Development of E-Modules Based on Project Based Learning on Virus Material to Improve Students' Creative Thinking

Istiadzah Darmastuti[1], Zulfiani[2*], Yuke Mardiati[3]

[1,2,3]Biology Education, Faculty of Teacher Training and Education, Universitas Islam Negeri Syarif Hidayatullah Jakarta. South Tangerang, Indonesia, 15412
*Corresponding author: zulfiani@uinjkt.ac.id

Abstract: *The existence of teaching materials, namely e-modules, followed by the need for adaptive technology, is needed to optimize learning. This research aims to produce an electronic module (E-Module) based on project-based learning of virus material to improve students' creative thinking. The research used the ADDIE (Analyze, Design, Development, Implementation, Evaluation) development model and used all five stages. The development process goes through expert validation stages, readability testing, student responses to electronic modules in field trials, and n-gain testing. Four experts and a practitioner validated the development results, readability testing with 20 students and field trials with 36 students. The research results show that the total average percentage of electronic module media validation is 85,83% with a very good predicate. Meanwhile, the total average percentage of electronic module material validation was 92.3%, with a very good predicate. The readability test results were 97.56% with a very good predicate. The response results of 36 students to the electronic module were 97.26%, with a very good predicate. Apart from that, there was an increase in students' creative thinking after using the electronic module, namely 0.45 with moderate n-gain criteria. Based on the research results, the electronic module developed is suitable for biology learning with virus material to improve students' creative thinking.*

Keywords: *Electronic Module, Project Based Learning, Virus Material, Creative Thinking.*

1. INTRODUCTION

Education is preparing human resources that can answer the challenges of changing times. Given the importance of education in the life process, improving the quality of human resources is done by improving attitudes, knowledge and skills so that humans can adjust to their environment (Meke *et al*., 2022).

In the past, a person's talent was seen from his intelligence (IQ) level. However, it is now increasingly realized that what determines giftedness is not only intelligence but also creativity and task commitment or motivation to achieve (Munandar, 2014).

The school system has yet to develop and produce graduates to become fully creative individuals. Students tend to be prepared to become clerks who do technical things rather than being a visionary. Learning needs to be more focused on leading students to become their whole selves and think original. Learning in schools often needs more benefits of being in tune with the development of the environment, where the environment continues to change rapidly and is difficult to predict. (Restian, 2020).

Learning is emphasized on reproductive thinking, memorization, and finding one correct answer to the questions given. Higher-order thought processes, including creative thinking, are rarely practised (Munandar, 2014). Therefore, schools should be able to provide a curriculum that allows students to think creatively and have

problem-solving skills so that in the future, they can respond positively to every opportunity and challenge and be able to manage risks for the benefit of life in the present and in the future (Restian, 2020).

This happened at SMAN 1 Parung, according to one of the biology teachers, students' creativity still needs to be improved in the learning process because some teachers still need to implement learning by the scientific approach. The scientific approach was used when the school was still using the 2013 Curriculum. While currently using the Merdeka Curriculum, it is better prepared for differentiated learning (Fatma, 2021).

Differentiated learning is learning that accommodates students' learning needs. Teachers facilitate students according to their needs because each student has different characteristics, so they cannot be treated equally. The results of interviews with Biology teachers show that it is necessary to pay attention to the needs of each learner (Hennilawati, 2023).

One of the learning approaches that can be used to implement the independent curriculum is the PjBL learning model. Project-based learning involves students in investigating problems and producing a real product. Learners are actively involved and are expected to have independence in designing a learning activity and producing a real product or project (Purwanto, 2023).

PjBL learning is applied to virus material. The selection of virus material is based on the actual occurrence of the Covid-19 pandemic a few years ago. In addition, this learning is applied by the learning outcomes (CP) of virus material, and students have the ability to create solutions to problems based on local, national, or global issues related to understanding viruses and their role.

Applying this PjBL learning model is one of the learning strategies that can train students' creative abilities. The project aims to make props for various forms of viruses. The purpose of making these props is to visualize various viruses. Students are more or less able to distinguish the types and roles of each virus in life.

PjBL learning can direct students to achieve 21st-century skills, namely 4C skills. These skills include Communication, Collaboration, Critical Thinking, Problem Solving, Creativity and Innovation (Hamidah et al., 2020). A number of these skills lead to higher-order thinking which is the challenge of 21st-century education (Zulfiani et al., 2023). This is in line with the implementation of project-based learning that can improve 4C skills, one of which is effective student creative ability (Hamidah et al., 2020).

The results of interviews with biology teachers show that during teaching virus material itself, the PjBL model has never been used. The learning model used in teaching virus material usually uses the PBL (problem-based learning) model. Therefore, the use of the PjBL model is expected to be a new breakthrough to achieve more effective learning outcomes.

Research conducted by (Maksum & Purwanto, 2022) showed that the electronic module with PjBL model developed showed increased psychomotor abilities than before. Likewise, the results of research belonging to (Kartikasari, 2024) the application of the Project Based Learning model can improve the creative thinking skills of elementary school students in learning mathematics. Therefore, PjBL is one of the important learning models that needs to be implemented.

Educators in the era of the Industrial Revolution 4.0 must have critical thinking, problem-solving, creative, and innovative skills, as well as good communication and teamwork skills. In addition, it is also necessary to be able to search, organize, and present information, as well as the ability to utilize information and technology effectively (Mustari, 2022).

Teachers have the flexibility to choose various teaching tools so that learning can be tailored to student's learning needs and interests in the implementation of the independent curriculum (Kartikawati, 2022). Quality teaching materials are needed to realize effective learning and be able to pay attention to the creative thinking aspects of students.

Digitalization has brought changes to the implementation of education towards a technology-based learning paradigm. Almost all learning devices today are digital devices. Technology is mandatory at this time. One digital utilization in education is digital learning media (Widarti, 2022).

The learning process using electronic media broadly is also known as e-learning (Septiani,

2018). In this development, the use of e-learning is focused on the development of digital teaching materials. The teaching materials used should contain various learning information, contain good grammar, and be able to include all types of media, such as images, animations, and videos (Utomo, 2015).

One strategy to increase learner development is to formulate the concept of teaching materials, in this case, modules. Learning modules are packaged as one complete unit, stand-alone, and consist of learning activities. Learning modules are prepared to assist students in achieving several learning objectives that have been explicitly formulated and operationally (Amirudin, 2023).

Printed modules are an old type of module. Currently, electronic modules are a product of technological development. Electronic module development can be done by teachers to add to the treasury of learning resources to increase student learning independence (Marto, 2021).

Electronic modules are one of the digital teaching materials. Electronic modules can be used without space and time limits. In addition, it can be used dynamically and flexibly. E-Modules can also be used for both online and face-to-face learning. This shows that modules can be used as digitalized teaching material to adapt to the Industrial Revolution 4.0.

Excellent and appropriate module packaging can improve good learning quality (Noviyatani et al., 2021). Electronic-based module development is one of the alternative teaching materials for self-study. The development of online e-modules in Suwasono's research produced teaching materials suitable for use in learning (Suwasono, 2013).

Electronic modules contain material content, learning methods, and assessments that are structurally designed and made as attractive as possible (Krisnayuni et al., 2015). It is designed not only as a source of teaching materials but also as a navigator for students to make learning more structured. The arrangement starts with a predetermined topic, material, methodology, and presentation by utilizing time as efficiently as possible (Ilyas et al., 2019).

The electronic module was developed to see whether there is an increase in students' creative thinking skills, where creativity is the key to achieving the 4Cs. According to Munandar, students' creative thinking can be described by four indicators as follows, namely: fluency, flexibility, novelty (originality), and elaboration of ideas (Munandar, 2014).

The analysis was carried out by identifying needs through interviews with educators and students, analyzing students, analyzing basic competencies, and studying documents. The earliest identification of needs carried out by researchers was an interview with the Biology class X teacher and representatives of several students related to learning conditions and teaching materials used during learning activities (Ardiansah & Zulfiani, 2023).

In line with the results of interviews with biology teachers, there is an interest in developing electronic modules with creative achievements. According to her, the creative element brings important value because learning can not only be achieved in terms of cognitive, but also in terms of skills. In addition, electronic modules have also never been used as teaching materials. So far, teaching materials that are often used include package books, power points, or e-books.

Following up on this background, the researcher is interested in conducting a study entitled "Development of E-Modules Based on Project Based Learning on Virus Material to Improve Students' Creative Thinking." The choice of virus material or concept is based on the current situation, namely the Covid-19 pandemic. In addition, the rampant development of various other types of viruses, such as the HIV, ebola virus, adenovirus, rabies virus, and so on are also important in this study.

2. RESEARCH METHOD

This development research uses the ADDIE model. The ADDIE model is an approach to analyzing each component to interact and coordinate with each other according to the existing phases (Rayanto & Sugianti, 2020). There are steps in the ADDIE model in sequence: analyze, design, development, implementation, and evaluation.
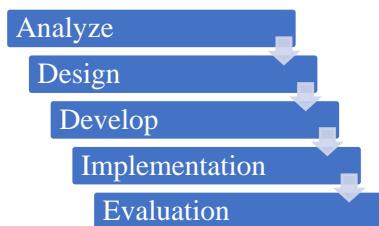
Figure 1. ADDIE Stage

In the analysis stage, researchers conducted needs analysis interviews with teachers and students to obtain initial conditions. The next stage is design; at this stage, the researcher begins to make a draft design of the e-module product to be developed. Next is the development stage; at this stage, the e-module is validated by experts or experts in their fields. Validation was carried out with five experts, namely with three material experts and two media experts.

After getting validation and declared feasible, the e-module is tested on a small scale as a readability test in the implementation stage. The implementation stage is divided into a small-scale trial (readability test) and a large-scale test (field test). The questionnaire was distributed to a small number of students in the readability test. After that, the field test was conducted on a larger scale, namely 36 grade X students. The field test was conducted to get responses from students to the e-modules developed. In addition, in the implementation stage, pre-test and posttest were also conducted to measure whether or not there was an increase in students' creative thinking.
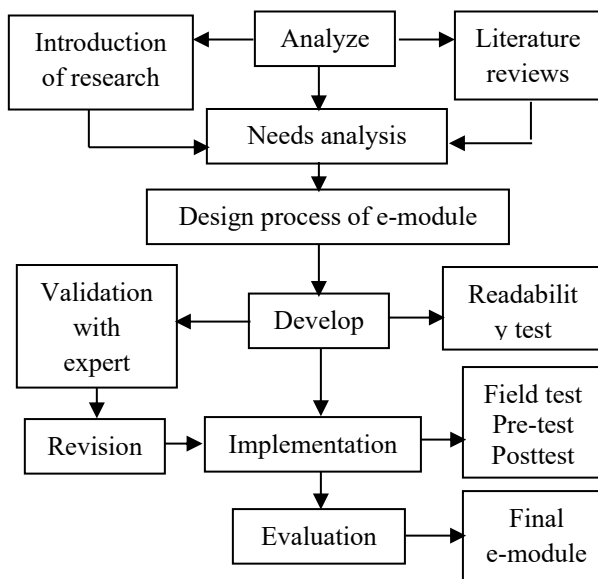
Figure 2. ADDIE Steps

Data processing in this study used two main techniques: the Guttman scale and the Likert scale (Mumtaza & Zulfiani, 2023). The Guttman scale was used to calculate the readability test results and learner response test data, while the e-module validation results were processed using the Likert scale. Analysis of validation results using a Likert scale, analysis of readability tests and learner responses using a Guttman scale, and analysis of creative thinking improvements using the n-gain test. The evaluation stage is the stage of refining the electronic module that has been tested. Respondents gave responses to the e-modules that were tested. Input and criticism are used as a reference to improve the resulting electronic module so that it can be used in a targeted and valuable manner.

3. RESULTS AND DISCUSSION
Validation

Validation data is processed using a Likert scale. The Likert scale contains 1-5 answers ranging from very unfavourable to very good. Each answer choice has a different weight, and all respondents' answers are summed based on their weight (Morrisan, 2012). The form of assessment is described as follows in the table.

Table 1. Likert Scale

Score	Description
5	Very good
4	Good
3	Simply
2	Less appropriate
1	very unsuitable

Validation is a stage where the e-module is assessed for its feasibility before use. The purpose of this stage is to provide input related to the product that has been developed. To get the feasibility value, validation from experts is needed. These experts are validators who are experts in their fields, so that the product can be assessed as valid or not. The e-module PjBL virus material was validated by two material experts, two media experts, one material practitioner, and one learning practitioner.

Table 2. E-Module Media Validation

No	Aspect	Percentage (%)	
		Validator 1	Validator 2
1.	Graphic quality	88	82
2.	Quality of supporting components	100	80
3.	Language	85	80
	Mean	91	80,67
	Total Mean	85,83	
	Description	Very Good	

Table 2. shows that the mean total percentage of the assessment of media feasibility aspects is 85.83%, with a very feasible description. This figure shows that the e-module developed by researchers is suitable for use in research.

Table 3. E-Module Material Validation

No	Aspect	Percentage(%)			Description
		Validator 1	Validator 2	Validator 3	
1.	Structural/Construction Quality	96	96	80	Very good
2.	Relevance of Material/Substance/Content	96	96	84	Very good
3.	Suitability of Substance with PjBL Model	100	100	80	Very good
4.	Creativity	100	100	80	Very good
	Mean	98	98	81	Very good
	Total Mean		92,3		Very good

Table 3. shows that all material feasibility aspect assessment percentages are very feasible. From the material expert validation results, an average overall percentage of 92.3% was obtained. This figure shows that the e-module developed by researchers is very feasible to use in research.

Reliability Test

The reliability test is used to show the degree of consistency and accuracy of a questionnaire or questionnaire. The reliability test was carried out on statement items that had been declared valid. An item is declared reliable if the Cronbach's Alpha value is> 0.60 and is said to be unreliable if the Cronbach's Alpha value is <0.60 (Rachbini, 2020). The reliability test results on 10 question items obtained the Cronbach's Alpha value as follows.

Table 4. Reliability Test Results of Creative Thinking Questions

Cronbach's Alpha	N of Items
0,620	10

The test instrument is reliable if it is positive or greater than 0.6. The data in Table 4, which is related to the reliability test results, show a Cronbach's Alpha value of 0.620, where > 0.60. These results indicate that 10 items are considered reliable for measuring creative thinking variables in students.

Creative Thinking

Pre-test and posttest data are processed using the N-Gain formula. To analyze the existence of an increase in the pre-test and posttest questions of students' creative thinking, the Normalized Gain (N-Gain) test was carried out. The following is the N-Gain formula:
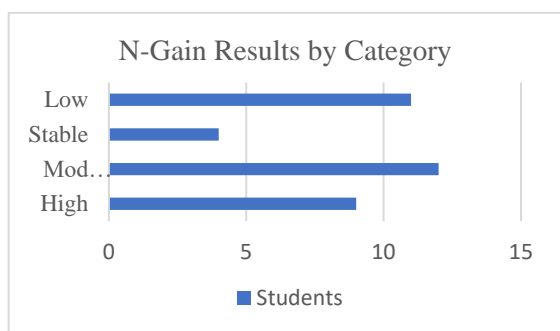
$$\text{N-Gain (g)} = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}}$$

Table 5. N-Gain Score Guidelines

Nilai *N-Gain (g)*	Criteria
$0,70 \leq (g) \leq 1,00$	High
$0,30 \leq (g) \leq 0,70$	Moderate
$0,00 \leq (g) \leq 0,30$	Low
$(g) = 0$	Stable
$-1,00 \leq (g) < 0$	Decrease

Table 6. Creative Thinking N-Gain Results

Value Data	Pre Test	Post Test
Maximum score	90	100
Minimum score	10	20
Mean	41,38	66,94
Median	40	70
Modus	30	70

Figure 3. N-Gain Results by Category

Table 7. Mean N-Gain

	N	Mean
NGain	36	0,4562

The results showed that the average acquisition of students' scores from the pre-test and posttest results showed a value of 0.45 with a moderate interpretation. This means that the creative thinking ability of SMAN A students in class X-J is known to have increased with a moderate value range based on the results of the N-Gain test.

Readability Test

Small-scale trials were conducted before the e-module was implemented on a large scale. As for this small-scale trial, what was assessed by students was the e-module readability test. Learners filled out a questionnaire or readability test questionnaire distributed by the researcher by choosing 'Yes' or 'No' on each question item. Data on students' responses to implementing e-modules were obtained using a Guttman scale.

The results of the small-scale trial (readability test) can be seen in the following table.

Table 7. Result of Small Scale Trial (Readability Test)

No	Aspect	Percentage (%)	Description
1.	Ease of use	95	Very good
2.	Linguistics	98,75	Very good
3.	Graphics	97,5	Very good
4.	Understandability	99	Very good
	Mean	97,56	Very good

The data from Table 7 above shows that all aspects assessed by students get very good results. The average percentage value of the e-module readability test is 97.56% with a very good description.

Field Test Results

Table 8. Field Test Results

No	Aspect	Percentage (%)	Description
1.	Usability	98	Very good
2.	Readability	96,73	Very good
3.	Graphics	97,2	Very good
4.	Presentation Suitability	97,2	Very good
5.	to the material	97,2	Very good
	Mean	97,26	Very good

The data on the results of students' responses in Table 8. above shows very good results in all aspects. Because the results obtained are positive, the e-module developed is considered suitable for use as teaching material. The average response results showed a figure of 97.26% with a very good interpretation.

The e-module developed is equipped with YouTube links, article links, and Google Forms links for filling out learning outcomes evaluation questions. The material presented is packaged in language that is easy to understand so that students can easily understand it and learning

objectives can be on target. this is in accordance with the (Rohman, 2019) statement that learning media that utilize technological advances, information, and communication can contain text, sound, images, videos, and animations to present learning materials. This causes the material to be conveyed more interestingly, easily understood, and not monotonous. Therefore, the students' response to the developed e-module is positive with a percentage of that.

4. CONCLUSION

The research entitled "Development of an E-Module Based on Project Based Learning on Virus Material to Improve Students' Creative Thinking" resulted in a product in the form of an e-module, which has been validated by three material experts and one media expert. Based on the validation results, the e-module developed is considered very good and worthy of implementation. The results of student responses also showed positive results, namely with a percentage of 97.26%. Then, to see students' creative thinking abilities, a pre-test and posttest were carried out, where the results showed an increase in the creative thinking abilities of SMAN P students, precisely in class X-J, with an average N-Gain score of 0.45 with a moderate interpretation. Based on these results, the developed PjBL e-module is suitable for use as teaching material and can improve students' creative thinking abilities regarding virus material. The researcher also hopes that this e-module can be used as a companion to textbooks in schools with the achievement of students' creative skills. There should be further research on electronic modules with different displays and topics so as to add innovation to new teaching materials.

5. ACKNOWLEDGEMENTS

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