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Effectiveness of learning kit with guided inquiry model on cell metabolism topic to improve students' critical thinking skills

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Abstract

This study aims to produce a learning kit with a guided inquiry model on cell metabolism topic that effectively improves students' critical thinking skills. This research is developmental research using the Dick & Carey developmental model. The learning kit includes Learning Implementation Plans (RPP), Learner Worksheets (LKPD), and critical thinking test instruments. The research was conducted at MAN Insan Cendekia Gorontalo and MAS Muhammadiyah Kabila with a sample of students of Class XII in the academic year 2023-2024. Indicators of the effectiveness of the learning kit in this study were reviewed from the aspect of students' responses to the learning process conducted and the results of students' critical thinking tests. The results showed that the learning kit could improve students' critical thinking skills. The effectiveness aspect based on the student response questionnaire is in the excellent category. The critical thinking test results in the small group test increased by 41% with an N-Gain value of 0.61 (moderate). In the field test at MAN Insan Cendekia Gorontalo, there was an increase of 32% with an N-gain of 0.54 (moderate) and at MA Muhammadiyah Kabila, there was an increase of 31% with an N-gain of 0.36 (moderate category).

Keywords: Learning Kit; Guided Inquiry; Critical Thinking Skills; Cell Metabolism

1. Introduction

Critical thinking skills are fundamental skills that learners need in 21st-century learning. Critical thinking is a key element in building learners' knowledge. According to Zubaedah (2010), critical thinking skills will stimulate learners' cognitive reasoning skills in acquiring knowledge and finding solutions to problems contained in learning materials. This skill can be achieved if habituation activities are carried out. Therefore, the learning kit must be designed to stimulate students' critical thinking skills.

One of the subjects in Class XII Biology for which the learning kit can be developed is Cell Metabolism. The results of a survey conducted on the respondents consisting of teachers of Class XII Biology in Gorontalo Province showed that 42% of the respondents stated that the student's learning achievement in the topic of Cell Metabolism was the lowest compared to other subjects. Various obstacles were identified, including a lack of support in the form of laboratory facilities, a lack of literacy among students, and a low understanding of the material.

The low level of understanding of the material also occurs at MAN Insan Cendekia Gorontalo. Most students are incapable of determining the correct answer when the given questions require their critical thinking skills. Based on the analysis, only a maximum of 55% of the students in Class XII can answer these questions. This is assumed to be because the learning activities designed have not been able to stimulate the critical thinking skills of the students, thus, when the questions tested are of higher complexity, the students are unable to answer them correctly. Therefore, teachers

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need to carefully design a learning kit and choose the appropriate learning model so that the learning objectives can be successfully achieved.

One of the learning models that can be used is the guided inquiry model. According to Priansa (2008: 264), guided inquiry is a set of learning activities that focus on critical and analytical thinking processes and are designed so that students can actively learn and find their answers to challenging problems. In this learning model, the teacher guides the students in dealing with a problem, while the students actively try to find a solution with the teacher's guidance. As a result, they become more confident in investigating and formulating conclusions, which ultimately improves the process of mastering the subject matter.

The results of various studies show a positive and visible trend that supports the practice of inquiry-based learning, especially in the context of studying that emphasizes the active involvement of learners in thinking and drawing conclusions based on data. Therefore, this learning model can train students to develop critical thinking skills. Therefore, researchers want to design a learning kit with guided inquiry models to improve students' critical thinking skills, especially on cell metabolism topics.

2. Material and Methods

This research is development research that aims to produce products in the form of a learning kit consisting of Learning Implementation Plans (RPP), Learner Worksheets (LKPD), and test instruments that are improving students' critical thinking skills effectively. The procedure in this study follows the research and development steps of the Dick & Carey model adopted from Khotib (2010) and Elisa (2023), which consists of identifying learning objectives, conducting learning analysis, analyzing learner characteristics, formulating specific learning objectives, developing assessment instruments, developing learning strategies, developing and selecting teaching materials, and designing and conducting formative evaluations (small group tests and field tests).

This research was conducted in MAN Insan Cendekia Gorontalo and MAS Muhammadiyah Kabila, where the research subjects were students of class XII in the academic year 2023-2024. This research was conducted in the odd semester, from July to November 2023. The small group test was conducted at the beginning of September 2023 at MAN Insan Cendekia Gorontalo, while the field test was conducted at the end of September 2023 at MAS Muhammadiyah and MAN Insan Cendekia Gorontalo. Prior to use, the learning kit was validated by experts and declared fit for use.

The analysis of the effectiveness of the kit is obtained from learner response data and critical thinking test results. The questionnaire is analyzed by determining the percentage of the learner's evaluation of the learning process that has taken place. This assessment uses a 1-5 Likert Scale with criteria being strongly agree, agree, disagree, neutral, and strongly disagree. To calculate the percentage of students' responses using the formula:

$$\text{Percentage of Student Response (P)} = \frac{Total\ Score}{Score\ Criteria}\ X\ 100\%$$

The results of the analysis of the student's responses to the learning process are then interpreted in terms of criteria, which can be seen in Table 1 below:

Table 1 Interpretation of Student Response Questionnaire

Percentage of Student Response (%)	Criteria
86 – 100	Excellent
71 – 85	Good
56 – 70	Enough
41 – 55	Poor
≤ 40	Very Poor

Source: Yazid (2016)

The method used to test the effectiveness of the use of learning devices based on the results of students' critical thinking skills tests is a quasi-experimental design with a one-group pretest-posttest design as follows (Sugiyono, 2022: 409):

$$O_1 \; X \; O_2$$

in which:
O_1 = Pre-test data to measure the student's thinking skills before treatment.
O_2 = Post-test data to measure the student's thinking skills after treatment.
X = Action to improve students' critical thinking skills using a learning kit with guided inquiry models.

The critical thinking test is created based on five indicators of critical thinking skills, according to Facione (2015), which consist of interpretation, analysis, inference, explanation, and evaluation. The gain score in students' critical thinking skills is calculated based on the difference between the pretest and posttest scores. In addition, it is normalized using the N-Gain formula (Gain Normality) to see how much the increase in critical thinking scores is.

$$N - Gain = \frac{Spost - Spre}{Smax - Spre}$$

Description (Wahab, et al., 2021):
N-Gain = N-Gain normalization score
S_{post} = Post-test score
S_{pre} = Pre-test score
S_{max} = Maximum Score

In addition, the results of the N-Gain calculation were interpreted using Hake's N-gain index (Wahab, et al., 2021).

Table 2 Normalized Gain (N-Gain) Criteria

N-Gain Score	Criteria
> 0.70	High
0.30 ≤ N-Gain ≤ 0.70	Moderate
< 0.30	Low

3. Results and discussion

There are two indicators to measure the effectiveness of the developed learning kit, which are the student's response questionnaire and critical thinking test results. In the small group test consisting of 18 students of class XII IPA MAN Insan Cendekia Gorontalo, a score of 87% was obtained. The data is obtained based on the average of the evaluation column entries consisting of strongly agree, agree, neutral, disagree, and strongly disagree with the statements included in the response questionnaire sheet. Based on this score, the learning activities implemented for the students are categorized as very good.

Student response data in the field test was obtained from 17 students of MAN Insan Cendekia Gorontalo and 11 students of MA Muhammadiyah Kabila. The average percentage response of either MAN Insan Cendekia Gorontalo or MA Muhammadiyah Kabila students was 86%. Based on this value, the learning activities implemented for the students are categorized as very good.

The analysis shows that students give positive feedback to the learning kit that has been developed. As explained by Noviar, et al. (2016), students are more motivated to actively participate in learning and master their subjects using guided inquiry learning models. This can be seen from the student's activities during the learning process.

The second indicator to measure the effectiveness of the learning tool is the critical thinking test results. In the small-group test, the pre-test results showed that the average percentage of each critical thinking indicator, namely interpretation, analysis, evaluation, inference, and explanation, was 31%, 27%, 38%, 42%, and 30%, respectively. Meanwhile, in the post-test, the average scores of each critical thinking indicator were 72%, 75%, 78%, 85%, and 60%, respectively. It is concluded that there is an increase in the student's critical thinking skills after using the learning kit. The improvement in critical thinking skills for each indicator is shown in Figure 1.

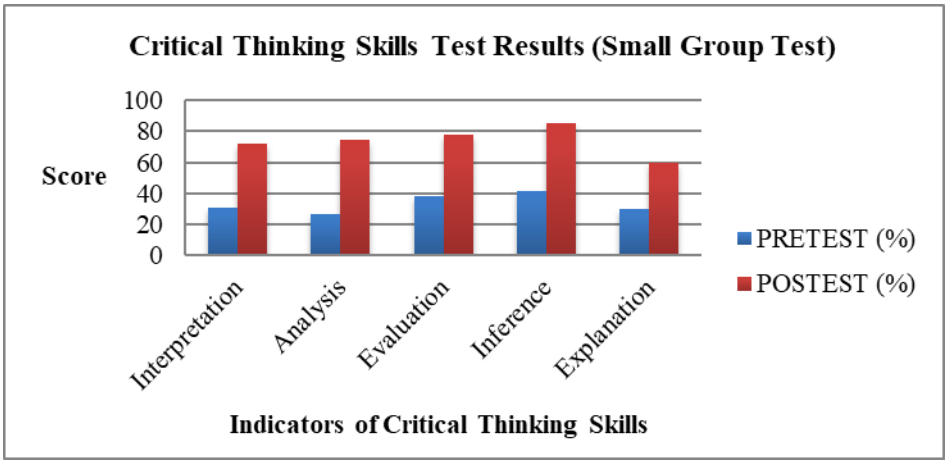

Figure 1 Critical Thinking Ability Results on the Small Group Test

The pre-test and post-test data were analyzed using N-Gain to determine the amount of improvement in students' critical thinking skills. The results of the N-Gain analysis are shown in Table 3.

Table 3 N-Gain Analysis of Critical Thinking Skills in Small Group Tests

Indicators of Critical Thinking Skills	Average Pre-test Score	Average Post-test Score	N-Gain Score	Category
Interpretation	31	72	0,60	Moderate
Analysis	27	75	0,65	Moderate
Evaluation	38	78	0,65	Moderate
Inference	42	85	0,74	High
Explanation	30	60	0,43	Moderate
Average	33	74	0,61	Moderate

Based on this data, the N-Gain values for the interpretation, analysis, evaluation, and explanation indicators are categorized as moderate, while the inference indicator is high. The average N-gain for all critical thinking indicators is 0.61. This means that the learning kit with guided inquiry models is quite effective in improving students' critical thinking skills. The increase in the critical thinking scores is because the students have followed the learning process using the learning kit products with guided inquiry models.

The critical thinking skills test in the field test was conducted on 17 students of Class XII Science of MAN Insan Cendekia Gorontalo and 11 students of MA Muhammadiyah. The pre-test results of MAN Insan Cendekia Gorontalo students showed the average percentage of each critical thinking indicator, namely interpretation, analysis, evaluation, inference, and explanation, was 41%, 53%, 44%, 41%, and 29%, respectively. In the post-test, the average achievement of each critical thinking indicator was 67%, 71%, 75%, 76%, and 75%, respectively. It is concluded that there is an increase in the student's critical thinking skills after using the learning kit. The improvement in critical thinking skills for each indicator is shown in Figure 2.

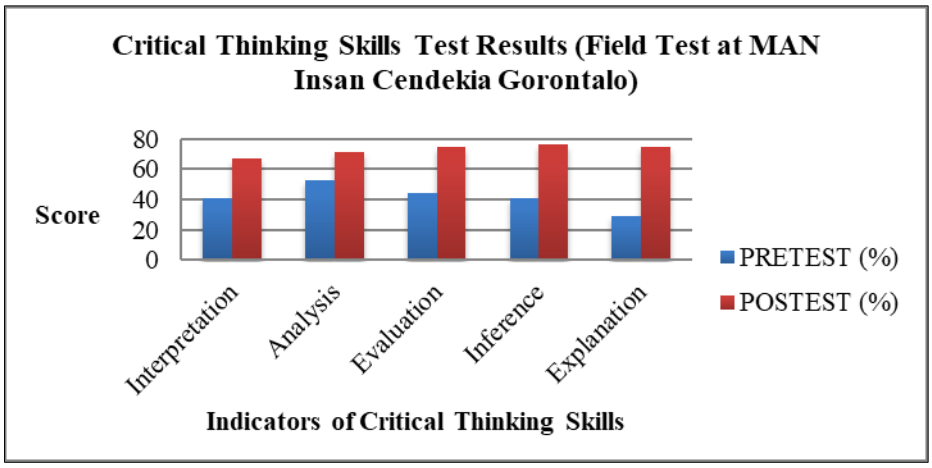

Figure 2 Critical Thinking Skills Test Results in the Field Test at MAN Insan Cendekia Gorontalo

The pretest and posttest data were analyzed using N-Gain to determine the magnitude of the increase in students' critical thinking skills. The results of the N-Gain analysis are shown in Table 4.

Table 4 N-Gain Analysis of Critical Thinking Skills Test in Field Test at MAN Insan Cendekia Gorontalo

Indicators of Critical Thinking Skills	Average Pre-test Score	Average Post-test Score	N-Gain Score	Category
Interpretation	41	67	0,45	Moderate
Analysis	53	71	0,39	Moderate
Evaluation	44	75	0,57	Moderate
Inference	41	76	0,60	Moderate
Explanation	29	75	0,64	Moderate
Average	41	73	0,54	Moderate

Based on the results of the N-gain analysis, all indicators are in the moderate category, which means that learning devices with guided inquiry models are quite effective in improving students' critical thinking skills. The increase in the critical thinking scores is because the students participated in the learning process using the learning kit products with guided inquiry models.

The pre-test results in the field test at MAS Muhammadiyah Kabila showed the average percentage of each critical thinking indicator, namely interpretation, analysis, evaluation, inference, and explanation, was 20%, 12%, 14%, 8%, and 11%, respectively. Meanwhile, the post-test showed an average of 42%, 39%, 42%, 60%, and 38%, respectively. It is concluded that there is an increase in the student's critical thinking skills after using the learning kit. The improvement in critical thinking skills for each indicator is shown in Figure 3.

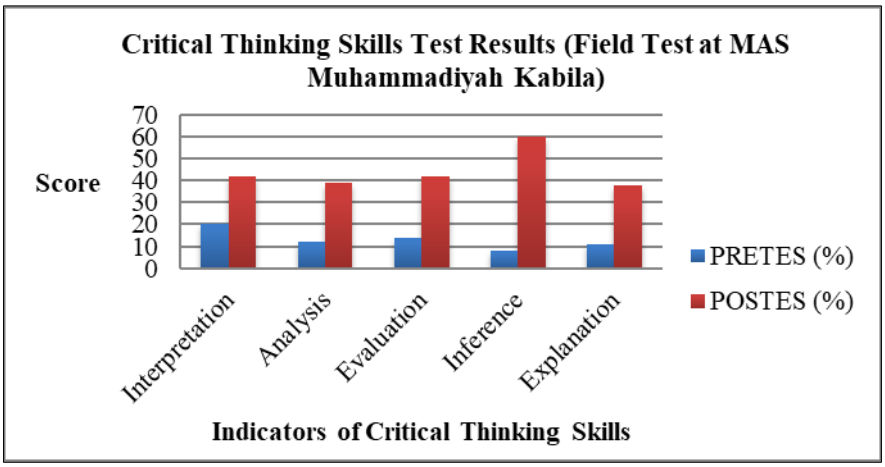

Figure 3 Critical Thinking Skills Test Results from Stage 1 Field Test at MA Muhammadiyah Kabila

The pretest and posttest data were analyzed using N-Gain to determine the magnitude of the increase in students' critical thinking skills. The results of the N-Gain analysis are shown in Table 5.

Table 5 N-Gain Analysis of Critical Thinking Skills Test Stage 1 Field Test at MA Muhammadiyah Kabila

Indicators of Critical Thinking Skills	Average Pre-test Score	Average Post-test Score	N-Gain Score	Category
Interpretation	20	42	0,27	Low
Analysis	12	39	0,30	Moderate
Evaluation	14	42	0,33	Moderate
Inference	8	60	0,57	Moderate
Explanation	11	38	0,30	Moderate
Average	13	44	0,36	Moderate

Based on these data, the N-gain values for the analysis, evaluation, inference, and explanation indicators are in the medium category, while the interpretation indicator is categorized as low. This means that the learning kit is less effective in improving students' critical thinking skills on the interpretation indicator. Although the average post-test score is low, the average N-Gain value for all indicators is 0.36 (moderate). This means that the learning kit is quite effective in improving students' critical thinking skills.

The student's low performance at MA Muhammadiyah Kabila may be caused by several factors, such as the student's initial ability, the learning resources used, and the facilities and infrastructure available. Madrasahs do not have adequate laboratories and only have limited learning resources. Students' initial understanding of the material is also very low, as evidenced by the low average of overall test scores. As stated by Lestari, et al. (2020), the enhancement of students' critical thinking skills is supported by learning media, books, and other supporting facilities and infrastructure, so that the learning process can be effective and enjoyable for students and that the desired learning objectives can be achieved.

Based on the results of analyzing students' responses and the critical thinking tests, it can be concluded that the learning kit with guided inquiry models is quite effective in improving students' critical thinking skills on cell metabolism material. This is consistent with the results of research by Maulida, et al. (2021), that the development of learning devices with the guided inquiry model can train students' critical thinking skills. As stated by Priansa (2008: 264), the guided inquiry learning model is a set of learning activities that emphasize the critical and analytical thinking process, which is designed so that students can actively learn and find their answers to a questionable problem. In this way, students' critical thinking skills are enhanced.

4. Conclusion

The learning kit can improve the student's critical thinking skills effectively, as evidenced by the data of students' responses and critical thinking test results. Students' feedback on the small group test achieved an average score of 87% (categorized as excellent). Meanwhile, the field test results at MAN Insan Cendekia Gorontalo and MAS Muhammadiyah Kabila obtained a score of 86% (categorized as excellent). This shows that the students have positive feedback on the learning kit using the guided inquiry learning model on the cell metabolism topic. The test results show an increase in the students' critical thinking scores, which means that the application of the learning kit is quite efficient. In the small group test, there was an increase of 41% with an N-Gain of 0.61 (moderate). In the field test, there was an increase of 32% with an N-Gain of 0.54 (moderate) at MAN Insan Cendekia Gorontalo and 31% with an N-Gain of 0.36 (moderate) at MA Muhammadiyah Kabila.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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