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Development of E-Modules Based on Guided Inquiry to Improve Students' Critical Thinking Ability

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ABSTRACT

This type of research is development research that aims to determine the characteristics, feasibility, and effectiveness of the guided inquiry-based respiratory system E-module to improve students' critical thinking ability. The development model used is research and development (RND), which refers to the Borg and Gall development model that has been modified and adapted to conditions in the field, consisting of nine stages: 1) Research and informing collecting, 2). Planning, 3) developing a preliminary form of product, 4) preliminary feed testing, 5) main product revision, 6) main field testing, 7) operational product revision, 8) operational field testing, 9) e-module final product. The data analysis technique used is the descriptive analysis which is used to describe the characteristics of the e-module to be developed, and the feasibility analysis of the e-module based on the N-gain score obtained. The results of the N-gain test score in the control class, which is 0.65, are included in the medium category, while for the experimental class the average N-gain score of 0.78 is included in the high category. Based on these results, E-modules based on guided inquiry are very feasible to be used in learning and have proven effective in improving students' critical thinking ability.

Keywords: Development, electronic modules, guided inquiry, students' critical thinking skills, respiratory system, science

Introduction

The development of Science and Technology (IPTEK) in the 21st century will significantly impact the education system in Indonesia so that innovation and optimal use of technology are needed. In addition, learning in the 4.0 revolution era can apply hybrid or blended learning and case-based learning (Nastiti & 'Abdu, 2020). Even education in the era of society 5.0 allows students to apply the latest technology, with or without teachers, to support education and learning anytime, anywhere (Sabri, 2019). The development of IT makes it easier for teachers to use learning media that are easy to access, and flexible (Rahmi et al., 2017). The IT-based learning media can be combined with innovative learning models or commonly referred to as e-learning (Abudlhak, 2017).

Based on the results of interviews with science teachers and the results of the questionnaire filled out by class VIII students, it was stated that the learning activities carried out were still conventional. Teachers still use textbooks lent by schools, LKS compiled by the MGMP team, or other guide books. Textbooks used by students require students to memorize, which contains the whole material and long explanations. In addition, the teacher also uses video to support the teacher in explaining the material. However, many students are not serious about listening to the teacher, are inactive, bored, and lack student motivation because of monotonous learning. Therefore, easy and flexible teaching media solutions are needed such as electronic modules (e-modules).

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Electronic modules (e-modules) are independent teaching materials that are systematically arranged and presented in electronic form (Yayang & Eldarni, 2019). The use of the e-module is very easy and efficient, it can be opened using a computer, smartphone, tablet, and another gadget (Asmiyunda et al., 2018). E-modules have advantages compared to print modules because e-modules are equipped with pictures, video tutorials, learning videos, animations, and audio so that they can have a positive impact on students (Suarsana & Mahayukti, 2013). Research (Syahrial et al., 2019) shows that students have a high perception, motivation, and interest in participating in learning after using e-modules. Students are more interested in using e-modules to study independently or in groups at school (Violadini & Mustika, 2021).

Developing e-modules requires a strategy to be successful in the purpose of the creation of the media, especially to prepare students to face 21st-century learning. Competencies that must be possessed by students are Higher order thinking skills (HOTS). HOTS is a thinking activity that not only requires memory skills, but requires other higher skills (Wardany & Ramli, 2017), such as analyzing skills (C4), evaluating skills (C5), and creating (C6) (Anderson & Krathwohl, 2001). 21st-century society needs to develop skills that focus on developing HOTS, such as critical thinking, problem-solving, communication skills, being able to use technology and information, and understanding the media (Basuki & Hariyanto, 2012). One of the abilities that students must have is the ability to think critically. Critical thinking is a thinking process that aims to direct someone to be able to make decisions (Fisher, 2001). Critical thinking can support students to think clearly and rationally, easily understand the views of others, become more independent, find new opportunities, and reduce misperceptions (Katoningsih & Sunaryo, 2020). In the opinion (of Cahyana et al. (2017) critical thinking skills are used to solve problems in line, make decisions, analyze hypotheses and conduct scientific research. The ability to think critically is an important element that must be possessed by students in learning science (Wiyoko, 2019).

Based on interviews with science teachers at SMP Muhammadiyah 2 Surakarta, there is a gap between expectations and reality, where students are still not able to optimize their critical thinking skills. Based on the results of the tests tested on students, it can be seen that students' critical thinking skills are still low, and students have not been able to solve HOTS-type questions. Even students are still not able to understand things related to critical thinking ability indicators. This is supported by research (Wiyoko, 2019) which states that students are only able to get high scores on only a few indicators, such as self-regulation, analyzing meaning, and conceptual explanations, besides that they still get low scores.

The low critical thinking ability of students is still low can be caused by several factors, both for students, teachers, media, and learning models. Critical thinking can be improved by using an active and innovative learning system, such as using a student-centered learning model and supporting students to learn actively. One of the learning models that can increase student activity is the guided inquiry learning model. The guided inquiry learning model is a learning model that encourages students to be active and critical (Amijaya et al., 2018) and able to construct conceptual understanding through the stages in the scientific method (Lalang et al., 2017).

The guided inquiry learning model is believed to be able to improve student's critical thinking skills because in this learning model all activities involve students investigating and looking for something related to the material being studied so that students can formulate their findings. Indirectly, this learning emphasizes the discovery process in students, to encourage student activity in learning and grow their critical thinking skills (Seranica et al., 2018). The steps of guided inquiry learning include orientation, formulating problems, formulating hypotheses, collecting data, testing hypotheses, and drawing conclusions (Sanjaya, 2011). Based on the steps of guided inquiry learning, it can be seen that the guided inquiry learning model can help students improve critical thinking skills in the learning process. The learning process is centered on students (student center) and the teacher only acts as a moderator or facilitator.

Based on this description, the authors are interested in developing an electronic module (e-module) based on guided inquiry on the material of the human respiratory system class VIII which

will be used as teaching material in learning activities. This study has three objectives which include: 1) knowing the characteristics of e-modules based on guided inquiry to improve students' critical thinking skills, 2) knowing the feasibility of e-modules based on guided inquiry, 3) knowing the effectiveness of e-modules based on guided inquiry

Material and Methods

The research carried out includes the type of research and development (RND), which refers to the Borg and Gall development model and has been modified and adapted to conditions in the field, consisting of nine stages: 1) Research and informing collecting, 2). Planning, 3) developing a preliminary form of product, 4) preliminary feed testing, 5) main product revision, 6) main field testing, 7) operational product revision, 8) operational field testing, 9) e-module final product. The selection of this model is based on this model being developed systematically and by the theoretical basis and learning design used.

This research was conducted at SMP Muhammadiyah 2 Surakarta, Banjarsari District, Surakarta. The subjects of this study were 111 class VIII students which were divided into control class and experimental class. The experimental class uses conventional learning, while the experimental class uses the developed e-modules based of guided inquiry. The object of this research is an e-modules based of guided inquiry on respiratory system material for class VIII. The type of research used is Quasi Experiment Design with the design form of Noneequivalent Control Group Design. The following forms of research design Nonequivalent Control Group Design can be seen in Table 1:

Table 1. *Nonequivalent Control Group Design*

Group	Pretest	Treatment	Posttest
Kontrol	O1	X	O2
Experiment	O3	X	O4

(Sugiyono, 2012)

Information:

O1 = pretest score of the control class
O2 = posttest value of the control class
X = perlakuan
O3 = pretest score of the experimental class
O4 = posttest value of the experimental class

The data collection technique uses a validation sheet that aims to determine the feasibility of e-modules based of guided inquiry on the respiratory system material developed. The feasibility of the e-module was analyzed from the validation results of material experts, media experts, and linguists. The e-module feasibility data analysis technique uses descriptive analysis. The eligibility criteria for e-modules can be seen in table 2.

Table 2. E-modules eligibility criteria

Scor	Criteria
81-100	Very good
61-80	Good
41-60	Enough
21-40	Not good
0-20	Very not good

(Arikunto, 2013)

In addition, the study used a questionnaire given to 50 class VIII students, observation sheets to observe learning activities in class, and interview sheets conducted to science teachers in class VIII.

The instruments used in this study were treatment instruments and measurement instruments. Treatment instruments in the form of syllabus, lesson plans, and e-modules based on guided inquiry on respiratory system materials were given specifically for the experimental class. The measurement instrument is in the form of written test questions consisting of pretest and posttest questions in the form of essay questions. The selection of essay-type questions aims to measure students' critical thinking skills with a 0-5 scale rubric that is adjusted to the rubric (Zubaidah, 2018). The critical thinking ability measured includes 5 indicators of critical thinking ability according to Supriyati et al. (2018) consisting 5 indicators, namely: 1) elementary clarification; 2) basic support; 3) inference; 4) advanced clarification); 5 strategies and tactics. Before being used as an evaluation tool given to students, 11 essay questions were tested first to determine the level of validity, reliability of the items, the level of difficulty of the questions, and the discriminating power of the questions. The validity of the items is sought by using the product-moment correlation formula for rough numbers. From the results of the calculation of product-moment with a significant level of 5%, if the price r-count > r table product-moment then the items tested are declared valid. Testing using IBM SPSS Statistics 25.0.

Data analysis techniques to determine the effectiveness of the e-module can be seen by looking at the gain score (N-gain score). The increase in students' critical thinking skills that occurs before and after learning can be calculated using the N-gain formula which is determined based on the normalized average N-gain score, namely the comparison of the gain scores. The formula for finding the N-gain score (Hake, 2002) is as follows:

$$g = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}}$$

Information:
g = Score gain
S_{post} = average posttest score
S_{pre} = average pretest score
S_{max} = maximum score

The interpretation criteria according to (Hake, 2002) are seen in Table 3.

Tabel 3. Criteria for Interpretation on N-gain Score

Range	Criteria
g > 0,70	High
0,30 ≤ g ≥ 0,70	Medium
g < 0,30	Low

Results and Discussion

The research and development that has been carried out have produced a product in the form of an electronic module (e-module) as a digital teaching material that uses the guided inquiry learning method on the human respiratory system material which is specially made for class VIII. The output of the product developed is web-based developed with the Google site, so that students can access it easily and without having to download applications on their respective gadgets. The e-module developed in this study refers to the Human Respiratory System material contained in Basic Competency 3.9, namely analyzing respiratory organs in humans and understanding disorders of the respiratory system, as well as efforts to maintain a healthy respiratory system, as well as Basic Competence 4.9. namely presenting work on efforts to maintain a healthy respiratory

system. Consideration system material is important to be reached by students, so it takes students' seriousness to understand and learn it. To facilitate students in learning, e-modules are arranged systematically by integrating the learning model in guided inquiry and adapted to the syntax of the guided inquiry learning model.

The guided inquiry-based e-module was developed and adapted to the syntax and characteristics of the guided inquiry learning model. Furthermore, the e-module is validated by experts to find out whether the e-module developed is feasible to be used as teaching material in learning activities. This product feasibility validation activity involves several experts including material experts, media experts, and language experts. The task of the validator is to provide assessments, comments, and suggestions on the media developed through the product feasibility validation sheet. The assessment of the validation of the feasibility of the material is reviewed from 1) the introduction, which contains learning instructions, learning steps, and clarity of material achievement; 2) the content aspect, containing the description of the material, the relevance of the material to student competence, completeness of the material, media illustrations, clarity of examples and the suitability of the material with learning objectives; 3) evaluation, which contains the clarity of the problem, the level of difficulty of the questions, the suitability of the questions with the learning objectives; 4) closing, which contains the clarity of the summary and presentation of the bibliography. The validation results from the two material expert validators can be seen in Table 4.

Table 4. Result of material expert validation

Aspect	Σ P	Kategori
Introduction	80	Good
Content	90	Very good
Evaluation	80	Good
Closing	85	Very good
Average	83,75	Very good

The results of the material feasibility analysis by material experts on the developed guided inquiry e-module obtained an average of 83.75 with a very good category. In the introduction the score was less than the maximum, this was because the learning instructions contained in the e-module were not clear and detailed, while in the closing section there was a learning summary that did not cover all the material provided.

The results of the assessment of media feasibility validation in terms of 1) media introduction, which contains clarity of titles, general descriptions, guidelines, and ease of use of buttons in e-modules; 2) media display, which contains layout consistency, correct use of color, background, type of text and fonts, consistent use of icons and navigation buttons, animation suitability. Images, videos with materials, video quality, and the sound produced; 3) media assistance, containing clear instructions for using media, and ease of accessing assistance; 4) the end of the media, contains the clarity of the end of the media. The validation results of the two media expert validators can be seen in Table 5.

Table 5. Result of media expert validation

Aspect	Σ P	Kategori
Media introduction	95	Very good
Media display	87	Very good
Media help	80	Good
End of media	70	Good
Average	83	Very good

The results of the material feasibility analysis by material experts on the developed guided inquiry e-module obtained an average of 83 with a very good category. Some of the suggestions given by the validator include: a guide to using the e-module is made in the form of a flow chart, as well as adding a link to the table of contents according to the material or quote in the e-module.

Assessment of media feasibility validation is viewed from 1) straightforward and communicative, consisting of sentence structure determination, sentence effectiveness, use of standard terms, and understanding of the information presented; 2) dialogical and innovative, which consists of the ability to motivate students; 3) conformity with the development of students with intellectual and emotional students; 4) conformity of language rules, use of grammatical accuracy and spelling used; coherence and coherence of the flow of thought between chapters and paragraphs. The validation results of the two linguist validators can be seen in Table 6.

Table 6. Linguistics expert validation results

Aspect	Σ P	Category
Straightforward and Communicative	90	Very good
Dialogic and Interactive	80	Good
Compatibility with student development	100	Very good
Conformity with the Language Rule	90	Very good
Coherence and Coherence of Mindset	95	Very good
Average	91	Very good

The results of the material feasibility analysis by material experts on the developed guided inquiry e-module obtained an average of 91 with a very good category. Some of the suggestions given by the linguist validators include: it is necessary to check usage that is adapted to Indonesian spelling guidelines, and e-modules do not increase student motivation.

The guided inquiry e-module on the respiratory system material that has been developed can be seen in Figures 1-3.

Figure 1. Home e-module

Figure 2. Student activity page

Figure 3. Material page

After the guided inquiry e-module on the human respiratory system material has been validated by material, media, and language experts, and has been revised according to the suggestions given so that the e-module is ready to be used. The next step is the limited field trial phase which aims to determine the readability of the e-module, which is carried out on 35 students of class VIII D. The results of the readability test analysis can be seen in table 7.

Table 7. Readability test analysis

Validation	Presents (%)	Category
Material	96,7	Very good
Media	94,6	Very good
Language	90,9	Very good

Based on the results of the analysis of the readability test that has been done, the results are very good. The assessment given by students is then taken the average percentage, and analyzed. In the material aspect, it gets a percentage value of 96.7% with a very good category, from the media aspect it gets a percentage value of 94.6% with a very good category and for the language aspect, it gets a percentage value of 90.9% with a very good category. It can be concluded that e-modules based of guided inquiry on respiratory system materials can use e-modules according to their learning objectives well.

The next stage is an operational test that aims to determine the effectiveness of the guided inquiry-based e-module. To test the effectiveness of the developed e-module requires pretest and posttest scores conducted by students. The questions that are done by students are in the form of essay questions that are adjusted to the indicators of students' critical thinking abilities. The indicators for critical thinking skills according to Ennis 1898 in (Supriyati et al., 2018) consist of 5 indicators, namely: 1) elementary clarification; 2) basic support; 3) inference; 4) advanced clarification; 5) strategies and tactics.

The values obtained from the pretest and posttest from the control class and the experimental class were then used to calculate the N-gain score. The purpose of the N-gain test is to determine the effectiveness of the e-module. The results of the N-gain score on each indicator of critical thinking skills can be seen in Table 8.

Table 8. The results of the N-gain score on each indicator of critical thinking ability

Class	Category	N-gain	Kategori
Control	Elementary Clarification	0,69	Medium
	Basic Support	0,57	Medium
	Inference	0,65	Medium

To be continued…

	Advance Clarification	0,64	Medium
	Strategy and Tactics	0,65	Medium
Experiment	Elementary Clarification	0,80	High
	Basic Support	0,76	High
	Inference	0,77	High
	Advance Clarification	0,72	High
	Strategy and Tactics	0,78	High

Based on table 8, it can be seen that there are differences in the N-gain scores of the five critical thinking indicators of students, from the control class and the experimental class. In the control class, it can be analyzed from the five indicators of students' critical thinking skills, only one indicator gets an N-gain score in the high category, while four indicators get an N-gain score in the medium category. The elementary clarification indicator with an N-gain score of 0.73 is included in the high category. Furthermore, the basic support indicator gets an N-gain score of 0.66 in the medium category, the inference indicator also gets an N-gain score of 0.68 in the medium category, and the advanced clarification indicator gets an N-gain score of 0.62 in the medium category. In the fifth indicator, namely strategies and tactics, students get an N-gain score of 0.64 which means they are in the medium category.

The results of the N-gain score in the experimental class showed different results when compared to the control class. From the five indicators of critical thinking skills, students get an N-gain score with a high category. The elementary clarification indicator with an N-gain score of 0.80 is included in the high category. Furthermore, the basic support indicator gets an N-gain score of 0.76 in the high category, the inference indicator also gets an N-gain score of 0.77 in the high category, and the advanced clarification, indicator gets an N-gain score of 0.72 in the high category. In the fifth indicator, namely strategies and tactics, students get an N-gain score of 0.78, which means that they are in the high category.

Based on the results of the calculation of the N-gain score in the control class and the experimental class. In the control class, the N-gain score was 0.65 which was included in the medium category. Meanwhile, in the experimental class, an N-gain score of 0.78 was obtained in the high category. By the results of these calculations, it was concluded that the N-gain score in the experimental class was higher than the N-gain score in the control class. This proves that learning using guided inquiry-based e-modules is effective in improving students' critical thinking skills. The results of this study are in line with research (Indah et al., 2019) which states that guided inquiry learning can increase students' critical thinking skills, supported by research (Parwati et al., 2020) that guided inquiry learning models can improve students' critical thinking skills and scientific attitudes and students give positive responses to the application of the model. guided inquiry learning. In addition, the guided inquiry model also has a positive effect on learning outcomes (Amijaya et al., 2018)

Conclusion

Based on research that has been conducted at SMP Muhammadiyah 2 Surakarta, the results of the N-gain test show that there are differences in students' critical thinking abilities between the control class and the experimental class. In the control class, the N-gain score was 0.65 which was included in the medium category, while in the experimental class the N-gain score was 0.78 in the high category. So, it can be concluded that learning using e-module based of guided inquiry is effective in improving students' critical thinking skills. The results of the e-module feasibility validation test based on guided inquiry which was validated by material experts, media experts, and linguists got an average score of 85.9% which was included in the very good category. Therefore, the e-module based of guided inquiry material on the human respiratory system is suitable for use in science learning.

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