0,60$	Enough
$0,21 < r \leq 0,40$	Low
$0,00 < r \leq 0,20$	Very low

The questionnaire was also used as instrument in this study. This instrument is used to obtain data regarding the validity of the media to be developed. This questionnaire contains aspects and product assessment components of SETS (Science, Environment, Technology and Society)-based digital modules for environmental change. The validation questionnaire will be filled out by experts, namely

material and media experts. Experts examine and assess the media from the aspects of content, presentation and language feasibility. The questionnaire was prepared using a Likert scale with a score range of 1 to 5 (Sungkono, 2012).
Then, the material expert validation questionnaire consists of three aspects which include content feasibility, presentation and language. The questionnaire was prepared using a Likert scale with a score range of 1 to 5 consisting of 16 statement items. The grid of the questionnaire was presented in Table 6.

Table 6. Product validation questionnaire grid for material experts

No	Aspect	Indicator	Item Number
1	Content eligibility	Conformity of content with Basic Competency and Learning Objectives	1
		Clarity of learning topics	2
		Consistency, coverage, completeness of the material	3, 4, 5
		Relevance of sample material with the conditions that exist in the surrounding environment	6
		Appropriateness of the evaluation with the material and learning objectives	7
		The answer key given is correct	8
2	Presentation eligibility	Cover attractiveness	9
		Ease of reading	10
		Ease of use	11
		Presentation of digital modules on student involvement in learning	12
3	Language feasibility	Clarity of instructions for using the digital module	13
		The ease of understanding the material through the use of language	14
		Term accuracy	15
		Politeness in the use of language	16

The media expert validation questionnaire consists of two aspects which include presentation feasibility and language (Table 7). The questionnaire was prepared using a Likert scale with a score range of 1 to 5 consisting of 12 statement items.

Table 7. Product validation questionnaire grid for media experts

No	Aspect	indicator	item number
1	Presentation eligibility Language feasibility	The cramped presentation of digital modules	1
		Presentation of digital modules on student involvement in learning	2
		Ease of use	3
		Cover attractiveness	4
		Page design settings	5
		The choice of font type and size supports the media to be more attractive	6
		Ease of reading text	7
		Color selection	8
2	Presentation eligibility	The clear instructions for using the digital module are conveyed clearly	9
		Language suitability at the student level	10
		The ease of understanding the material through the use of language	11
		Politeness in the use of language	12

Then, the study also used questionnaire sheet contains questions given to teachers and students regarding the media developed. This questionnaire is used to obtain suggestions from teachers and students on the product being developed. Then improvements will be made to the product based on the suggestions submitted (Table 8).
The response questionnaire consists of three aspects which include the appropriateness of the content, presentation and language. The questionnaire was prepared using a Likert scale with a score range of 1 to 5 consisting of 7 statement items.

Data analysis

The data analysis technique used is descriptive quantitative. The data were obtained from the validation questionnaire sheet and the validator's assessment then the average value was calculated. The product assessment category is determined based on the average value of the validator. Validation in this case is directed to the feasibility test of the product being developed. Product validation criteria, as follows in Table 9 (Sudjana, 2014).

Table 8. Response questionnaire grid

No	Aspect	Indicator	Item Number
1	Content eligibility	Relevance of sample material with the conditions that exist in the surrounding environment	5
2	Presentation eligibility	Ease of reading text	6
		The ability of the media to increase knowledge and broaden horizons	3, 4
		Interest in using digital modules in learning	7
3	Language eligibility	Instructions for using the digital module are clearly conveyed	1
		The ease of understanding the material through the use of language	2

Table 9. Product validation criteria

Score Intervals	Rating Category	Information
3.21 – 4.00	Very worth it	Can be used without revision
2.41 – 3.20	Worth it	Usable with minor revisions
1.61 – 2.40	Not worth it	Can be used with multiple revisions
1.00 – 1.60	Not feasible	Not yet usable and requires more consultation

The analysis used for the test of conceptual understanding and critical thinking aims to obtain mastery of students' cognitive learning based on the results of the pretest and posttest scores of conceptual understanding and critical thinking. The analysis was carried out by looking at the increase in students' conceptual understanding and critical thinking before and after implementing the product developed. Then, responses were obtained from response questionnaires given to students and teachers in trials and learning activities using the products developed. Analysis of the data obtained using descriptive qualitative techniques. Response questionnaire scores can be categorized as follows in Table 10 (Sudjana, 2014).

Table 10. Response Questionnaire Results Criteria

Percentage	Criteria
81-100	Very strong
61-80	Strong
41-60	Enough
21-40	Weak
0-20	Very weak

The effectiveness of the media in increasing conceptual understanding and critical thinking is determined based on increasing conceptual understanding, critical thinking and the use of the products developed This analysis was used to obtain data on the effectiveness of the SETS-based digital module for environmental change based on differences in student pretest and posttest scores. The analysis phase involves a prerequisite test (normality and homogeneity test) and hypothesis test (paired samples t-test). Furthermore, N-gain was also calculated. The N-Gain test is used to obtain data on the effectiveness of SETS-based digital modules on environmental change based on increased conceptual understanding and critical thinking after learning activities are carried out. The gain score is also called the increase or difference in score which is the difference between the pretest and posttest scores in one sample group. The results of the N-Gain calculations can be categorized in Table 11.

Table 11. N-Gain effectiveness category

N-Gain	Category
$(g) > 0,7$	High
$0,3 \leq (g) \leq 0,7$	Currently
$(g) \leq 0,3$	Low

Results and Discussion

This development resulted in a SETS (Science, Environment, Technology and Society)-based digital module for environmental change in the form of a flipbook that can be used or accessed via mobile phones or laptops. This digital module is designed to be able to improve students' conceptual understanding and critical thinking. The digital module is developed through five stages based on the ADDIE development model. The following describes the results of the SETS-based digital module development.

Analyze

Needs analysis was carried out by distributing questionnaires to class X students and conducting interviews with teachers at SMAS Cahaya Fadilah. The number of students who filled out the questionnaire was 70 students. The results of the analysis of student needs in terms of learning difficulties can be seen in Figure 1.

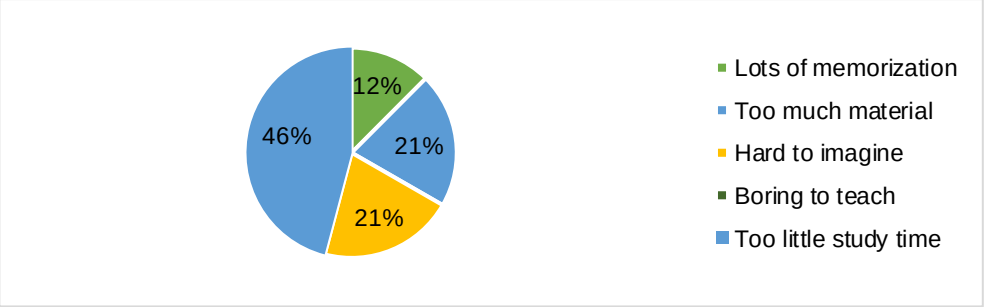


Figure 1. Biology learning difficulty factor diagram

The results of the questionnaire showed that 43% of respondents thought that the time for studying biology was too little. In addition, 19% thought that biology material was too much and difficult to imagine. A lot of memorization in biology learning by 12% is also a factor for students' difficulties in learning. Respondents also thought that environmental change material is one of the most widely discussed material which can be seen in Figure 2. This was also supported by the results of interviews with biology teachers at Cahaya Fadilah High School who stated that during the learning process the teacher only used lecture, question and answer and discussion methods. In addition, the learning media used are in the form of teacher's handbooks, powerpoints and worksheets. The use of digital modules has never been used by teachers in the learning process.

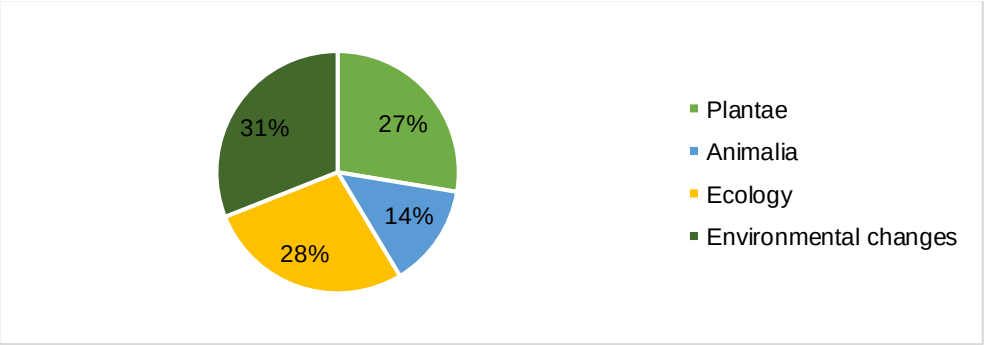


Figure 2. Biological material diagram

Design

Product development begins with the analysis stage, a needs analysis is carried out to determine the conditions and problems that exist in schools. A needs analysis was carried out on biology teachers and 70 class X students through interviews, observation and distribution of questionnaires. Based on the results of interviews and teacher observations, it was found that the teaching materials used in learning were teacher handbooks, worksheet, and PowerPoint. Apart from that, the learning methods usually used by teachers are lecture, question and answer or discussion methods. This is also supported by the results of interviews with teachers that generally students obtain learning outcomes below the passing grade from daily tests, PTS and PAS assessments.

Based on the results of the needs analysis, it was found that the learning media used by students was only the textbooks they had. In fact, information from textbooks is still inadequate for learning, so learning media that is suitable for students is needed. Apart from that, during learning, students have never used digital modules as a learning resource. This is supported by the results of the distribution of questionnaires which show that biology has too much material and is difficult to imagine.

Apart from that, the gap in biology learning time is small, which means that students' understanding is not optimal. Abstract biological material and less interesting media are factors that cause students to have difficulty learning. One material that is considered difficult and numerous is environmental change. This is in line with research by Jorgenson et al. (2019) which states that environmental change material is very complex and therefore quite difficult to understand.

The results of the needs analysis are used as an illustration of the extent to which the learning resources developed are needed for students to achieve learning goals. One learning resource that can be used independently is digital modules. This digital module is integrated with SETS which can accommodate students in developing their understanding of concepts and critical thinking. SETS seeks to provide an understanding of the role of the environment in science, technology and society as an integrated whole.

Based on the results of the needs analysis, it was continued at the design stage, so this stage was determined to design digital modules that empower students' understanding and critical thinking. This was done as an effort to provide learning media for students independently in biology learning, especially environmental change material. Students feel comfortable using digital modules and encourage students to study independently in more depth regarding topics (Kaliyadan et al., 2010).The design stage begins with designing and compiling digital module products. The manufacturing stage uses the Canva application which is designed in such a way that it will be formed into a flipbook.

Development

At the development stage, digital modules began to be developed using the Canva application in PDF form and continued with the Fliphtml5 application in flipbook form. This application can be accessed via cellphone or laptop. The components developed begin with the outer and inner covers including the title, author's name and logo. The cover section is created to provide initial information on the material to be studied. Next, a table of contents is created to make it easier for students to find the pages they want to read.

The introductory page is initial information about the digital module which contains the module identity, core competencies, basic competencies, and instructions for using the module. It is also equipped with a concept map as an initial overview of the materials and sub-materials that will be studied. Next, learning activities to be studied are arranged which consist of two main topics, namely environmental change and overcoming environmental problems. At the beginning of the learning activity, the learning objectives to be achieved by students are conveyed.

In the material description, it is also equipped with life examples as a real source of support. Apart from that, the application of SETS was created to develop students' understanding and thinking skills by linking the concepts of science, environment, technology and society according to examples from everyday life. The SETS approach is effectively implemented which is focused on the student's environment which can train students to be more sensitive to environmental problems (Wahono et al., 2020).

The advantage of this SETS-based digital module is that it connects the scientific concepts studied and their relationship to the environment, technology and society. Apart from that, problems that occur in everyday life are presented so that students can explore the knowledge contained therein. This is in line with what was stated by Lee and Erdogan (2007) in their research that SETS-based modules involve problem-driven activities that begin with questions, problems and situations that are relevant to the students.

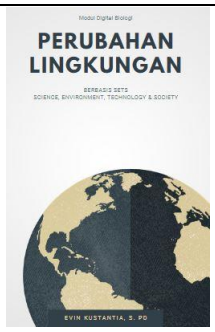
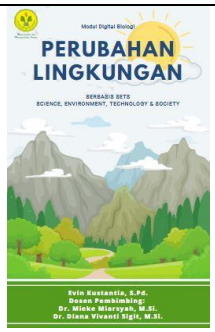
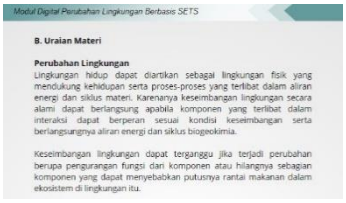
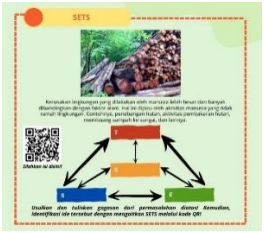
The digital module is also equipped with a QR code as a follow-up to the learning activities that students carry out. Then, an evaluation is also made in the form of questions as a form of student reflection to determine the achievement of indicators for each learning activity that has been carried out. At the end of the digital module there is an answer key for the evaluation provided, a glossary to help students understand unfamiliar terms, a bibliography and author profile. Attractive digital modules contain images or videos as supporting material, are interactive, have example questions, contain practice questions, use language that is easy to understand and provide problems related to the environment that encourage students to explore (Conradty et al., 2020).

It is hoped that the preparation of this digital module will make it easier for students to learn, especially in environmental change material, by linking the concepts of science, environment, technology and society. This is done so that students can develop their understanding and thinking abilities. Understanding concepts is the beginning of a thinking process which ends with the ability to think critically, solve problems and make decisions as the final stage in the thinking process that has been passed previously (Marczak, 2019).

At the product development stage, product validity was tested by media experts and material experts. Media expert validators consist of two validators who are experts in their fields. Material expert validation

is carried out by assessing the quality of the product material content. The material expert validator consists of two validators who are experts in their fields. The aspects assessed consist of three aspects, namely content, presentation and language aspects. Based on the validation results from two material experts, the digital module was declared valid for further use in learning. Digital modules contain material that is arranged systematically so that students can easily understand the material well and can develop their understanding of concepts and critical thinking. The aspects assessed consist of two aspects, namely presentation and language aspects. The product development results before and after being revised according to the validator's suggestions can be seen in Table 12.

Table 12. Results of Digital Module Product Development

Page	Before revision	After revision
Cover		
	Suggestions and comments: The design is still simple and the color is not bright enough on the cover, it is better to include the name of the supervisor in product development.	Revision: The cover is more colorful and the supervisor's name has been included on the cover.
Material description		
	Suggestions and comments: It would be better if the initial part of the material was given trigger questions to stimulate students	Revision: Equipped with trigger questions at the beginning of each material
Application sets		
	Suggestions and comments: It is better if there is a follow-up for students in integrating SETS by providing a filling link	Revision: The application of SETS is clearer and a link for filling in has been made as a follow-up for students

Eight items measuring the presentation aspect and four items assessing the language aspect received a "very worth it" rating from media experts. According to the validation results from media experts, the average score for all aspects was 90%, indicating that the digital module was considered suitable for use with minor revisions in line with the suggestions. Furthermore, four items in the content aspect, two in the presentation aspect, and all items in the language aspect attained a "very worth it" rating from material experts, while the remaining items were rated as "worthy." The material expert validation results yielded an average score of 85% for all aspects, signifying that the digital module is deemed feasible for use with minor revisions in line with the recommendations. Based on the validation results from two media experts, it was stated that the digital module was valid for further use in learning. This states that the digital module

is well structured in terms of cover, introduction, concept map, material description, images, application of SETS, summary, equipped with evaluation questions and bibliography. Modules are independent and structured learning experiences with a coherent and explicit set of learning outcomes and assessments (Donnelly, & Fitzmaurice, 2005).

Implementation

The implementation stage is carried out after the product is declared feasible to be tested on students in learning. The stage was carried out in class X MIPA 2 which consisted of 34 students. In the initial stage, students are asked to take a pretest of 11 questions on understanding concepts and 19 questions on critical thinking. The application of the digital module was carried out in two meetings where students carried out learning using the SETS-based digital environmental change module that had been developed. At the end of the meeting, students were asked to return to do the posttest.

The results of the students' pretest and posttest can be seen in Table 13. Based on the results of the pretest and posttest, it can be seen that the use of the SETS-based digital environmental change module has differences in the pretest and posttest scores of students' conceptual understanding and critical thinking. The results of the pretest and posttest understanding of concepts carried out by students respectively obtained an average score of 41 and 82. It can be seen that the average pretest score for understanding concepts has increased in the posttest score for understanding concepts.

Table 13. Pretest and posttest results for understanding concepts and critical thinking

Statistic	Concept understanding		Critical thinking	
	Pretest	*Posttest*	*Pretest*	*Posttest*
Average	41	82	28	80
Max value	64	100	53	99
Min value	18	64	13	53

For the results of the critical thinking pretest and posttest carried out by students, the average scores were 28 and 80 respectively. It can also be seen that the average critical thinking pretest score has increased in the critical thinking posttest score. These results show that there are differences in pretest and posttest scores in students' conceptual understanding and critical thinking. At the end of the meeting, students and teachers were asked to fill out a questionnaire assessing the products that had been developed. The results of the teacher and student questionnaires show that they strongly agree that the SETS-based digital environmental change module can be used in the biology learning process. Digital modules have a positive effect on students' understanding of concepts and critical thinking. Digital modules are useful in terms of training and improving students' critical thinking and argumentation skills (Noroozi & Mulder, 2017).

After that, respondent's questionnaire was distributed to teachers and students as a product assessment. Based on the results of the teacher respondent questionnaire, the average was 4.7, which means teachers strongly agree that digital modules can be used in learning. In line with the result, based on the results of the student respondent questionnaire, the average was 4.8, which means students strongly agree that digital modules can be used in learning.

Evaluation

After conducting pretests and posttests, the data were analyzed for distribution and variance. The analysis using the Kolmogorov-Smirnov test indicated that all data followed a normal distribution, including the pretest ($p = 0.086$) and posttest for the concept understanding variable ($p = 0.06$), as well as the pretest ($p = 0.200$) and posttest for the critical thinking variable (0.095). Furthermore, the homogeneity test results revealed that the concept understanding data were homogeneous ($p = 0.298$), as were the critical thinking data ($p = 0.137$). Since both variables met the prerequisite tests, both variables were further analyzed using the t-test.

A summary of the t-test results is presented in Table 14. Based on Table 14, a significant difference was found between the pretest and posttest for concept understanding ($t = 41.470$, $p < 0.001$). Similar results were also observed for critical thinking skills ($t = 20.182$, $p < 0.001$). Consequently, the presence of the developed module had a significant impact on improving both variables. Furthermore, based on the effectiveness test results, the average N-Gain for the concept understanding was 0.72, and for critical thinking, it was 0.71. Therefore, it can be concluded that the use of SETS-based digital modules for environmental change falls into the high effectiveness category in enhancing students' conceptual understanding and critical thinking.

Table 14. Concept Understanding Hypothesis Test Results

Variable	Mean	Std. Deviation	Std. Error Mean	t	df	Sig.
Concept understanding	-40.706	5.724	.982	-41.470	33	.000
Critical thinking	-51.647	14.922	2.559	-20.182	33	.000

The use of SETS-based digital environmental change modules can have an influence on students' conceptual understanding and critical thinking. SETS-based digital modules are interactive learning media with visual designs that can stimulate students to develop their understanding and thinking abilities (Huang, 2005). SETS-based digital modules can be applied to learning for students both in the classroom and outside the classroom independently. This is in line with research by Bernacki et al. (2020) which states that the development of SETS-based e-modules is effective for improving students' conceptual understanding and critical thinking skills and can help students in learning.

Based on the finding, an increase in students' pretest and posttest scores for understanding concepts and critical thinking was obtained. This proves that conceptual understanding and critical thinking can be improved by using SETS-based digital modules by making it easier for students to understand the material and develop their thinking skills through activities in the digital module. Thus, there can be seen an increase in the pretest and posttest of students' conceptual understanding and critical thinking. This is in line with research by Soroko (2020) which proves that the use of SETS in e-modules makes students focus on developing problem-solving skills creatively, critically and systematically so that it has an effect on increasing students' understanding of concepts and critical thinking.

In the digital module there are SETS application activities where students are asked to formulate problems and know the material to be studied. Then, students hold discussions on problem topics that contain examples from life. Students are asked to complete the SETS chart by linking the concepts of science, environment, technology and benefits to society. This activity can develop students' conceptual understanding and critical thinking. This is in line with research by Hickman and Akdere (2017) which states that the application of SETS can encourage students to be more active in learning by involving an environment to seek and form their own knowledge based on experience.

The SETS-based digital module is expected to provide an understanding of SETS elements by guiding students to think globally, solve problems, develop science process skills, and be motivated by good learning outcomes. SETS-based digital modules can help students learn subject matter independently because digital modules are arranged systematically, the material is coherent, the language is communicative and two-way in nature. Apart from that, the SETS-based digital module contains images that can visualize concepts in the material.

Conclusion

In summary, the findings of this research indicate that the development of a SETS-based digital environmental change module, presented in flipbook format, was executed using the ADDIE development model. This module has demonstrated a high degree of validity for enhancing students' conceptual understanding and critical thinking. Furthermore, the module's implementation in class X of high schools has effectively improved students' conceptual understanding and critical thinking skills. The practical implication of these findings suggests that educators can utilize the SETS-based digital environmental change module as an instructional resource to enhance students' conceptual understanding and critical thinking. Similarly, students can employ this module as a self-directed learning tool to bolster their comprehension of concepts and critical thinking skills.

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Conflicts of Interest

No potential conflict of interest was reported by the authors.

Author Contributions

E. Kustantia: methodology; analysis; writing original draft, review and editing. **M. Miarsyah**: review and editing. **D. V. Sigit**: review and editing.

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