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# Development of Guided Inquiry-Based Mathematical E-Module in Improving Critical Thinking Ability and Mathematical Disposition Ability

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## ABSTRACT

The purpose of this development research was to determine: Validity, Practicality, and Effectiveness of guided inquiry-based mathematics e-modules in improving critical thinking skills and mathematical dispositions of fifth-grade elementary school students. The type of research used was R&D with the ADDIE model, where the ADDIE development procedure was carried out, Analysis, Design, Implementation, and Evaluation. The research design used one group pretest – posttest design. The results of the development of guided inquiry-based e-modules show the results that (1) the developed e-module is stated to be very valid with a score of 3.44, (2) the guided inquiry e-module is stated to be practically based on the acquisition of student responses with a score of 3.18 and practical based on the teacher's response, response score 3.00 was obtained. (3) the effectiveness of the guided inquiry e-module obtains an n-gain score for critical thinking skills with a gain value of 0.57ponse. This value is included in the moderate improvement category. While the n-gain for the ability of mathematical disposition is 0.71, with a high improvement category.

***Keywords:*** [*e-module, critical thinking, mathematical disposition*]

## INTRODUCTION

At present, the rate of development of science and technology is increasing rapidly, which in the 21st century entered the industry 4.0 era. Industry 4.0 in this era impacts the development of science and technology in various sectors of life, including the education sector. Technological developments in education are known as technology using a systematic approach. A systematic approach is an approach that focuses on students' efforts to design, develop, implement, and assess media learning.

The success of education can be influenced by the curriculum applied. The government's efforts to improve the quality of education in Indonesia consistently review the applicable curriculum and revise it from time to time. Currently, the 2013 revision of the 2018 Curriculum in Indonesia and the Merdeka Curriculum are in effect. The implementation of the two curricula is the emphasis and integration of learning with character education and HOTs (Higher Order Thinking Skills) or higher order thinking. In addition, the 2013 curriculum also integrates the 21st-century skill literacy culture called 4C (Creative, Critical Thinking, Communication, and Collaborative). (Maharani, Nindiasari, and Fatah, 2020:2)

In addition to the 4C skills (Creative, Critical Thinking, Communication, and Collaborative), students are also expected to have mathematical disposition abilities. A mathematical disposition is one of the practical abilities, students must have to

achieve success in mathematics. Students become persistent in solving challenging problems, are responsible for assignments, and in learning mathematics, have good habits.

The success of student competency in the 21st century is determined by many factors, namely educators, students, facilities, and other components. Educator factors can be seen from the pedagogical abilities of an educator, the ability to utilize technology, and design learning. Every appropriate learning plan is carried out by utilizing technology.

Ministry of National Education (2008), several benefits are obtained by teachers and students when teachers can develop their teaching materials. Among them are obtaining teaching materials that follow students' learning needs and curriculum, learning is no longer dependent on textbooks which are challenging to obtain, students having many learning resources so that they can add new references and knowledge, increasing teacher experience in writing teaching materials, and be able to build effective learning communication between teachers and students. Learning activities become more enjoyable with a variety of teaching materials. Students will not get bored quickly, are more active in learning, and make it easier for students to achieve the competencies they must master. By utilizing available teaching materials, students can learn more independently. (Anggreini & Dewi, 2019).

At the international level, we see that the mathematics ability in Indonesia is still low. The 2015 Survey Program for International Student Assessment (PISA) explained that out of 76 countries, Indonesian students were ranked 69th. Students were weak in understanding space and shapes in geometry material. The TIMSS study (Trend in International Mathematics and Science Study) explains that out of 42 countries, Indonesian students are ranked 38th. From the results of the TIMSS p, it is explained that in Indonesia, learning mathematics is more about memorizing a concept without emphasizing the ability to think critically in everyday contexts.

The results of observations and interviews at SDN 01 Sawangan, Doro District, Pekalongan Regency, show that learning at the school is not as ideal as previously described. Observations were carried out at SDN 01 Sawanagan on July 25, 2022. From the results of observations and interviews at the school, it can be concluded that the school has not carried out learning optimally. Where the availability of books in schools financed by the Government budget requires that these books can only be used while studying at school. Many students think bringing books is too dull, uninteresting, impractical, and monotonous. So, when traveling, they prefer to bring gadgets. Therefore, by using technology, the authors are trying to develop e-modules so that students can use them wherever they want to study. Because per the principles of educational technology, technology facilitates learning, and learning can be done anywhere, anytime, by anyone from any source.

This study aims to determine the results of guided inquiry-based mathematics e-module development products in improving critical thinking skills and critical mathematical dispositions of fifth-grade elementary school students in geometric material, analyze the validity of the mathematics e-module, analyze the practicality of the mathematics e-module, and analyze the effectiveness of guided inquiry-based mathematics e-modules in improving critical thinking skills and critical mathematical dispositions of students on cube and block building materials in grade V elementary school students.

## LITERATURE REVIEW

Research conducted by Mardiah et al (2020) found that based on data analysis and the two-way ANOVA test and the discussion conducted, the critical thinking skills of students with high initial abilities were significantly different from the thinking skills of mathematics students who had low

initial abilities. The critical thinking skills of students who apply the RME learning approach are significantly different from those of students who use conventional learning. There is no trick between the RME approach with high initial competence, which is very different from the mathematics of students with low initial competence. The mathematical dispositions of students who take part in learning with the RME approach are significantly different from students who take conventional learning. In addition, there is no interaction between the learning approach and initial abilities that influence student classmate tendencies.

Karim (2011) in his research stated that students who took part in learning mathematics using the guided discovery method had better critical thinking skills than students who received conventional learning seen at the school level, where students showed a positive attitude towards learning mathematics using the guided discovery method.

Rahmawati et al. (2013) in his research suggested that based on data analysis the average mathematical critical thinking ability of students and the learning completeness of students participating in guided discovery learning was higher than conventional learning. Herawaty et al. (2020) found in their research that learning RME with an ethnomathematics approach can be a means for students to make functional concepts meaningful. Herawaty et al. (2019) found that learning through an ethnomathematics approach can improve mathematical connection skills, problem solving, mathematical communication, and mathematical expression.

## MATERIALS & METHODS

This development research uses the ADDIE development model. The ADDIE model development process is a Preliminary Study (Analysis), Design (Design), Implementation (Implementation), and Evaluation (Evaluation). (Alddoobi, 2015:68).

Data collection techniques in this development research used questionnaires to analyze students' needs for the product to be developed, critical thinking ability tests for the pretest and posttest, and mathematical disposition questionnaires for the pretest and posttest.

The validity, practicality, and effectiveness tests are data analysis techniques to obtain quality e-module products. Validity analysis and practicality analysis were tested using a validity and practicality questionnaire, then calculated using the following formula: (Arifin, 2014).

$$N = \frac{\sum X}{\sum S}$$

Explanation:

$N$ = Obtained score

$\sum X$ = Total score

$\sum S$ = Assessment items

The quantitative data is converted into qualitative data based on the classification of the validity assessment as follows:

**Tabel 1. Module Validity Criteria**

| Validity Criteria | Validity Level |
|---|---|
| 3,26 – 4,00 | Very valid, e-module is used without repair. |
| 2,51 – 3,25 | Valid, e-module is used but needs a little improvement. |
| 1,76 – 2,50 | Invalid, it is recommended that the e-module is not used because it needs a lot of improvement |
| 1,00 – 1,75 | Invalid, e-module cannot be used |

The quantitative data is converted into qualitative data based on the practicality assessment classification as follows:

**Tabel 2. Module Practicality Criteria**

| Practicality Criteria | Practicality Level |
|---|---|
| 3,26 – 4,00 | Very Practical |
| 2,51 – 3,25 | Practical |
| 1,76 – 2,50 | Less Practical |
| 1,00 – 1,75 | Not Practical |

E-modules that have been declared feasible by the validator, are then tested in learning to test the effectiveness of critical thinking and mathematical disposition. The e-module trial is declared effective if there is an increase in critical thinking skills before using the e-module with critical thinking skills and mathematical disposition abilities after using

the e-module. The research design used was one group pre test – post test design.

Test the hypothesis in the final stage of analysis using the t-paired statistical test. The t-pired hypothesis in development research is as follows:

$$H_0 : \mu_1 \leq \mu_2$$
$$H_1 : \mu_1 > \mu_2$$

Explanation:

$H_0$ : The posttest score is less than or equal to the pretest score, which means there is no increase in critical thinking skills and mathematical disposition.

$H_1$:. The posttest score is more than the pretest score, which means there is an increase in critical thinking abilities and mathematical dispositions.

The t test formula used in this study is as follows (Arikunto, 2010):

$$t = \frac{Md}{\sqrt{\frac{\sum X^2 d}{N(N-1)}}}$$

Explanation:

$Md$ : The mean of the difference between pretest and posttest *(posttest – pretest)*

$xd$ : Deviation of each subject (d-Md)

$\sum X^2 d$ : Sum of squared deviations

$N$ : Subjects on sample

The significant level used in this study is 5% with db = N-1 (Arikunto, 2010). With the condition that H0 can be accepted if the tcount value is less than the ttable value. If these conditions are not fulfilled then H0 is rejected and H1 is accepted (Sugiyono, 2017). If H1 is accepted, the results that can be concluded are that there is a significant increase in critical thinking skills and mathematical dispositions after administering the e-module.

## RESULT

This development research obtained results from a guided inquiry-based mathematics e-module product. This E-Module development research was carried out through several tests: validity analysis tests, practicality analysis tests, effectiveness analysis tests on critical thinking, and effectiveness analysis tests on mathematical dispositions. E-modules need to be tested for validity before being tested in learning at school. The following results are tested for the validity of the e-modules presented in the table.

**Table 4. Module Validity Results**

| No. | Validator | Nilai | Keterangan |
|---|---|---|---|
| 1 | V1 (Validator Materi) | 3,42 | Very Valid |
| 2 | V2 (Validator Media) | 3,20 | Valid |
| 3 | V3 (Validator Bahasa) | 3,70 | Very Valid |
| 4 | Praktisi (Kepala Sekolah) | 3,48 | Very Valid |
| 5 | Praktisi (Guru Kelas) | 3,43 | Very Valid |
| | Rata – Rata | 3,44 | Very Valid |

Generally, the values obtained from the five validators are converted based on the module validity criteria in the table. 2, is that the e-module can be implemented without revision with an average score obtained from the validator of 3.44. However, the researcher made several revisions according to the suggestions for improvement and the validator's comments without re-validating.

Furthermore, teacher's and student response questionnaire sheets were analyzed for their practicality using the 1-4 module rating scale. The student response questionnaire obtained an average score of 3.18, included in the practical category. In contrast, the teacher's response questionnaire obtained an average score of 3.00, included in the practical category.

The normality test is carried out before the t test on critical thinking skills.

**Table 5. Test Results - Normality of Critical Thinking Ability**

| | | Unstandardized Residual |
|---|---|---|
| N | | 96 |
| Normal Parameters[a,b] | Mean | ,0000000 |
| | Std. Deviation | 5,83788079 |
| Most Extreme Differences | Absolute | ,090 |
| | Positive | ,090 |
| | Negative | -,089 |
| Test Statistic | | ,090 |
| Asymp. Sig. (2-tailed) | | ,055[c] |

Based on the statistical results in the table above, it can be seen that the significance

value (sig) is 0.055 so it can be concluded that the data is normally distributed.

After the data is normally distributed, then the data is tested with the t-paired test and the n-gain test to find out whether there is an increase in critical thinking skills that occurs after learning using guided inquiry-based mathematics e-modules. The t-paired test can be seen in the table below.

**Table 6. Results of the t-paired Critical Thinking Ability**

**Paired Samples Test**

| | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|
| Pair 1 | PRE - POST | -19,377 | 95 | ,000 |

Based on the results of the data above, it can be seen that the paired pretest posttest t test obtained a significance value (sig) of 0.000 which is less than 0.05 so that it can be concluded that H0 is rejected and H1 is accepted. Therefore, there is a significant increase in critical thinking skills after giving the e-module.

**Table 7. Results of the N-Gain Test for Critical Thinking**

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| NGAINS_SKOR | 96 | ,00 | ,87 | ,5519 | ,19614 |
| NGAINS_PERSENT | 96 | ,00 | 87,27 | 55,1865 | 19,61381 |
| Valid N (listwise) | 96 | | | | |

Based on the statistical data above, it can be seen that the average value is 0.5519, which means the value of the effectiveness of the e-module's critical thinking skills is in the medium category.

**Table 8. Disposition Ability Normality Test Results**

**One-Sample Kolmogorov-Smirnov Test**

| | | Unstandardized Residual |
|---|---|---|
| N | | 96 |
| Normal Parameters[a,b] | Mean | ,0000000 |
| | Std. Deviation | 2,04102874 |
| Most Extreme Differences | Absolute | ,147 |
| | Positive | ,090 |
| | Negative | -,147 |
| Test Statistic | | ,147 |
| Asymp. Sig. (2-tailed) | | ,028[c] |

Based on the statistical results in the table above, it can be seen that the significance value (sig) is 0.028 so it can be concluded that the data is normally distributed.

**Table 9. Disposition Ability T-Paired Test Results**

**Paired Samples Test**

| | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|
| Pair 1 | Pretest Disposisi - Postest Disposisi | -95,755 | 95 | ,000 |

Based on the results of the data above, it can be seen that the paired pretest posttest t test obtained a significance value (sig) of 0.000 which is less than 0.05 so that it can be concluded that H0 is rejected and H1 is accepted. Therefore, there is a significant increase in mathematical disposition ability after giving the e-module

After being tested using the paired t-test, it needs to be tested again using the N-Gain test to find out the magnitude of the increase that occurs after the use of guided inquiry-based mathematics e-modules. The N-Gain test can be seen in the table below.

**Table 10. Disposition Ability N-Gain test results**

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| NGAINS_SCORE | 96 | ,57 | ,84 | ,7437 | ,04614 |
| NGAIN_PERSET | 96 | 57,14 | 83,67 | 74,3677 | 4,61388 |
| Valid N (listwise) | 96 | | | | |

Based on the statistical data above, it can be seen that the average value is 0.7437, which means the e-module effectiveness value is in the high category.

The average pretest score for critical thinking skills is 59.8 while the posttest average score for critical thinking skills is 83.0. Based on the calculation of the n-gain formula above, a gain value of 0.57 can be obtained where this value is included in the category of moderate improvement in critical thinking skills.

The pretest results of students' mathematical disposition abilities obtained an average score of 2.00 while the posttest scores of students' mathematical disposition abilities obtained an average score of 3.50. From this acquisition, the gain value is 0.75 where this value is included in the category of increasing the ability of high mathematical dispositions.

## DISCUSSION

An electronic module or e-module is a module printed in an electronic version designed with specific software and read on a computer or gadget. The e-module contains learning materials, learning methods, and limitations used to evaluate. E-modules arranged in a systematic and exciting way serve to achieve the learning objectives and essential competencies set according to the level of complexity. E-modules present particular material that is presented electronically using flash drives, CDs, or online software that can be read via computers or gadgets in book format. (Turip, et al, 2021 : 493)

There are several e-modules compiled, including the Let's Find activity. This activity contains the syntax of guided inquiry that students must carry out to obtain the concept of the surface area of cubes and blocks and the concept of the volume of cubes and blocks independently.

The e-module developed using the live worksheet application is teaching material that can be accessed online using either a computer or a gadget. This e-module has the advantage that it is more attractive because the appearance of the module can be added to audio-visual media in the form of video.

This development research produced a product in the form of a mathematical e-module containing block and cube material whose validity had been tested by the five validators with a score of 3.44. With this value, the e-module is feasible to be implemented on students without revision with an average value validation result of 3.44. The module has been declared fit for use by experts and has a complete, systematic, and structured structure. The results of this study are also per the opinion of Donnelly (2015), which states that a complete module must be arranged in a

systematic and structured manner. (Lestari & Andriani, 2019) explain that modules that are appropriate for use and implemented for students have received validation from both material validators, media validators, and language validators. Improve critical thinking skills and mathematical disposition. In addition, the e-module also received a positive response from teachers and students. The teacher and student responses to the module were obtained from filling out the student response questionnaire and the teacher's response questionnaire to the implementation of the e-module. Module assessment uses an assessment scale of 1-4. The student response questionnaire obtained an average score of 3.18 which was included in the practical category. At the same time, the teacher's response questionnaire obtained an average score of 3.00 which was included in the practical category. According to (Nesri & Kristanto, 2020), giving the opinion that the positive response from students and teachers to the product being developed is an indicator of the practicality of the product being developed. These responses can be obtained by taking questionnaires and interviews.

The effectiveness test was carried out after the e-module was implemented on students. The results of students' critical thinking skills experienced a significant increase seen from the increase in scores (pretest) and scores (posttest), namely from an average score of 59.8 to 83.0 and obtained a gain value of 0.57 which is included in the moderate improvement category. In addition, the mathematical disposition ability also showed a significant increase, namely from before using the e-module, which obtained an average value of 2.00. After using the module, it increased to 3.50. This average comparison obtained a gain value of 0.75, which was included in the category of moderate increase. This happens because students can be actively involved in learning using guided inquiry e-modules so that students gain new learning experiences to discover the concepts of surface area and volume of cubes and blocks through their own understanding.

The guided inquiry-based mathematics e-module in this development research is able to improve critical thinking skills and mathematical dispositions because the preparation is based on the syntax of guided inquiry learning. Each guided inquiry syntax can train students' critical thinking skills. The e-module activity section of collecting data and analyzing data can hone students' critical thinking skills. Students who have the habit of solving problems independently so that they can find a concept independently will have higher critical thinking skills and mathematical disposition abilities than students who only learn rote and textually. Learning by finding its concept, students are always required to explore, analyze and handle the information they are looking. This statement is also supported by (Estri, 2015) argument that learning with inquiry raises students' curiosity to extract information independently in searching for a concept and solving problems. Students are motivated to continue their activities until they find the concept they want.

In addition to the preparation based on the guided inquiry syntax, the editing, and development of this e-module are per predetermined development procedures so that the value of the validity and practicality of the e-module gets a good assessment. So, development research is successful when the development procedure is carried out correctly.

## CONCLUSION

The results of the research and discussion described above can be obtained from several conclusions: the results of the validity of the e-module obtain an average value of 3.44 which is included in the criteria of being very valid and worthy of being tested in learning. The results of the practicality of students get a practical category with a value of 3.18. Meanwhile, the teacher's response analysis received a practical category of 3.00. This shows that the developed module helps teachers and students in learning. Based on

the results of the data, it can be seen that students' critical thinking skills experienced a significant increase from before using the module (pretest) to after using the module (posttest), from an average score of 59.8 to 83.0 with an n-gain value of 0. 57 which is included in the moderate improvement category. In addition, the mathematical disposition ability also showed a significant increase from before using the e-module, which obtained an average value of 2.00. After using the module, it increased to 3.50. This average comparison obtained an N-gain value of 0.75, which entered the high improvement category.

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