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Increasing Critical Thinking Skills by Using Electronic Modules Based on Flipped Classroom Virus Material for Phase E Students

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ABSTRACT

Students critical thinking abilities can be improved through the use of innovative learning resources in order to achieve these competencies. This research aims to determine the feasibility, practicality and effectiveness of electronic modules based on flipped classroom circulation system material for class XI SMA. Researchers used the R&D development method with the ADDIE development model with stages: Analysis, design, development, implementation and evaluation. The subjects of this research are material experts and media experts. The instrument used in this research was a questionnaire. Data analysis uses a Likert scale. The results of this research show that the product is suitable for use based on the material expert's assessment of 93.58% (very feasible) and the media expert's assessment of 86.9% (very feasible). It is practically used based on the biology teacher's assessment of 95.38% (very practical) and small-scale test results of 91.02% (very practical), and is effective for improving students' critical thinking skills based on the N-gain score with a value of 0.61

Introduction

Learning in the 21st century is the implication of individual development from time to time, starting from primitive to agrarian individuals then to industrial individuals and to an informative society marked by the development of digitalization. In its implementation, 21st century learning requires teachers and students to interact in the educational process, use multimedia, build cooperation between teachers and students and be able to develop creative and critical thinking.

Apart from that, 21st century learning is defined as a learning process that is student-centered. So that students have skills in the 21st century, namely 4C skills which include communication, collaboration, critical thinking and problem solving. The learning challenges of the 21st century are characterized as an era of knowledge, openness, automation and computing which requires teachers and students to have competencies that must be mastered to face global competition in the 21st century world, namely individuals who are creative, think critically, independently, collaborate with teams, are creative, informed , communication and independent learning (Kivunja, 2015: 7). Based on the 4C abilities, critical thinking skills are one of the

important abilities that every student must have.

Critical thinking ability is thinking systematically which allows someone to formulate and evaluate their own beliefs and opinions (Lestari 2016: 14). Through critical thinking activities, students can summarize the knowledge they have, search for and utilize the information obtained to solve problems, and use relevant sources to support these problem solving activities. According to Febriani (2016: 26) states that individuals who carry out critical thinking activities use reasonable thinking to decide what should be done according to their intellectual abilities. Therefore, efforts are needed to foster critical thinking skills.

Based on the results of initial observations at one of the schools, it shows the same conditions at SMAN 1 Bandar Seikijang, which shows that students' critical thinking skills are still low based on the low percentage of passing daily tests (UH) on virus material, 47.3% of 55 students. According to (Agnafia, 2019: 50) students' critical thinking abilities are still lacking because they are not used to learning with critical thinking indicators and there is a lack of learning that is applied to empower students' critical thinking abilities. Therefore, every student needs to optimize critical thinking skills. This opinion is in line with the research conducted by Kurniawan (2017), which states that learning with the flipped classroom mode is suitable for biology education, as it is considered to improve students' learning outcomes.

Furthermore, Putra and Utami (2022: 271) state that the use of flipped classroom shows a high increase in student learning independence compared to the control class, which is categorized as moderate, in biology learning.The findings of this study are in line with the characteristics of flipped classroom learning, which creates active learning through discussion and problem-solving. This is in line with Umam's (2018) thinking that critical thinking skills are thinking activities that test, question, connect and evaluate all aspects of a problem. If students can carry out critical thinking activities, it can make it easier for students to solve other problems in learning.

Method

In this study, a development research type is used, referring to the Research and Development (R&D) approach with the ADDIE model, which was developed by Walter Dick and Low Carry.Research using the ADDIE model consists of five stages, namely: analyze, design, development, implement, and evaluate (Gumanti et al., 2016).

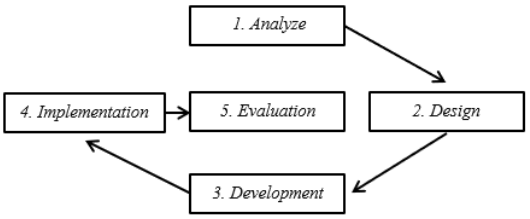

Figure 1. ADDIE Development Flow

This research was carried out from July to September 2023. The research location was SMA N 1 Bandar Seikijang. The research population was students in Phase E class. The test subjects were students in Classes X1 and X4 with a total of 28 students in each class. The experimental class used electronic modules based on a flipped classroom, while the control class used textbooks that are commonly used in schools. The small scale test was 20 students and the large scale test was 28 students.

Research data was obtained using observation techniques, interviews, questionnaires, validation sheets, critical thinking ability test sheets and documentation. Validation subjects consisted of experts (material and media), and biology teacher assessments. Assessment data from experts and teachers is qualitative data in the form of product improvement suggestions and quantitative in the form of questionnaire assessment scores using instruments.

The stages of developing an electronic module based on a flipped classroom on virus material are as follows:

The first stage of analysis was carried out to determine the needs for teaching materials in the form of flipped classroom-based electronic modules so as to get an idea of the teaching materials that will be developed. The analysis stage is: curriculum

analysis, material analysis and student needs analysis.

The Design stage is carried out to design research products and instruments. This stage designs the basic framework of a flipped classroom-based electronic module on virus material. Designs an electronic module equipped with several features such as images, audio, video and questions and designs learning concepts that will be included in the electronic module on virus material. Designing a Learning Objective Flow Plan (ATP) and teaching modules for learning using modules in the flipped classroom mode. Designing instruments used to measure the results of development and use of electronic modules. Apart from that, we also designed critical thinking ability instruments in the form of HOTS level questions.

The Development Stage aims to produce a viable product that is practical for students to use. Product validation by material experts includes aspects of appearance, content and material. Product validation by media experts includes aspects of design, appearance and operational aspects of the application. Biology teacher assessment includes aspects of material/content, language, media and learning. Limited trials were carried out on aspects of assessment on structure, language and content specs. Test the electronic module based on the flipped classroom to determine its implementation and feasibility of use, assessing the aspects of appearance, language, content and material.

The research instrument was validated by material experts and media experts as well as practitioners using a Likert scale. The acquisition score is converted into percentages and categories based on the product feasibility scale range. The initial analysis used based on score data refers to the following formula:

$$M=\frac{\sum fx}{N}$$

Information :
M = Average per aspect
$\sum fx$ = Total score per aspect
N = Number of components

Table 1. Likert scale assessment criteria scale

Scale	Assessment criteria
1	Strongly less/strongly disagree
2	Less/disagree
3	OK/agree
4	Very good/strongly agree

Source: (Sugiyono, 2017)

After getting the average of the aspects, then convert the average score to a value of 100 using the formula:

$$\text{Assess each aspect} = \frac{\text{Average score}}{\text{Maximum score}} \text{ X } 100$$

Next is the interpretation of the product feasibility and practicality assessment categories presented by (Riduwan, 2010).

Table 2. Product feasibility and practicality assessment categories

Mark	Category
81-100	Very worthy
61-80	Worthy
41-60	Enough
21-40	Not worthy
≤ 20	Very inadequate

(Source: Riduwan, 2010)

The Implementation stage aims to realize the results of product development that can improve critical thinking skills. At the small scale testing stage, it was carried out by 20 students to find out initial data about product readability. This stage was carried out to analyze the effectiveness of the product in improving students' critical thinking skills, practicality and response from phase E students to the use of the flipped classroom-based electronic module that has been developed. In the wide scale test, namely the actual test, there were 28 students.

At this stage, the analysis uses the n-gain score formula which aims to determine students' critical thinking progress. Hake, (1998) classification of criteria for improving students' critical thinking abilities using the following formula:

$$< g > = \frac{Sf - Si}{Smax - Si}$$

Information :
< g > = Score normalizad *gain*
Sf = Score postest
Si = Score pretest
Smax = Score maximum

Table 3. N-gain interpretation criteria

Mark	Criteria
g > 70	Tall
0,30 < g ≤ 0,70	Currently
g ≤ 0,30	Low

Source: (Hake, 1998)

This evaluation stage aims to determine student responses and the feasibility obtained based on assessments from experts, teachers, as well as student responses in testing on a small scale and a large scale. In the next stage, an evaluation is carried out to find out product deficiencies and then improvements are made based on the evaluation results.

The results and Discussion

The results of developing electronic module products using the flipped classroom mode on virus material are in the form of links that can be accessed via electronic devices. The development model used in this research is ADDIE which includes 5 stages, namely analysis, design, development, implementation and evaluation.

The learning process takes place with passive students, the method used is lectures, students have difficulty with the viral material so they still need guidance. Learning activities take place with explanations by the teacher and then students summarize the learning material. This learning process results in students feeling bored with biology learning. This shows the lack of use of technology in the learning process which should be able to create a more innovative learning atmosphere.

The design stage is carried out by designing teaching materials in the form of electronic modules based on a flipped classroom and the design required is in the form of designing virus material whose sources come from books and journals. The design of the research instrument included designing assessment sheets for material and media experts, along with biology teacher assessments and student readability sheets at the testing stage, then tests were carried out to determine students' critical thinking abilities and student response sheets in wide-scale trials. The design of this flipped classroom-based electronic module uses the Canva application and live worksheet.

The design of this development product is designed in such a way as to be attractive and easy to understand, this product contains attractive images. The design of this product is in the form of a front and back cover and other sheets. Electronic modules are arranged in a coherent manner to make it easier for students to learn. The research instruments used to collect data were validation sheets, questionnaires, interviews and tests of students' critical thinking abilities. The following is an example of a product design that was developed.

Figure 2. Example of flipped classroom-based electronic module product design content

The Development stage includes product validation involving material and media experts, biology teachers and product testing. The research instrument sheet was

validated by material experts to determine the suitability of the product to be used. The assessment carried out by material experts covers several aspects, including feasibility, material presentation and language.

Table 4. Validation results by material experts

No	Assessment Indicators	Score (%)	Category
1	Display Aspects	95,75	Very Worth It
2	Content Aspect	90	Very Worth It
3	Material Aspects	95	Very Worth It
Average of all aspects		**93,58**	**Very Worth It**

Table 4 shows an average score of 93.58 with the criteria "very feasible". This shows that the product being developed is suitable for use. Then the material expert provides advice before the product is tested. The material in the electronic module includes narratives related to explanations of images, adding images/videos to material on circulatory system disorders/abnormalities. Revisions have been carried out until the experts consider that there is no need for further revisions. This is in line with the thinking of (Krisma in Nana, 2019: 23) which states that the use of illustrations in teaching materials has various benefits such as clarifying the message or information conveyed and making the teaching materials more interesting through visual variations.

The feasibility of the product to be developed is assessed by media experts. The aspects assessed by media experts are aspects of visual communication, display quality, ease of operation, application reliability, and illustrations (images and videos).

Table 5. Validation results by media experts

No	Assessment Indicators	Score (%)	Category
1	Design Aspect	83,3	Very Worth It
2	Display Aspect	87,5	Very Worth It
3	Application Operational Aspect	90	Very Worth It
Overall average of aspects		**86,9**	**Very Worth It**

Table 5 shows an average score of 86.9 with the criteria "very feasible". This shows that the product being developed is suitable for use. Then media experts provide advice before the product is tested. suggestions for revision in several aspects. Images and videos must include the source, revised concept map, and bibliography using a journal. Revisions have been carried out until the experts consider that there is no need for further revisions. This is in line with Hasnida's thinking in (Rini, 2018: 49) which states that an illustration is an image or other form that aims to explain, decorate, be presented with a certain personality, and contains appeal as well as providing stimulus and the motif of a movement.Additionally, according to Krisma in (Nana, 2019: 23), the use of illustrations in teaching materials has various benefits, such as clarifying the messages or information conveyed and making the teaching materials more engaging through visual variations.

The biology teacher assessment aims to determine the practicality of the flipped classroom-based electronic module. Biology teacher assessments include: Material aspects, language aspects, media aspects and learning aspects.

Table 6. Assessment results by biology teachers

No	Assessment Indicators	Score (%)	Category
1	Material/Content Aspect	100	Very Practical
2	Language Aspect	83,33	Very Practical
3	Media Aspect	100	Very Practical
4	Learning Aspect	100	Very Practical
	Overall average of aspects	**95,83**	**Very Practical**

Table 6 shows an average score of 95.38 with the criteria "very practical". This shows that the product being developed is practical. There is input from the teacher to correct typo sentences in the module. Revisions have also been made to the electronic module based on the flipped classroom. The very practical assessment results show that the development of the module uses proper and correct language for students to understand.The use of language that is easy to understand and in accordance with EYD will create an interest that encourages the user's reading interest.The language used in the instruction section seems to invite readers to understand what is requested in the electronic module.This is supported by (PERLAN, 2008: 9) which states that the proper and correct use of language is one of the absolute requirements in scientific writing so that it can be easily understood by its readers.

Assessment of the readability of flipped classroom-based electronic module products on circulation system material by 20 students. Each student provides responses to structural aspects, language aspects and content aspects.

Table 7. Results of assessing the readability of flipped classroom-based electronic module products

No	Aspect	Score	Category
1	Structure	91	Very Practical
2	Language	89,25	Very Practical
3	Content	92,81	Very Practical
	Average	**91,02**	**Very Practical**

Table 7 shows an average score of 91.02 with very practical criteria, this shows that flipped classroom-based electronic module products can be tested on a wide scale.

The product in the form of an electronic module based on a flipped classroom was declared feasible and practical by experts and from the results of small-scale trials it was also declared practical, so this product can be tested on a wide scale.

The Implementation Stage is the activity obtained from the results of the implementation of learning. The wide-scale trial aims to assess and see the effectiveness of the flipped classroom-based electronic module. To assess and see the effectiveness of the flipped classroom-based electronic module being developed. Based on its effectiveness in learning, electronic modules are very useful because they can provide learning experiences and students actively interact. The results of the wide-scale assessment of flipped classroom-based electronic module products on circulation system material by 28 students include aspects of ease of display, language, content and material.

Table 8. Results of practicality assessment of flipped classroom-based electronic module products

No	Assessment Indicators	Score (%)	Category
1	Appearance Aspect	92,86	Very Practical
2	Language Aspect	90,36	Very Practical
3	Content Aspect	87,52	Very Practical
4	Material Aspect	90,77	Very Practical
	Overall average of aspects	**90,38**	**Very Practical**

Table 8 shows an average score of 90.38 with the criteria "very practical". Each aspect has a total score that indicates very practical.

Apart from that, the use of flipped classroom-based electronic modules as teaching materials for virus biology can improve the critical thinking abilities of Phase E students. Students' critical thinking abilities are analyzed using descriptive statistics.

Table 9. Comparison data for critical thinking ability variables

Analysis	Experimental Class		Control Class	
	Pretest	Post Test	Pretest	Posttest
Number of samples	28	28	28	28
Total score	1230	2180	1060	2030
Standard deviation value	11,75	12,64	37,86	72,50
Lowest score	20	50	10	54
Highest score	60	100	60	100

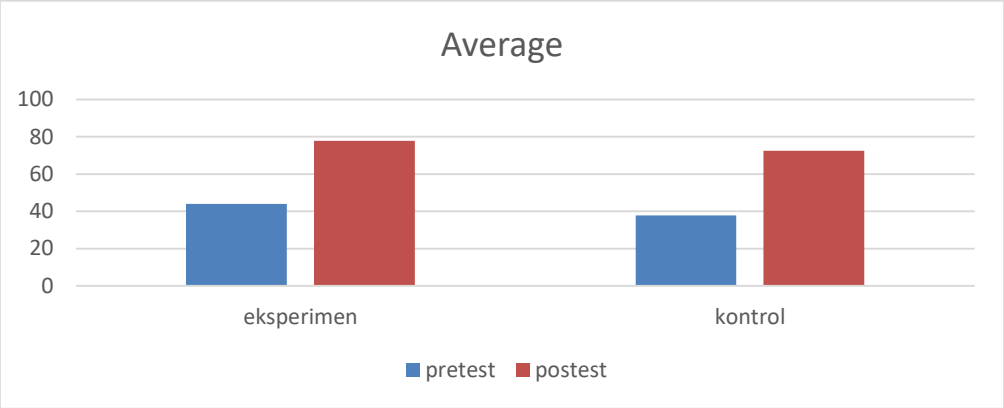

Figure 3. Comparison graph of the average value of critical thinking abilities

Table 10. Analysis of n-gain score

Class	Average		*n-gain score*	Criteria
	Pre test	Post test		
Eksperimen	43,93	77,86	0,61	Currently
Kontrol	37,86	72,50	0,55	Currently

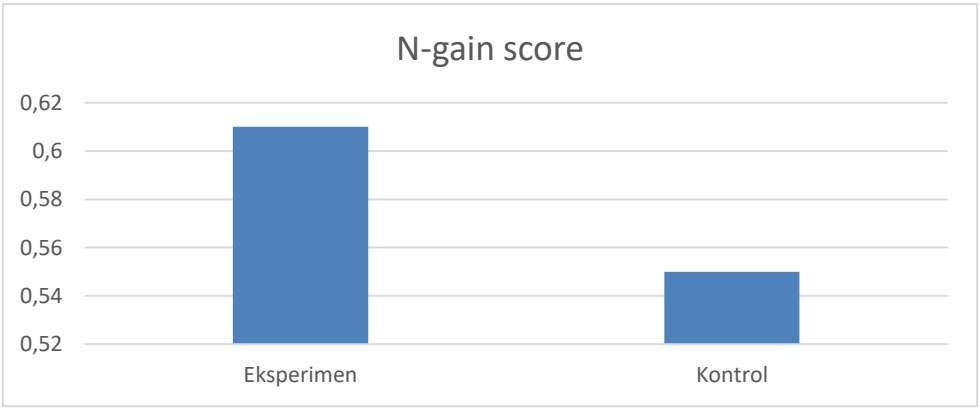

Figure 4. Graph of n-gain score.

Figure 4 shows information that there has been an increase in critical thinking abilities. The increase in critical thinking skills in the experimental class was higher as seen from the n-gain score of 0.61 (medium). Increased critical thinking skills in the control class ¬n-gain score of 0.55 (medium). The increase in the experimental class was higher due to the influence of using flipped classroom-based electronic modules. In line with research, the same research was also conducted by Rokhmania and Kustijono (2017: 94) who stated that learning using the flipped classroom was considered capable of improving critical thinking skills.

Conclusion

The development of a flipped classroom-based electronic module on virus material is categorized as valid because it has gone through a feasibility test. The average feasibility of the module by material experts and media experts reached 93.58 and 86.9 in the very feasible category.

The flipped classroom-based electronic module on practical virus material was implemented with a very practical category obtained from the biology teacher's assessment and students' responses. The use of electronic modules based on flipped classroom circulation system material can improve students' critical thinking skills.

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