

Validity of E-module Biology Based on Scientific Approach to Improve Students' Critical Thinking Skills on Biodiversity Class X SMA



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ABSTRACT: The development of science and technology is very fast and increasingly sophisticated, so schools as educational institutions are required to train critical thinking skills which are one of the skills demanded in 21st century learning. However, the facts found in schools are that the level of students' critical thinking skills is still relatively low. . One of the media that is effectively used to overcome problems related to low critical thinking skills is the E-module. E-module is a form of presenting self-learning material in electronic format which is arranged systematically into the smallest learning units which include animation, audio, video and navigation so that users are more interactive in learning. This type of research is Research and Development (R&D) research using the Plomp Model. The object of this research is a biology E-module based on a scientific approach to biodiversity material to improve the critical thinking skills of class X high school students. The subjects of this study were three lecturers from the Department of Biology, FMIPA UNP, and one teacher at SMAN 1 Ranah Pesisir as validators for the use of the biology learning E-module. Based on the validation results, it can be concluded that the overall value of the validity results for the development of a biological E-module based on a scientific approach is in the valid category, meaning that the E-module is feasible to be tested in schools.

KEYWORDS: E-Modul, Scientific Approac, Critical Thinking Skills

INTRODUCTION

Learning biology is part of science which includes facts, laws and principles resulting from scientific processes that require problem solving through critical thinking skills (Agnafia, 2019: 45). Critical thinking is important to develop because it can improve the quality of thinking for students in solving problems related to Biology lessons (Wulandari et al., 2021: 66). Moreover, currently science and technology are developing very fast and are increasingly sophisticated, so schools as educational institutions are required to train critical thinking skills which are one of the skills required in 21st Century learning (Septikasari, 2018: 108).

The importance of promoting students' critical thinking skills so that they can take action to make the right decisions in accordance with scientific truths and be able to solve the problems they face. However, the fact found in schools is that the level of students' critical thinking skills is still relatively low. This is in accordance with the results of the questionnaire analysis in the form of critical thinking skills questions that the researchers did in class X SMAN 2 Padang and SMAN 1 Ranah Pesisir with a total of 69 students as shown in Table 1.

Table 1. Percentage Results of Students' Critical Thinking Skills

Class	Indicator	Percentage	Description
X MIPA	Give a simple explanation	58.3%	Passably
	Build basic skills	69.6%	Good
	Conclude	40%	Deficient
	Provide further explanation	39.6%	Deficient
	Set strategy and tactics	38.7%	Deficient

Source: Observation Results based on Indicators put forward by Ennis (1985)

Based on the results of the analysis of the critical thinking skills questionnaire above, it shows that there are still several indicators that are in the unfavorable category. This is in accordance with the observational data that has been carried out at SMAN 2 Padang and SMAN 1 Ranah Pesisir, obtained information that students have not been able to take strategies in solving problem-based questions. Therefore, students' critical thinking skills are still relatively low.

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The low critical thinking skills of students cannot be separated from the role of educators, one of which is in the use of learning media. This is supported by the results of teacher interviews that the media used so far has not directed students to be able to solve problems and provide solutions to the problems given. Therefore, teachers have difficulty finding appropriate learning resources or media. The media that teachers usually use in the learning process are still in the form of power point slides, textbooks, worksheets, and innovative learning videos. The teacher believes that the learning media is still not effective because it has not been able to increase students' learning motivation. On the other hand, from the results of the interviews, it was found that the available time allocation was not in accordance with the complexity of the learning material so that students needed independent study time outside of class hours to understand the material.

Based on the results of teacher interviews, information was also obtained that biodiversity material is material that is difficult for students to understand. Because the scope of the material is too broad, interesting media is needed to increase students' understanding in learning. This is in accordance with the results of the student questionnaire analysis that as a whole students have used media in the learning process. However, the media used has not been fully able to guide the process of discovering learning concepts independently, but guidance is still needed by the teacher so that it has not been able to improve students' critical thinking skills. This is evidenced by the large number of students who have difficulty understanding the Odd Semester Biology material, especially on biodiversity material. Because they state that 37.5% of matter is abstract, not directly observable; 70% the number of terms that are difficult to understand; 30% of the language used in books is difficult to understand; 26.3% lack the availability of clear pictures to support material explanations; 23.3% material is too complex and broad in scope.

One of the media that is effectively used to overcome problems related to low critical thinking skills is E-module (Turnip et al, 2021: 487). This is in line with Prihatiningtyas, et al. (2021: 134-135) that Emodule can require students to learn to solve problems in their own way so as to improve critical thinking skills. Then also supported by Irfan, et al. (2019: 11-12) that Emodule is a form of presenting independent learning material in electronic format which is arranged systematically into the smallest learning units which include animation, audio, video and navigation so that users are more interactive in learning. In addition, Suryani and Sandika (2022: 23) also revealed that E-modules can be used as an alternative method of learning where students are able to understand and improve understanding independently.

To make the use of E-modules effective in the learning process, it can be supported by the application of a scientific approach that facilitates the learning process to become meaningful. According to Putri, et al. (2020: 216) learning with a scientific approach through scientific stages includes observing, formulating problems, conducting experiments, collecting data, analyzing data, drawing conclusions, and communicating them.

This scientific approach is very suitable in learning biology, because it includes the nature of learning biology which requires students to play an active role in the learning process, work independently to formulate problems, face problems and solve problems in the surrounding environment (Alfiana et al., 2022: 605). This way of learning can certainly improve students' ability to think critically. This is in accordance with Liana (2020: 24) that a scientific approach can improve students' critical thinking skills through the learning stages contained therein.

Previous research on module development based on a scientific approach has been carried out, among others, by Kliyanti, et al. (2018); Marera (2019); Ulandari, et al. (2018); and Setiyadi, et al. (2017). However, the module is not in electronic form (Emodule) so it still does not fully assist students in improving critical thinking skills. Likewise research on the development of Emodules in biology learning has been carried out, among others by Haka, et al. (2021) and Nia, et al. (2022). However, the developed E-module is not based on a scientific approach.

The use of scientific approach principles in the development of E-modules can facilitate students to be more active in learning. With the combination of E-module and scientific approach, it is expected to be an alternative as well as a solution to improve students' critical thinking skills in learning. Then it can motivate students to build and discover their own knowledge.

Based on this background, the authors compiled an article entitled the validity of the biology E-module based on a scientific approach to improve students' critical thinking skills in class X high school biodiversity material.

METHODOLOGY

This type of research is research development or termed Research and Development (R & D). This study aims to determine the validity of the Biology E-module based on a scientific approach to improve students' critical thinking skills in class X high school biodiversity material. This research began in the odd semester of July-December at SMAN 1 Pesisir, Academic Year 2022/2023. The research was conducted at the Faculty of Mathematics and Natural Sciences (FMIPA) Padang State University (UNP) and SMAN 1 Ranah Pesisir. The subjects of this study were 33 class X students of SMAN 1 Coastal Ranch, two lecturers from the Department of Biology FMIPA UNP and one biology teacher at SMAN 1 Coastal Ranch. The object of this research is a biology E-module based on a scientific approach to improve students' critical thinking skills in class X high school biodiversity material.

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The biology e-module based on a scientific approach was developed using the Plomp model. The Plomp (2013) development procedure has three stages of development, namely the Preliminary Research Phase, Development or Prototype Phase and Assessment Phase. However, in this study it was only carried out until the validity test stage (Development or Prototype Phase).

The instrument used to collect data in this study is a validity questionnaire. The validity questionnaire is used to find out whether the media that has been designed is valid or not. The validity questionnaire used consists of several assessment components based on the provisions of the Ministry of National Education (2008) which include content feasibility, language, presentation, and graphics. Analysis of the validity of the biological E-module based on a scientific approach with the following stages.

- a. Provides an answer score for each item based on a Likert scale
- b. All items scored are then tabulated and the percentage sought using the formula:

$$\text{Validity value} = \frac{\text{the total score obtained}}{\text{maximum number of scores}} \times 100\%$$

- c. Based on the validity value obtained, the criteria for evaluating the validity of the E-module based on a scientific approach are determined with the provisions as in Table 2. The product is declared valid if the percentage is greater than or equal to 61%.

Table 2. E-module Validity Criteria

Validity Value (%)	Category
81-100	Very Valid
61-80	Valid
41-60	Valid Enough
21-40	less valid
0-20	Invalid

Modified from Riduwan (2012: 29)

FINDINGS AND DISCUSSIONS

1. Preliminary Research Phase

This initial investigation stage was carried out to determine the initial conditions of learning biology, especially in class X SMAN 1 Ranah Pesisir and SMAN 2 Padang. This information is analyzed as a basis for designing biology E-modules based on a scientific approach, as described below. a. Curriculum Analysis

Based on curriculum analysis conducted through interviews with teachers, the material taught in class X semester 1 consisted of viruses and biodiversity. In this study, researchers only analyzed one material, namely biodiversity. This analysis was carried out on learning outcomes, learning objectives and the flow of learning objectives in the independent curriculum as shown in Table 3.

Table 3. Analysis of Learning Outcomes, Learning Objectives and Flow of Learning Objectives

No	Observed Aspects	Yes	No	Information
1.	Learning objectives in accordance with Learning Outcomes	√		
2.	The flow of learning objectives is in accordance with the learning objectives	√		
3.	Learning according to the characteristics of students		√	Not yet in accordance with the learning style and needs of students
4.	The material presented is well sorted	√		
5	Assessment according to the material presented	√		

Based on the curriculum analysis carried out, the learning outcomes and learning objectives for biodiversity material are described which can be seen in Table 4.

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Table 4. Learning Outcomes and Learning Objectives of Biodiversity Material

Learning Outcomes	Learning Objectives
At the end of phase E, students have the ability to create solutions to problems based on local, national or global issues related to understanding the diversity of living things and their roles, viruses and their roles, biological technological innovations, ecosystem components and interactions between components and environmental changes.	Students can identify types of biodiversity Students can identify Ecosystem Types (Water and Land) Students can identify the distribution of Indonesian flora and fauna Students can analyze Threats and Efforts to Preserve Biodiversity Students can understand the benefits and basic classification of living things Students can understand the sequence of animal and plant taxa Students can explain the Nomenclature Binomial Nomenclature Students can explain the Development of the Classification of Living Things Students can make cladograms

Based on the elaboration of CP and TP, an E-module based on a scientific approach is developed which is expected to be able to facilitate students to be able to improve students' critical thinking skills regarding material independently through various learning activities.

b. Analysis of problems and needs in biology learning

In the problem and needs analysis activities, the researcher collected information about learning biology at SMAN 1 Ranah Pesisir and SMAN 2 Padang through interviews with biology teachers and used observation sheets which were distributed to students. From the interview results it is known that the media used so far has not directed students to be able to solve problems and provide solutions to the problems given. Therefore, teachers have difficulty finding appropriate learning resources or media.

The media that teachers usually use in the learning process are still in the form of power point slides, textbooks, worksheets, and innovative learning videos. The teacher believes that the learning media is still ineffective because it has not been able to train students' reasoning abilities and critical thinking skills. This is also supported by the results of the analysis of 5 initial ability test questions given to students that they have not been able to take strategies in solving problem-based questions. Therefore, students' critical thinking skills are still relatively low.

Furthermore, from the results of teacher interviews, information was also obtained that biodiversity material was material that was difficult for students to understand. Because the scope of the material is too broad, interesting media is needed to increase students' understanding in learning. This is in accordance with the results of the student questionnaire analysis that as a whole students have used media in the learning process. However, the media used has not been fully able to guide the process of discovering learning concepts independently, but guidance is still needed by the teacher so that it has not been able to improve students' critical thinking skills. This is evidenced by the large number of students who have difficulty understanding the Odd Semester Biology material, especially on biodiversity material. Therefore they want interesting and interactive media to be used in the learning process such as reading in each picture, in color on each page, presenting material in short, concise and clear language. Then provided exercises on each topic of discussion.

Based on the results of the analysis of these problems and needs, in order to be able to improve students' critical thinking skills and guide them to be able to learn independently, the researchers designed learning media in the form of E-modules based on a scientific approach.

c. Concept analysis
Concept analysis is carried out so that it is easier for students to understand the material to be studied. Concept analysis is structured to arrange material concepts systematically by forming concept maps. This research will be carried out on biodiversity material for class X SMA in odd semesters. The results of the analysis of the concept are as follows.

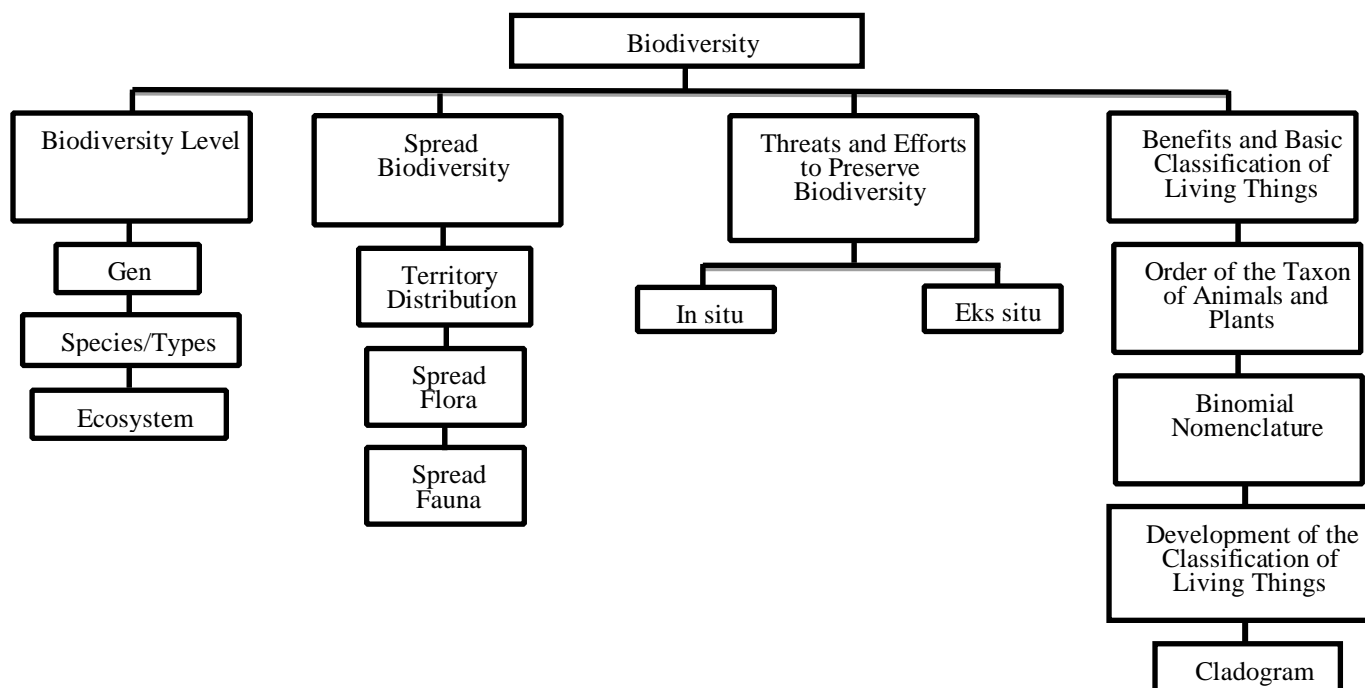


Figure 1. Concept Map of Biodiversity Material

2. Development or Prototype Phase

a. Results of E-module Design (Prototype I)

Based on the results of the initial investigation, a scientific approach-based biology E-module was designed for class X SMA on one learning material, namely biodiversity. According to Oktaviana et al (2020: 132). The use of E-modules can help the learning process become more interesting, because it can present material in the form of images or videos, and students can also study it repeatedly, making it easier for students in the learning process. This e-module was created using the Canva and Flip PDF Professional applications.

Characteristics The biology e-module based on a scientific approach has several components which include cover, main menu, table of contents, introductory words, concept maps, introduction, learning activities (1-9), evaluation questions and bibliography.

b. Biology E-module Validation Based on Scientific Approach

The results of prototype I were validated through 2 stages, namely self-evaluation and expert review. The two stages will be explained as follows.

1) Self-Evaluation Results

the self-evaluation stage, the researcher re-checked prototype I. The things that were noticed at the self-evaluation stage were typo errors, punctuation usage, sentence clarity, picture clarity, function of all buttons, menu presentation clarity and instructions for use., the suitability of the images for the problems given, the suitability of the material with the CP and TP and the suitability of the questions with the material. For more details, the results of the revision can be seen in Table 5 below.

Table 5. Results of Self Evaluation (Self Evaluation) Before and After Revision

No	Aspek yang Dinilai	Sebelum Direvisi	Sesudah Direvisi
1	Typing error	There are errors in writing words such as a lack of letters Error in writing the scientific name	There are no more mistakes in writing words The writing of the scientific name has been corrected
2	Functionality of all buttons	There are some buttons that don't work	All buttons are working after repair
3	Image clarity	There are some supporting images that are of poor quality	The supporting images used are of good quality
4	Clarity of menu presentation and instructions for use	There is no home menu on the E-module	The home menu has been added

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Based on Table 5. it is known that there are errors in writing letters, then there are several buttons that do not work. In addition, there are also several images that are of poor quality, as well as a lack of clarity in presenting the menu on the E-module. After the results of the self-evaluation were revised, the revised scientific approach-based biology E-module, called prototype II, was prepared for the expert review stage.

2) Expert Review Results

In the expert review validation stage, the researcher validated the E-module on experts, namely three Biology lecturers at FMIPA UNP and one Biology teacher at SMAN 1 Pesisir. The aspects assessed in the E-module are content feasibility, language, presentation, and graphics. The results of the biological E-module validation based on a scientific approach can be seen in Table 6 below.

Table 6. Results of Biology E-Module Based on Scientific Approach Analysis by Experts

No	Rated aspect	Validity value (%)	Criteria
1	Content Eligibility	80.55%	Very Valid
2	language	84.37%	Very Valid
3	Presentation	85.00%	Very Valid
4	graphics	85.22%	Very Valid
Average		83.78%	Very Valid

Based on Table 6. it can be seen that the average value of validity is 83.78% with very valid criteria. This shows that the biology E-module based on a scientific approach that has been developed has fulfilled all four aspects of the validity test based on the assessment of the validators. Thus this E-module can be used either as a learning medium or as a learning resource in accordance with the demands of the independent curriculum. This is supported by several research results on the development of biology modules which can be seen in Table 7 below.

Table 7. Validity results regarding the development of the biology module

No	Researcher	Category
1	Marera (2019)	Very Valid
2	Ulandari, et al. (2018)	Very Valid
3	Kliyanti, et al. (2018)	Very Valid
4	Hakka, et al. (2021)	Valid
4	Nia, et al. (2022)	Very Valid
5	Setyadi, et al. (2017)	Valid

Based on the results of the research above, the overall value of the results of the validity of the module development is in the very valid category so that the media is feasible to be tested in schools.

In this study, researchers developed an E-module based on a scientific approach to biodiversity material. This is caused by the lack of research that uses elements of a scientific approach to Biology learning, especially in the form of electronic modules on biodiversity material. The development of a biological E-module based on a scientific approach that has been carried out by previous researchers is only about the respiratory system (Marera, 2019). As for the research of Kliyanti, et al. (2018) on biodiversity material, but not yet in the form of an electronic module. Based on the results of a literature review, researchers have not yet found a biology E-module based on a scientific approach on biodiversity material for high school class X students. So with this complete combination of learning media, this learning media meets the requirements to be used as an alternative as well as a solution to achieve the desired learning objectives.

CONCLUSION

Based on the results of the research and discussion that has been presented, it can be concluded that the overall value of the validity results for the development of a biological E-module based on a scientific approach is in the valid category, meaning that the E-module is feasible to be tested in schools.

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