JPPS (Jurnal Penelitian Pendidikan Sains)
Homepage: https://journal.unesa.ac.id/index.php/jpps
Email: jpps@unesa.ac.id

p-ISSN: 2089-1776; **e-ISSN:** 2549-1597
JPPS, Vol. 12, No. 2, May 2023: 122-137

Development of E-Modules Based On Mobile Learning Applications to Improve Students' Critical Thinking Skills in Science Subject

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DOI: *https://doi.org/10.26740/jpps.v12n2.p122-137*

Sections Info

Article history:
Submitted: February 28, 2023
Final Revised: May 5, 2023
Accepted: May 6, 2023
Published: May 23, 2023

Keywords:
Education
E-module
Science subject
Critical thinking ability
Mobile learning application

ABSTRACT

Developing an E-module based on a mobile learning application is used to improve the critical thinking skills of junior high school science students. ***Objective:*** *This research aims to develop products in e-modules based on mobile learning applications that are valid, practical, and effective.* ***Methods:*** *The research method used is the ADDIE development model, which includes five stages: analyzing, designing, developing, implementing, and evaluating. The data analysis techniques used are validation sheets for validity tests and observation sheets for learning implementation for practicality. And the N-gain test and student questionnaire to test effectiveness.* ***Results:*** *Based on the results of the data analysis conducted, e-modules based on mobile learning applications have obtained valid results with average validation scores from the three validators, namely 83%, e-modules based on mobile learning in learning are considered very practical as teaching materials in science learning in junior high school because they get an average score of 94%, e-modules based on mobile learning applications are also considered to have been effective and feasible to use as teaching materials during science learning in junior high school because they have used e-modules based on mobile learning applications, students' thinking skills increase with grades N-gain with a high score of 0.77 and student response with a score of 74% with a good category.* ***Novelty:*** *Previous researchers have never done this research, which develop e-modules based on mobile learning applications to improve students' critical thinking skills.*

INTRODUCTION

Science learning consists of facts, concepts, and natural phenomena that will involve students being able to receive knowledge directly and contextually. Learning in the 21st century is a transition of learning into an approach to learning that is still focused on students (student-centered learning). The technology used in learning in the 21st century is following the times, namely the revolution 4.0 century (Andayani, 2019). The ability to think critically is an ability that will be needed by students in facing the learning process in the 21st century. Hidayat (2019) states that critical thinking is thinking by using reasoning in depth to be able to obtain relevant information and be able to be responsible. The ability to think critically is an ability that cannot be developed automatically simultaneously with one's physical development (Wahyuni, 2015). The ability to think critically can include various things such as classification, making decisions, giving conclusions, and further explanations, as well as integrating students' additional abilities (Ristiani et al., 2022). The ability to think critically can be identified with active, reactive, and reasoning processes or having reasons to solve and decide a problem (Nuryanti et al., 2018). Students with high critical thinking skills tend to have high cognitive abilities in classroom learning as well (Setyarini et al., 2017).

In fact, students' critical thinking skills are currently relatively low because the learning process is still teacher-centered (Nasihah, 2019). Nurhayati et al. (2018) critical thinking skills can be elicited by a lack of less active learning that maximizes critical thinking skills.The low ability of students' critical thinking is due to limited updates in the use of media in the learning activities. The use of media is very influential on the course of learning to increase the effectiveness of learning. Jamaluddin et al. (2020) stated that there are still very few learning activities that use media.

One way to improve student's critical thinking skills is to use e-modules based on mobile learning applications in learning activities. Most of the modules used by the teacher are textual, so it does not attract student to learn the material. Noperi (2021) reveals that developing modules accompanied by illustrated images can attract student so that students can more easily solve problems and understand the material. There several advantages of e-modules based on mobile learning applications, include: (1) nice and attractive appearance; (2) easy to operate; (3) do not require an internet network; (4) do not require large storage; and (4) users can choose learning material features according to their needs (Ismiarti, 2020). Students can explore using media easily and independently so that learning activities will take place more efficiently (Asabere, 2013).

The results of research conducted by Wahyuni et al. (2022) showed that Android-based mobile learning modules can increase digital literacy. Some research and development of mobile learning-based e-modules have been carried out (Cecep et al., 2019 and Saidah, 2022), but the development of mobile learning-based e-modules to improve critical thinking skills is still in science learning has never been done.Based on the explanation of the problem above. This study aims to develop e-modules based on mobile learning applications with valid, practical, and effective criteria to improve students' critical thinking skills in junior high school science learning.

RESEARCH METHOD

Research Design

This research was conducted using the ADDIE development model. E-module based on mobile learning application is a new product developed and designed with the aim of increasing critical thinking skills in junior high school science learning. This research was conducted at MTs Negeri 1 Jember in the odd semester of the 2022/2023 academic year. Data analysis techniques for the validity of e-modules based on mobile learning applications can be calculated using the following formula 1:

$$Ev = \frac{Tsa}{Tse} \; X \; 100\% \text{.....(1)}$$

Notes:
Ev = Expert Validation
Tsa = Total empirical score achieved (based on expert research)
Tse = Total expected score

The EV value obtained from each validator will be recalculated by finding the average value using the following calculation formula 2:

$$Ev = \frac{Ev1+Ev2+Ev3}{3} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Notes:
Ev = Average total value of expert validation
Ev1 = Validation value by the lecturer
Ev2 = Validation value by the Science teacher 1
Ev3 = Validation value by the Science teacher 2

The average total validation value that will be obtained will be referenced based on the value criteria on a certain scale can be found in Table 1:

Table 1. Validity criteria

Percentage (%)	Category	Description
81-100	Very Valid	Very valid no need to revise
61-80	Valid	Valid needs to be revised
41-60	Fairly Valid	Valid can be used but with moderate revision improvements
25-40	Invalid	Needs major revisions

Akbar (2013)

Practicality is analyzed based on observational data on the implementation of learning using e-modules based on mobile learning applications. The level of practicality of e-modules based on mobile learning applications is then calculated using the formula:

$$(P) = \frac{\text{amount of items resolved}}{amoount\ of\ question\ items}\ x\ 100\% \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

(P) is the percentage of practicality based on the observation of the implementation of learning by the observer. The criteria for learning implementation scores, according to (Nesri and Kristanto, 2020), can be seen in table 2:

Table 2. Criteria for the score of learning implementation

Practicality Criteria (%)	Practicality Level
80 %< P ≤ 100%	Very practical
60% < P ≤ 80%	Practical
40% < P ≤ 60%	Less practical
25%< P ≤ 40%	Impractical

(Nesri & Kristanto, 2020)

The effectiveness of the e-module is analyzed based on test results and results of student response questionnaires with the following formula:

Test Analysis

The effectiveness of the e-module is obtained from the N-gain test with the formula:

$$(g) = \frac{S_{post} - S_{pre}}{S_{m-ideal} - S_{pre}} \text{.....(4)}$$

Notes :

(g) = average normalized gain score

S_{post} = average *post-test*

S_{pre} = average *pre-test*

$S_{m\text{-}ideal}$ = maximum score

The average value of N-gain is then categorized based on the following table 3:

Table 3. Average score category scale N-gain

Normalized Gain Score	Critical Thinking Level
g ≥ 0.7	High
0.3 ≤ g ≥ 0.7	Fair
g < 0.3	Low

Student Response Questionnaire Analysis

The percentage of student responses is calculated using the following formula:

$$P = \frac{gained\ items\ score}{maximum\ score}\ X\ 100\% \text{.....(5)}$$

The score criteria for student response categories can be seen in Table 4.

Table 4. Student response criteria

Student Response	Student Response Criteria
80 < P ≤ 100%	Very good
60 < P ≤ 80%	Good
40 < P ≤ 60%	Fairly good
20 < P ≤ 40%	Less good

Apsari dan Ismono (2014)

RESULTS AND DISCUSSION

Results

Stage of Analyze

The results of this stage consist of needs analysis, student analysis, and curriculum analysis. In the curriculum analysis based on interviews, the practice questions given by teachers are generally located in printed books so that students feel bored. The printed book used only presents the material in full without involving students looking for information so that students are less critical in solving problems during learning activities. In the analysis of students based on interviews, students feel bored in the learning process. The results of the analysis that have been obtained are then used as a guide in compiling e-module development products. Curriculum analysis based on interviews at MTS Negeri 1 Jember using the 2013 curriculum.

Stage of Design

This stage is a process for designing learning designs and making e-modules based on mobile learning applications in science learning. In addition, researchers also designed a

learning implementation plan. This learning implementation plan is used as a reference and direction for the learning process to take place so that the learning process can be carried out efficiently and effectively. E-module look like as shown Figure 1, and it can be accessed in https://unej.id/Emodule.

Figure 1. E-Module Design

The Figure 1 is cover that contains the title of the material, class, images related to the material, and barcodes to make it easier for students to go to the e-module software page. The contents of the mobile learning application-based e-module include Core Competencies (KI), Basic Competencies (KD), learning objectives, topics/subject matter, as well as coverage of indicators of critical thinking ability consisting of (1) interpretation; (2) analysis; (3) evaluation; (4) inference; (5) explanation; and (6) self-regulation. The application of mobile learning-based e-module can installed in smartphone as shown in Figure 2.

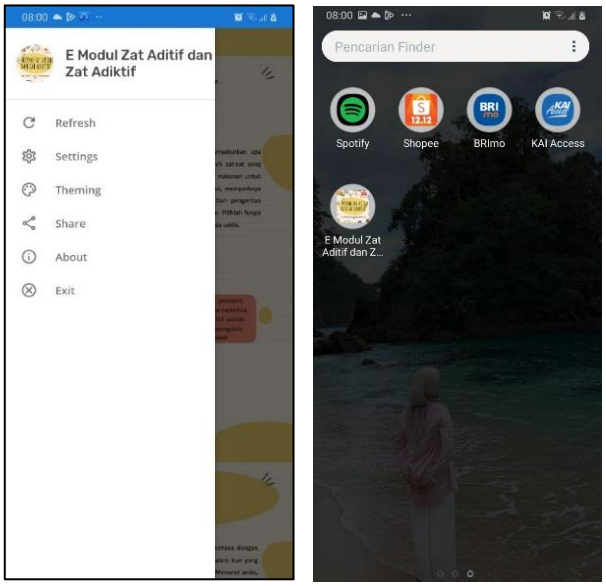

Figure 2. Mobile learning-based e-module display

The cover and contents of the e-module that have been designed are then converted into pdf format and uploaded to the pdf website for the application as shown in Figure 3. This upload is done to convert the e-module into electronic form.

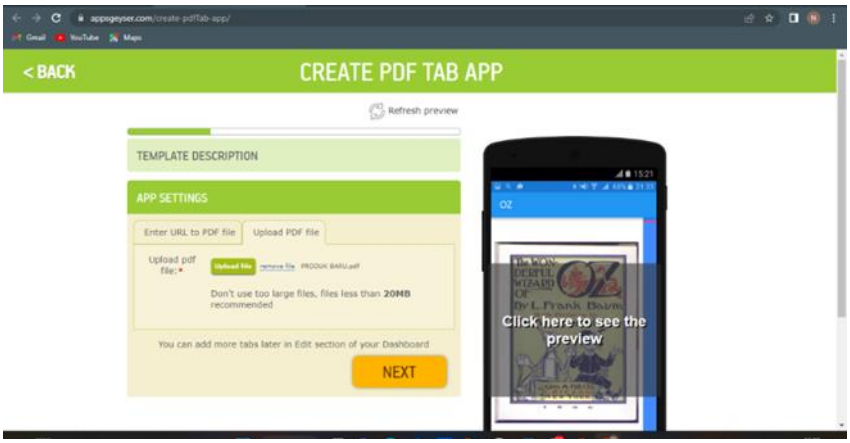

Figure 3. Uploading E-Modules based on mobile learning to the website

Stage of Develop

This stage aims to obtain results from product development. Validation results are used as guidelines to make revisions in accordance with suggestions and comments from the validator. The results of expert validity as shown in Table 5.

Table 5. Results of validity analysis

No.	Assessment Aspects	Interval Score			Percentage (%)	Category
		Validator 1	Validator 2	Validator 3		
I	Aspects of Contents and Materials	85	79	88	84	Very valid
II	Presentation Aspects	85	79	88	84	Very valid
III	Language Aspects	85	85	75	82	Very valid
Average Score		**85**	**81**	**83**	**83**	**Very valid**

Stage of Implement

This stage is the product trial stage in learning after being said to be valid. At the trial stage, data can be generated on implementing learning using based e-modules *mobile learning applications*, which is practicality analysis data as shown in Table 6.

Table 6. The results of the analysis of the implementation observation sheet

	Assessment Activities	Meeting number-						%	Category
		1	2	3	4	5	6		
I	**Introduction**	94	93	93	92	92	94	98	Very practical
II	**Core activities**								Very practical
a.	Accessing E-modules	100	100	100	92	83	83	93	Very practical
b.	Ask questions through the E-module	92	92	92	100	100	83	93	Very practical
c.	Watching the video continues the problem with the E-module	83	100	83	92	100	92	92	Very practical
d.	Answering questions.	83	100	92	83	83	83	89	Very practical
e.	Revisiting previous answers	92	83	83	90	92	100	92	Very practical
III	**Closing**	100	100	96	92	100	100	98	Very practical
	Average Score	**92**	**95**	**91**	**94**	**93**	**91**	**93**	**Very practical**

Stage of Evaluate

The evaluation stage can be used as a stage to measure the effectiveness of mobile learning application-based e-modules on science learning of additive and addictive substance materials obtained pre-test and post-test to obtain data on improving students' critical thinking skills, as well as using student response questionnaires to obtain student response data after using the product. The results of the analysis of the two activities are as follows in Table 7.

Table 7. The effectiveness of critical thinking skills

Component	VIII B Class		N-gain <g>	Category
	Pre-test	Post-test		
Number of students	32			
Lowest Score	6	60	0.77	High
Highest Score	94	100		

Regarding the results of data analysis, the increase in each indicator of critical thinking can be seen from the results pre-test and post-test in Table 8. Beside that the results of the analysis of student response questionnaires can be seen in Table 9.

Table 8. Improved data analysis results on each indicator

Indicators	No. quiz	Activities	N	Mean	N-Gain	N-Gain category
Interpretation	1	Pre-test	30	3	0.86	High
		Pos-test		5		
Analysis	2	Pre-test		1	0.96	High
		Pos-test		5		
	6	Pre-test		2	0.34	High

Indicators	No. quiz	Activities	N	Mean	N-Gain	N-Gain category
Evaluation	3	Pos-test		3		
		Pre-test		1	0.90	High
		Pos-test		5		
	10	Pre-test		2	0.91	High
		Pos-test		5		
Inference	5	Pre-test		2	0.46	Fair
		Pos-test		4		
Explanation	7	Pre-test		2	0.34	Fair
		Pos-test		3		
	8	Pre-test		2	0.90	High
		Pos-test		5		
Self-regulation	9	Pre-test		2	1.00	High
		Pos-test		5		

Table 9. The results of the analysis of student response questionnaires

No.	Assessment Indicator	Percentage (%)	Category
I	Interest	74	Good
II	Motivation	72	Good
III	Interest	75	Good
Average Score		**74**	**Good**

Disscussion

Based on the research results, e-modules based on mobile learning applications have been developed, as shown in Figures 1, 2, and 3. The resulting e-modules have been validated, as shown in Table 5. Based on the results of Table 5, the results of the validity of the content and material aspects obtained a percentage of 84% with a very valid category. This shows that the product that has been developed has a very clear description of additive and addictive substance material, clear learning outcomes, a coherent description of the material, clearly presented material, clear pictures, and videos, clear examples of questions, and a clear summary. Ridho et al. (2020) state that the criteria for the content and material aspects include the completeness of the material and content presented in a product. This is following research by Paramita et al. (2018) that the product used can be said to be valid in terms of content and material if the material concept with achievement indicators is appropriate and clear.

The validity results from the presentation aspect get 84% with very valid categories. This means that the product to be developed is easy to use, the cover is chosen correctly, the color on the background is selected correctly, the color selection on the contents and letters is appropriate, the typeface and font size are appropriate, the layout of the text and images is consistent, the presentation of material uses words, pictures, videos that are presented clearly. Agreeing with the statement of Ridho et al. (2020) stated that there are three criteria in the presentation aspect, namely presentation techniques that include

systematic consistency of chapter and subchapter presentations, the presentation of the material to be presented is in accordance with the research objectives, as well as presentations that include the ease of use of teaching materials in teaching and learning activities. Sriwahyuni et al. (2019) stated that the results of a high percentage in aspects of good language, accuracy in sentence structure, and term compatibility, then the mobile learning-based e-module media is at a stage worthy of use.

Furthermore, based on the validity results from the language aspect, it gets 82% percent with a very valid category. According to Ridho et al. (2020), the language aspect is the main aspect to support the validity of a product because the language can make it easier for readers to understand the content and material delivered in a product. The category is very valid regarding the language aspect in that the developed products use effective sentences, standard terms, communicative language, age-appropriate sentences for students, and proper spelling.

Based on Table 6, the results of the practicality analysis of the implementation observation sheet show an average percentage of 93% with very practical criteria at six meetings filled by three observers. Each assessment activity also achieves very practical criteria, with a percentage of preliminary activities at 98%, core activities at 92%, and closing activities at 98%. The acquisition value of 92% of core activities comes from the average of several activities using e-modules in it, such as accessing e-modules that get 93% value, asking questions through e-modules that get 93% value, observing videos continuing problems on e-modules that get 92% value, answering questions that get 89% value, reviewing previous answers that get 92% value. Thus, it shows that e-modules based on *mobile learning application*s in science learning are very practical to use when learning because all activities contained in the lesson plan can be carried out well. However, there were still a few obstacles, along with suggestions from the three observers, which could be used to improve learning activities in the next meeting.

Based on Table 7, it can be seen that the N-gain score for students is 0.77, with high criteria. This means that the improvement of critical thinking skills reaches the expected criteria, which is very good. Based on Table 8, activity pre-test And post-test were given to 32 class VIII students of MTs Negeri 1 Jember, before and after using the product, to determine the increase in students' critical thinking skills. Gain value analysis results on the pre-test And post-test, namely 0.77 with the high category, which means after using the e-module-based *mobile learning application*s in science learning. Students have an increased ability to think critically. So that it can be seen in the results of the analysis of the question items that refer to indicators of critical thinking skills. Critical thinking skills indicators consist of 6 indicators. After executing the pre-test And post-test, the researcher will analyze the data so that they can find out the improvement of the critical thinking skills of each student. The results of the N-gain of the indicator of critical thinking ability with the highest score lie in the self-regulation indicator with an N-gain value of 1.00 with high criteria. According to Friskilia and Winata (2018), students' self-

regulation can be more active, and regulating the achievement of high achievement in the learning process in each student will definitely require the right strategy. The lowest N-gain value on the explanatory and analytical indicators, with a value of 0.34, is included in the medium category. According to Nuryanti et al. (2018) stated that students are weak in analyzing because they are still unable to determine appropriate strategies for solving a problem by analyzing the truth of a problem. This opinion is similar to Hanna et al. (2017) that a problem is in the learning process, practicing questions that refer to indicators that are still inaccurate problems to choose strategies, so it can be said that there is an increase in students' critical thinking skills by using high-category *mobile learning application*-based e-module media.

Based on Table 9, the developed products' effectiveness will also be determined from student response questionnaires that provide positive and negative statements. Based on the analysis results, the average percentage of the three assessment indicators consisting of interest, motivation, and responses reached 74% with good categories. This means that on the indicators of interest according to students, the appearance of e-modules based on mobile learning applications can make students more excited and not bored in learning, the presentation of material in e-modules can encourage students to conclude material, discuss with other friends, and can affect critical thinking skills (Nuha at al., 2021; Andayani, 2019), while on the motivation indicators according to students, the material on e-modules based on mobile learning applications is related to daily life, easy to understand, there are pictures, and practice questions that can test the understanding of the material given (Laili, Ganefri, dan Usmeldi, 2019). The response indicators, according to students, the sentences used in e-modules are clearly easy to understand, the language used in e-modules is easy to understand, and the letters used are easy to read.

CONCLUSION

Fundamental finding: Based on the discussion of data and the results of the analysis, mobile learning application-based e-modules have been valid, practical, and effective to improve student's critical thinking skills in science learning. The validity of the E-Module was included valid category. The practicality of the E-Module obtained a percentage of the implementation of all meetings in very practical category. The results of pretest and posttest calculations obtained an N-gain value in high category and shows that the average student response result is included in the good category. **Implication:** This research product can be used to support science learning activities and improve students' critical thinking skills. In addition, the results of this study can be used as a basis for developing media or other teaching materials based on mobile learning. **Limitation:** The expert validator does not involve learning media experts. **Future research:** The development of e-modules based on mobile learning applications can be directed at providing other skills, such as creative thinking skills, problem-solving skills, or relevant skills.

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