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Improving Critical Thinking Skills of Junior High School Students in Science Learning Using the Development of Interactive E-Module Based Macromedia Flash

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Abstract

The aim of this research is improving student critical thinking skills using interactive E-module based on macromedia flash. Critical thinking skills are one of the 4C skills students need to have in dealing with 21st century learning. Critical thinking skills is the ability to think reflectively and deeply in obtaining relevant information or knowledge and being able to make conclusions or decisions correctly and appropriately. Science teacher at SMPN 3 Jember has never trained a student's critical thinking skills through the learning process and has never done research on class 7 student skills. Vastly improved technology can be used in education to develop the taught materials of modules called e-modules. The study aims to determine the validity, practicality, and effectiveness of an interactive e-module based on macromedia flash to improve the critical thinking skills of junior high school students in science learning. The type of research used is research and development with the ADDIE development model consisting of the analysis, design, development, implementation, and evaluation. The results showed that 1) the interactive e-module based on macromedia flash was declared very valid with a percentage of 93%, 2) the practicality of interactive e-module based on macromedia flash was declared very good with a percentage of 95.2%, and 3) the interactive e-module based on macromedia flash was declared effective for improving students' critical thinking skills with an n-gain value of 0.4 belonging to the medium category and getting a positive response from students with percentage of 81.25% which was classified as positive category. Based on the results of the study, the interactive e-modules based on macromedia flash is effective in improving students' critical thinking skills.

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INTRODUCTION

Critical thinking skills is one of the abilities needed by students in facing learning in the 21st century. Critical thinking is defined as thinking using in-depth reasoning to get relevant information and being able to take responsibility (Hidayat et al., 2019). Critical thinking skills are the basis of solving a problem (Ridlo et al., 2020). So, critical thinking ability is the ability to think reflectively and deeply in obtaining relevant information or knowledge and being able to make conclusions or decisions correctly and appropriately. Critical thinking skills enable students to process information logically and prepare for independent learning (Paramitha & Sriyanti, 2021). In addition, critical thinking is able to train students to think logically or enter and the information obtained is not immediately taken for granted (Bektiarso, 2018). Students who have critical thinking skills are able to determine information that is important, relevant, and useful.

Indicators of critical thinking skills consist of interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2015). However, the indicators of critical thinking skills used in this study include interpretation, analysis, evaluation, inference and explanation. Interpretation is the ability to understand the meaning of a problem. The ability to identify relationships between statements, questions, concepts or other representations that are expected to be explanations, reasons and reliable information is called analysis. The ability to assess the credibility of statements or representations and assess the relationship between statements, data, facts, concepts or other forms is called evaluation. Inference is the ability to identify and guarantee the basic needs in drawing a conclusion. Explanation is the ability to express opinions and justify reasons through investigation and evidence based on data or facts obtained and explain strong reasons for a statement.

The critical thinking ability of students in Indonesia is still relatively low because the learning process is still teacher-centered (Nasihah et al., 2020). The data presented by PISA regarding scientific literacy in students in Indonesia shows that 60% of students are still below level 2 and 40% of students are classified as level 2 and above. The top level achieved by students from Indonesia is level 4, (OECD, 2019). This shows that students in Indonesia cannot determine abstract scientific ideas or concepts in explaining unknown and more complex phenomena, events and processes that involve many causal relationships. Students in Indonesia have not been able to evaluate alternative experimental designs and justify their choices and interpret information or make predictions, (OECD, 2019). Research in analyzing the critical thinking skills of class VIII junior high school students is by making and distributing essay questions that adhere to the critical thinking ability indicators from Ennis, but the results of data analysis show that the critical thinking skills of class VIII junior high school students are low because students are not familiar with the active learning process that centered on students' thinking potential (Nuryanti et al., 2018). The explanation shows that there are several factors that cause students' critical thinking skills to be low.

Students' critical thinking skills can be formed through the application of interactive classes, the role of students in teaching and learning activities and the role of the teacher (Nuryanti et al., 2018). The role of students in teaching and learning activities is not as a person being taught, but as a thinker. The teacher's role is not as a teacher, but as a facilitator, moderator, and motivator who helps students in the learning process. Research on the effect of scientific-based science modules on students' critical thinking skills and shows that the use of scientific-based science modules affects students' critical thinking skills (Rikizaputra et al., 2021) however, in the application of scientific-based science modules do not use technology as preparation for learning in the 21st century. The role of technology in 21st century learning is as a tool to develop 21st century skills (Andayani et al., 2019).

Based on the results of interviews with 2 science teachers at SMP Negeri 3 Jember, science teachers train students' critical thinking skills by providing practice questions to fulfill the 4C skills needed by students to face learning in the 21st century. However, no research has been conducted on the level of critical thinking skills. So that the category of critical thinking skills of students at SMP Negeri 3 Jember is not yet known. In addition, teaching and learning activities during the Covid-19 pandemic only use textbooks from the Ministry of Education and Culture as learning resources and worksheet of a learner as teaching materials. Thus,

it can be seen that there are still obstacles faced by teachers and students in Indonesia in the learning process and the teaching materials used still have shortcomings that cause students to have not been trained to carry out the scientific investigation process as a whole so that this can affect students' low critical thinking skills.

Most of the modules used by teachers are verbal or textual so that they do not attract the attention of students to study them. Efforts that can be made to attract students' attention on studying the module is to develop a module accompanied by illustrations or pictures to make it easier for students to understand the material and solve problems (Noperi et al., 2021). Rapid advances in technology and communication can be used in the field of education to develop teaching materials, namely modules, so they are called electronic modules or e-modules. E-module is a teaching material that is used through a technology network to encourage the spread and accessibility of independent and equitable learning processes in the learning process period (Candy & Rudyanto, 2021).

The development of e-modules in this study uses Macromedia Flash software which is integrated with PhET simulation software so as to create interactive e-modules that can motivate students to study independently or by minimizing teacher guidance. The development of this Macromedia Flash-based e-module was made by taking into account the indicators of critical thinking skills. It aims to improve students' critical thinking skills after using interactive e-module development products. The purpose of this developmental research is to examine the validity, practicality, and effectiveness of interactive e-modules based on Macromedia flash. The study has been helpful as a teaching material in sciences learning and as a reference to other researchers for developing teaching materials for further research on the interactive e-module based on macromedia flash.

METHODS

The type of research in this research is research and development using the ADDIE development model which consists of analyze, design, development, implementation, and evaluation.

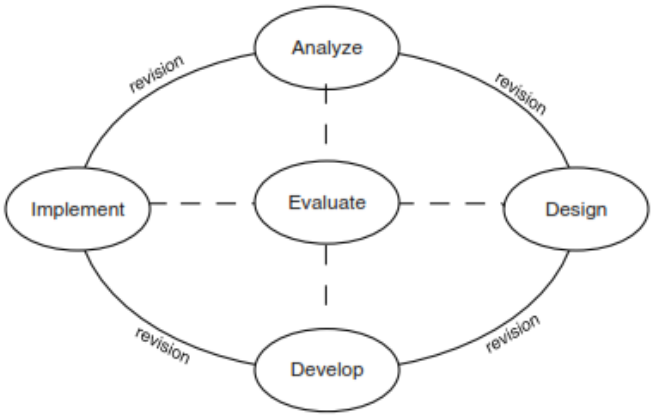

Figure 1. ADDIE development model phase

The analytical phase includes curriculum analysis, student analysis, situations analysis, and technology analysis. The design stage is to design a product that will be developed based on analysis that has been done. The stage of the development by making an interactive e-module based on macromedia flash that corresponds with a predetermined design. Implementation stages are test products for field development (schools). The evaluation stage by improving development products based on the Suggestions, comments, and input of validator and advisers during consultation and validation.

The location of this research was conducted in SMP Negeri 3 Jember. The implementation of this research is in the odd semester of the 2021/2022 academic year. The subjects of this study were students of class VII D SMP Negeri 3 Jember. Data collection techniques and instruments in this study included observation, interviews, documentation,

validation questionnaire sheets, critical thinking skills tests (pretest and posttest), student response questionnaire sheets, and learning implementation observation sheets.

Data analysis techniques in this study are validity analysis, practical analysis, and effectiveness analysis. The validation of interactive e-modules based on Macromedia flash was carried out by 3 validators, namely 3 teachers with a minimum of Masters Education (S2) using the validity formula (Fatmawati, 2016). The results of the calculation of the validation percentage can be matched with the validity criteria consisting of very valid, quite valid, not valid, and invalid.

The practicality of product development was carried out by observers, namely 2 students and 1 science teacher to assess the implementation of the learning process using an interactive e-module based on Macromedia flash using the practically formula (Nurhusain & Hadi, 2021). The results of the calculation of the percentage of learning implementation can be matched with the criteria of learning implementation which consist of very good, good, average, less, and very less.

The results of the effectiveness analysis were obtained from tests of critical thinking skills and student response questionnaires. Critical thinking ability tests include pretest and posttest. Calculation of critical thinking ability test results using the N-gain formula (Hake, 1998). The calculation results of N-gain are matched with the criteria of N-gain which consist of high, medium, and low.

Student responses were obtained from student response questionnaire sheets to interactive e-module based on Macromedia flash that were given to students. Calculation of the percentage of student responses using the percentage of student responses formula (Nurhusain & Hadi, 2021). The results of the calculation of the percentage of student responses were matched with the student response criteria which consist of very positif, positif, average, less, and very less.

RESULTS AND DISCUSSION

The results of this research and development are in the form of an interactive e-module based on macromedia flash to improve the critical thinking skills of seventh grade junior high school students on concepts, forms and energy sources that can be operated via Android with the help of Adobe Flash Professional CS6 software and PhET simulation. The end of the development product in the form of an Android application with the ".apk" extension. The stages carried out using the ADDIE development model.

Analysis

The analysis was carried out through observations of science teaching and learning activities in class VII and interviews with 2 science teachers at SMP Negeri 3 Jember. Curriculum analysis was obtained by SMP Negeri 3 Jember applying the Revised 2013 Curriculum which requires teachers to combine teaching and learning activities using the help of technology. Student analysis obtained the characteristics of class VII students can be observed through observation during the learning process. The online learning process due to the Covid-19 pandemic, it can be seen that the characteristics of class VII students do not like reading material, especially material that contains only writing and a few pictures as material visualization. However, grade VII students become interested in learning if the learning resources used contain lots of pictures that make it easier for students to understand the material. In addition, class VII students are also less interested in learning videos with a long enough time duration.

Analysis of the situation revealed that teaching and learning activities at SMP Negeri 3 Jember apply blended learning with a percentage of 50% face-to-face activities and 50% online activities. Learning resources used in the learning process are textbooks and LKPD. Teaching materials in the form of modules have been designed by science teachers, but have not been applied during teaching and learning activities. In addition, science teachers only train students' critical thinking skills through practice questions without providing material explanations that train students' critical thinking skills. The technology used by class VII students during online and online teaching and learning activities is by utilizing technology in the form of an Android smartphone and a small number of students using technology in the form of a laptop or computer. Technological analysis obtains interactive e-modules to train and improve the thinking skills of class VII students in science learning material concepts, forms and energy

sources. The technology that can be applied to train the critical thinking skills of grade VII students is using technology in the form of an Android smartphone with the help of Adobe Flash Professional CS6 software.

Design

The media used to develop e-modules is Adobe Flash Professional CS6 software whose products have the extension ".apk" as an android application, so users can interact directly with the developed e-module (interactive). The display of the e-module uses a pink background and is given a frame on the inside of the background to fill the content or material in the e-module. The contents of the e-module consist of a cover, preface, table of contents, introduction, learning activity 1, learning activity 2, evaluation, evaluation answer key, glossary, and bibliography. The initial display of the e-module begins with a cover containing the title of the e-module, science material, author's name, the identity of the education unit (class and semester) and the start button. When the start button is clicked, the introduction page will appear with the page number, e-module name and arrow icon to the right to move to the next page. The next screen is a table of contents page that contains the page name and page number that can be clicked so that it goes to the desired page, besides that there is also an arrow icon to the left to return to the previous page, a home icon to return to the cover and an arrow icon to the right to return to the previous page. go to the next page, as well as the introduction page, learning activities, evaluation, evaluation answer keys, glossary, and bibliography has the same appearance as the table of contents, but the content or material is different.

The introduction page consists of several sub-chapters, namely KD and GPA, description of conceptual material, forms and sources of energy, time allocation for studying e-modules, and instructions for using e-modules. The learning activity page 1 discusses the material concept of energy and learning activity 2 discusses the material form and energy sources. The learning activity page is divided into several sub-chapters, namely learning objectives, material descriptions, summaries, practice questions and self-assessments. The description of the material in learning activities 1 and 2 contains material on concepts, forms and energy sources that train students' critical thinking skills. The evaluation page contains multiple choice questions, totaling 15 questions. The evaluation answer key page contains the answer key for multiple choice questions on the evaluation. The glossary includes definitions of several terms in the material realm of concepts, forms and sources of energy. The bibliography includes reading sources that are used as references in the preparation of the e-module.

Development

At the development stage, it is done by making syllabus, lesson plans and developing e-modules. The syllabus and lesson plans are arranged according to the material Concepts, Forms, and Energy Sources in Basic Competence 3.5 Analyzing the concept of energy, various energy sources, and energy changes in everyday life including photosynthesis. The syllabus is prepared with a time allocation of 6 hours of lessons, assessment in the realm of knowledge only in the form of written tests and learning resources from science textbooks from the Ministry of Education and Culture K13. The lesson plans are prepared using a conventional learning approach, lecture learning methods, discussions, and questions and answers, the assessment is carried out critical thinking skills tests in the form of pretest and posttest each consisting of 5 essay questions, learning activities in the lesson plan are divided into 4 meetings.

The making of this e-module was made with reference to the design stage. The e-module is designed by combining various images, materials, questions, and icons that function as buttons to make the e-module more interactive. The display of the e-module which was made according to the design at the design stage.

Figure 2. Description of integrated material indicators of critical thinking skills "interpretation"

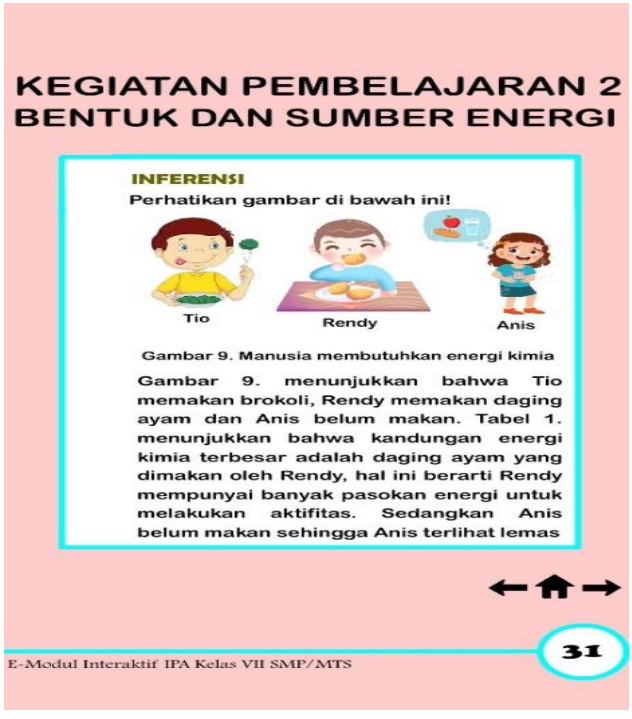

Figure 3. Description of integrated material indicators of critical thinking skills "inference"

The next development stage is the validation of learning tools (syllabus and lesson plans) and interactive e-modules based on Macromedia flash. The results of the syllabus validation were declared very valid with a percentage of 96.75%. The results of the RPP validation were declared very valid with a percentage of 97.75%. Thus, it can be seen that the validity of the learning device is stated to be very valid by 3 validators and is worthy of being used for testing.

Table 1. The results of the validation of the interactive e-module based on macromedia flash

Validation aspect	Average score (%)	Validity (%)	Criteria
Content validation	96.3		
Material aspect	92.8		
Presentation aspect	90.8	93	Very valid
Graphic aspect	88.5		
Language and image aspect	96.5		

The results of table 1 show that the interactive e-module based on Macromedia flash to improve the critical thinking skills of junior high school students on the material Concepts, Forms, and Energy Sources is stated to be very valid with a percentage of 93%. Although the interactive e-module based on Macromedia flash has been declared very valid, there are several things that must be done first before been tested on students according to the suggestions and comments from the validator. The validity of the interactive e-module based on Macromedia flash must meet the requirements of content validity and construct validity (Plomp & Nieveen, 2010).

The content validity of interactive e-modules based on Macromedia flash are components of interactive e-modules based on Macromedia flash that must be based on scientific knowledge to improve students' critical thinking skills. The e-module developed is different from the previous e-module, an interactive e-module based on Macromedia flash was developed to train the critical thinking skills of seventh grade junior high school students in science learning material Concepts, Forms and Energy Sources which are integrated with PhET simulations. The developed e-module is interactive, meaning that students can interact directly with the e-module because it provides icon buttons and an answer column to write students' answers in answering a question contained in an interactive e-module based on Macromedia flash. The purpose of making this interactive e-module is so that students have the freedom to learn by using android smartphones, which are the demands of using technology in 21st century learning. Technology plays a role in 21st century learning as a tool to develop 21st century skills, one of which is the ability to think critically (Andayani et al., 2019).

The validity of the interactive e-module constructs based on Macromedia flash is that all components (appearance, composition, font size, science theory, language, etc.) must be consistent and connected to each other. Construct validity consists of aspects of material, presentation, graphics, language, and images. Based on the results of the presentation, the interactive e-module based on Macromedia flash has met the requirements of content and construct validity so that it is declared very valid or suitable for use in teaching and learning activities. This is in line with the literature which reveals that adobe flash-based interactive e-modules are feasible to be applied in science learning (Raharjo et al., 2017). The interactive e-module can increase students' interest in learning it because students can interact directly with the e-module (Herawati & Muhtadi, 2018).

Implementation

The syllabus, lesson plans and e-modules that were declared valid were then applied to the class VII D of SMP Negeri 3 Jember which consisted of 33 students. The implementation of the implementation phase was carried out 4 times face-to-face meetings which were divided into 2 sessions with each session consisting of 16-17 students. During the teaching and learning activities, 3 observers were observed to complete the learning implementation questionnaire.

The results of the practicality data analysis of interactive e-module based on Macromedia flash at the 1st meeting were 66,7%, the 2nd meeting was 100%, and the 3rd meeting was 100%, so that the percentage of implementatuon of learning using interactive e-module based on Macromedia flash is categorized as very good with a percentage of 92.5%. This means that the overall learning using interactive e-modules based on Macromedia flash has a very good degree of practicality. In line with the literature that interactive e-modules can make learning more meaningful and satisfying because the learning process is more practical and controlled (Trimansyah, 2021).

The effectiveness of the interactive e-module based on macromedia flash can be seen from the students' critical thinking ability test through the

pretest and posttest, the results of the critical thinking skills test on table 2 and student response questionnaires that obtain the student's response results on table 3.

Table 2. The results of the critical thinking skills test

Value	Pretest	Posttest
Nmin	0	40
Nmax	56	76
Mean	35	60.7
Standard devation	18.4	10.1
N-gain	0.4	
Criteria	Medium	

The mean score of the students' pretest was 35, while the average score of the students' posttest was 60.7. The results of the two tests were then analyzed using the N-gain test to measure the improvement in students' critical thinking skills before and after the use of interactive e-modules based on Macromedia flash. The results of the N-gain analysis showed that the increase in students' critical thinking skills was in the moderate category of 0.4 so that the use of interactive e-modules based on Macromedia flash was declared effective to improve students' critical thinking skills. This can be influenced by the intellectual development of students, (Dores, et al., 2020). Intellectual development is a person's mental ability in responding to and solving a problem, connecting one thing to another and being able to respond to stimuli well. The level of intellectual development of students affects students' critical thinking skills because the intellectual development of each student is different. In addition, the obstacles experienced during the learning process using interactive e-modules based on Macromedia flash are that some students cannot install interactive e-module applications based on Macromedia flash because students' android smartphones do not support using this interactive e-module based on Macromedia flash.

Student responses to the interactive e-module based on macromedia flash were measured using a student response questionnaire distributed to 33 students of class VII D at SMP Negeri 3 Jember.

Table 3. The students' response results

Aspect	Percentage of average score (%)	Average percentage of student responses (%)	Criteria
Interest	82.5	81.25	Positif
Material mastery	77.5		
Language	82.5		
Critical thinking skills activity	82.5		

The results of the student response data analysis showed that the student's response to the interactive e-module based on Macromedia flash was included in the positive category with a percentage of 81.25%. The results of students' positive responses to interactive e-modules based on Macromedia flash make teaching and learning activities more fun and motivate students to learn. This is because the e-module is interactive, there are image visualizations that make it easier for students to understand the material and there is a PhET simulation which is a new experience for students. Learning to use interactive e-modules based on Macromedia flash can eliminate students' boredom, this is because e-modules are interactive with icon features that are used to operate interactive e-modules based on Macromedia flash so that students can be directly involved with e-modules in learning. In line with the literature, that interactive e-modules can engage students with e-modules directly and increase motivation and interest in the material being studied (Trimansyah, 2021).

Evaluation

The syllabus, lesson plans and interactive e-modules based on macromedia flash need to be improved according to the suggestions and comments from the supervisor before validation. After revision and validation have been carried out, the interactive e-module based on macromedia flash needs to be improved according to the suggestions and comments from the validator. Although there are several revisions to the interactive e-module based on Macromedia flash, the interactive e-

module based on Macromedia flash was declared very valid or feasible to use, then implemented for students to measure the level of effectiveness and practicality of the interactive e-module based on Macromedia flash.

The obstacle during the research was that a small number of students were unable to install interactive e-module applications based on macromedia flash because some students' android smartphones did not support downloading the Adobe Air application which functions as an application that can run interactive e-modules based on macromedia flash on Android smartphones and other applications. The playstore on the student's Android smartphone is connected to the student's parent's e-mail account so that students cannot download the application freely. In addition, there are students who do not have an Android smartphone. Efforts to overcome these obstacles are students who are constrained by joining their group of friends to study interactive e-modules based on macromedia flash.

CONCLUSION

Based on the results of the analysis of the interactive e-module based on macromedia flash, the validity of the e-module is included in the very valid category by the three validators. The practicality of the interactive e-module based on Macromedia flash was included in the very good category by the three observers. The effectiveness of interactive e-module based on Macromedia flash to improve students' critical thinking skills was declared effective in the medium category and student responses included in the positive category. The study has been helpful as a teaching material in sciences learning and as a reference to other researchers for developing teaching materials for further research on the interactive e-module based on macromedia flash.

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