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The natural science practical guide developed based on critical thinking skills: Implementation test results

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Abstract

The expected learning outcomes in the 21st century are that students have critical thinking skills. The critical thinking skills are an important requirement to solving problems in life. The material in the Natural Science subject needs to be understood by relying on critical thinking skills, and is relevant to the environment. However, SMP Negeri 1 Hulu Sungai Tengah has not been equipped with an optimal learning guide to meet these demands, so a science practicum guide based on critical thinking skills has been developed. This study aims to test the practicality and effectiveness of the developed science practicum guide. Practicality is obtained from student response questionnaires and observations of the implementation of the use of practicum guides, while effectiveness is obtained from the categorization of the N-Gain Test of students' critical thinking skills. The results show: a practical science practicum guide developed with one-to-one evaluation results 97.22% (very good), student responses of 98.57% (positive), and 100% (very good) implementation; and effective with the results of the N-Gain categorization of students' critical thinking skills high for three indicators, and moderate for two indicators.

Abstrak

Hasil belajar yang diharapkan di abad 21 adalah peserta didik memiliki keterampilan berpikir kritis. Keterampilan berpikir kritis merupakan syarat penting untuk memecahkan masalah dalam kehidupan. Materi dalam mata pelajaran Ilmu Pengetahuan Alam perlu dipahami dengan mengandalkan keterampilan berpikir kritis, dan relevan dengan lingkungan hidup. Namun, di SMP Negeri 1 Hulu Sungai Tengah belum dilengkapi dengan panduan belajar yang optimal dalam memenuhi tuntutan tersebut, sehingga dikembangkan panduan praktikum IPA berbasis keterampilan berpikir kritis. Penelitian ini bertujuan menguji kepraktisan dan keefektivan dari panduan praktikum IPA yang dikembangkan. Kepraktisan diperoleh dari angket respon peserta didik dan observasi keterlaksanaan penggunaan panduan praktikum, sedangkan keefektifan diperoleh dari kategorisasi Uji N-Gain keterampilan berpikir kritis peserta didik. Hasilnya menunjukkan: panduan praktikum IPA yang dikembangkan praktis dengan hasi uji perorangan 97,22% (sangat baik), hasil respon peserta didik 98,57% (positif), dan keterlaksanaan 100% (sangat baik). dan efektif dengan hasil kategorisasi N-Gain keterampilan berpikir kritis peserta didik tinggi untuk tiga indikator, dan sedang untuk dua indikator.

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A. Introduction

The increasingly large development of education in the 21st century requires students to have high-level skills. Currently famous for 4C (Communication, Collaboration, Critical thinking, and Creativity) (Nurngaeni, 2018; Lestari, 2020; Mujahid, 2020). However, the critical thinking skills of students who are one of the 4Cs in Indonesia are still low (Ridho et al., 2020; Sundari & Sarkity, 2021; Rachmatika et al., 2021).

Critical thinking skills are needed by students to face the problems of everyday life, connecting existing knowledge with concepts in science subjects to make decisions (Ridho et al., 2020; Wahyuni & Sari, 2021). In addition, critical thinking skills significantly affect learning outcomes (Komariyah & Laili, 2018; Wanelly & Fitria, 2019; Wedekaningsih et al., 2019).

Student critical thinking skills can optimize through the practicum. Critical thinking skills are also low with the low intensity of practicum (Permana et al., 2016). Practical activities can improve students' skills (Zulpianti et al., 2017). Critical thinking skills do not come naturally. Practical activities can help optimize critical thinking skills (Nuraida, 2019).

Science learning cannot separating from practical activities because of the characteristics of the learning (Purnamasari & Surtikanti, 2015; Retno & Yuhanna, 2018; Mardhatilla, 2021). However, a science practicum guide oriented to critical thinking skills has not been developed and tested at SMP Negeri 1 Hulu Sungai Tengah. Therefore, this science practicum guide can affect the thinking skills of students.

Based on the needs analysis, in general, 100% of students stated that practicum activities did not use guidelines because they only used textbooks, and 78.3% of students experienced difficulties because the textbooks used did not have activity sheets and practicum steps that were difficult to understand (Fitriani, 2019). Furthermore, it statement shows that students' critical thinking skills were lacking due to the use of practical instructions, which on average, only contained questions to be filled out by students and seemed stiff (Yuanita & Yuniarita (2018). Students were less able to integrate theory causing students to be less proficient). in applying theory in everyday life because there is no practical problem-solving oriented guide available (Fajarianingtyas & Hidayat, 2020).

The research above reinforced clinical supervision results on practical guides, namely data that the Science Subject Teacher Consultative Forum (MGMP) has not published a practical guide that trains critical thinking skills. Practicum only refers to the available textbooks. The practical guide in the textbook is not equipped with student worksheets. In addition, tools, materials, and working methods are difficult to implement because they are not adapted to the existing infrastructure in the school and the school environment. The practical guide in the textbook is also not yet oriented towards emphasizing critical thinking skills.

The characteristics of science learning in these schools need to be optimized by making appropriate practicum guidelines. The practical guide is also oriented toward critical thinking skills to meet the demands of 21st-century education. A practical guide is the basis for this development research and to test the practicality and effectiveness of the developed science practicum guide.

B. Material and Method

This research is the implementation test phase of the formative evaluation of the Tessmer model. The research focuses on testing the practicality and effectiveness of the developed science practicum guide. Research location at SMP Negeri 1 Hulu Sungai Tengah. Research data were collected at the field test stage by involving 20 students. Practicality was obtained through individual testing, observation of the implementation of practicum guides, and student response questionnaires. Effectiveness obtained from the N-Gain test categorization. The calculation formula and categorization table used are as follows.

1. Practicality test

   Practical calculation formula:

$$X = \frac{\sum X}{n} \times 100\%$$

   Description:
   X = Mean
   ∑X = Total of all sample score
   n = Number of individuals

Table 1 Practicality criteria

Percentage	Criteria
85 – 100	Very good
70 – <85	Good
60 – <70	Medium
50 – <60	Not good
< 50	Very not good

Source: Sugiyono (2013)

2. Effectiveness test

N-Gain calculation formula:

$$g = \frac{S1 - S0}{Smax - S0} \times 100\%$$

Description:
g = gain score
S1 = Test score
S0 = Initial score
Smax = Maximum score

Table 2 N-gain classification

Gain Score	Criteria
g > 0,7	High
0,3 ≤ g ≤ 0,7	Medium
g < 0,3	Low

C. Results and Discussion

The science practicum guide that has been developed has gone through the expert validation and improvement stages. The improvement results are declared valid so they can be forwarded to the practicality and effectiveness test. Product development that has been declared valid can be continued to the next stage, namely the practicality and effectiveness test (Rachman et al., 2017; Susanti & Elfizon, 2019; Krismadinata et al., 2021). Practicality and effectiveness tests aim to determine the quality of the products that have been developed (Sukardi & Rozi, 2019) or determine the level of practicality and effectiveness of the products developed (Wandani & Nasution, 2017). The practicality and effectiveness test of a science practicum guide are as follows.

1. Practical Science Practicum Guide

The individual test results can be seen in table 3, and the results of the student response questionnaire can be seen in table 4. Then, the results of observations on the implementation of the practicum guide can be seen in table 5. These two test results support each other to determine the level of practicality of the science practicum guide developed.

Based on the student response test, the developed science practicum guide obtained an individual test result of 97.22%, with a very good category. Positive responses were also obtained with an average response percentage of 98.57%, with a very good category at the field test stage. Only 1.43% less than 100%. The observation results of the implementation of the use of science practicum guides are also very good, obtaining a maximum result of 100%.

The practical guide is very easy to understand because the presentation of the material is equipped with images that are easy to understand, associated with knowledge and adapted to the student's experience, and presented using simple language.

The results of Darmayanti & Haifaturrahman's research (2019), the analysis of the readability of an integrated science practicum guide book that is environmentally oriented obtained the practical category by 86% so that students can use it. However, it still needs revision to make it better. The results of Rasyidi & Muhsinun's (2020) research on developing science practicum instructions to improve critical thinking skills also received a positive response based on the student's readability test.

Table 3 Individual test results by students

No	Indicators/Aspects assessed	Student			Mean percentage	Category
		1	2	3		
1	Every part learned is easy to understand.	4	4	4	100	Very good
2	Include practical goals.	4	3	4	91,75	Very good
3	Include theoretical basis.	4	4	3	91,75	Very good
4	Instructions for use and how to work practicum are clear.	4	4	4	100	Very good
5	The entire contents are complete in logical order.	4	4	4	100	Very good
6	The words used are easy to understand.	4	4	4	100	Very good
7	The picture is of good quality and can be understood.	4	3	4	91,75	Very good
8.	No typos or grammar errors found.	4	4	4	100	Very good
9.	The photo on the cover is clear and understandable.	4	4	4	100	Very good
	Percentage (%)	**100**	**94,44**	**97,22**	**97,22**	**Very good**

Table 4 the results of the student response questionnaire using the developed science practicum guide

No.	Question	Percentage (%)		Category
		Yes	Not	
1	Are the contents of the practical guide easy to learn and understand?	100,0	0,0	Very good
2	Are the instructions given to acquire critical thinking skills understandable?	90,0	10,0	Very good
3	Is the time allotted for studying the practical guide sufficient?	100,0	0,0	Very good
4	If the study time exceeds the predetermined schedule, can you continue studying outside of study hours?	100,0	0,0	Very good
5	Is the content of the practical guide related to critical thinking skills unprecedented?	100,0	0,0	Very good
6	Has learning using a practical guide never been implemented before?	100,0	0,0	Very good
7	Are the learning materials interesting to study?	100,0	0,0	Very good
Total		**690,0**	**10,0**	**Very good**
Mean (%)		**98,57**	**1,43**	**Very good**

Table 5 The results of observing the implementation of learning using the developed science practicum guide

No	Question	Percentage (%)		Category
		Yes	Not	
1	Students read the beginning of the practicum guide (table of contents, rules, Core Competencies and Basic Competencies)	100,0	0,0	Very good
2	Students read the preliminary information (practice title, practicum objectives, theoretical basis, material tools, and working methods)	100,0	0,0	Very good
3	Students prepare tools and materials	100,0	0,0	Very good
4	Students observe and discuss how the practicum works	100,0	0,0	Very good
5	Students use a practical guide when making observations	100,0	0,0	Very good
6	Students use practical guides when conducting data analysis	100,0	0,0	Very good
7	Students use practical guidelines when drawing conclusions	100,0	0,0	Very good
Total		**700,0**	**0,0**	**Very good**
Mean (%)		**100,0**	**100,0**	**Very good**

According to Hasmiati et al. (2017); Mahardini (2020), simple language makes it easier for students to understand the material. Furthermore, according to Hasmiati et al. (2017), using simple tools and materials, easy to find, and equipped with guides will make it easier for students to understand the subject matter.

The basic theory has also been shown in the science practicum guide, and the practicum objectives have been included with the results of very good student readability. The results of the research on the development of genetic practicum instructions by Susantini & Lisdiana (2012) showed a positive response from the readability test results on the completeness of practicum objectives. Fajarianingtyas & Hidayat (2019), in their research on developing practical instructions for science students, also received a positive response. One aspect of the assessment is the existence of practicum objectives and the suitability of the sentences in the practicum instructions with Indonesian Spelling (EBI).

The contents have been arranged completely and in a logical sequence, and there are no more typos in the practical guide. According to Sundari et al. (2017), the contents of the practicum guide must be arranged attractively, adjust the image to the content, and uniform the letters with the sub-chapters of content in sequence. According to Chan & Budiono (2019), implementing the practicum requires a practicum guide with the main points, namely the format, content, and language, under the criteria for an appropriate practicum guide. According to Purwaningsih & Harjito (2019), the preparation of the practicum guide consists of sequential contents, starting from the cover page, content page, and back cover page.

Previous studies have been conducted on learning products oriented to learning models. Some of them are Syamsu's research (2017) on developing a guided inquiry-based science practicum guide for junior high school students with valid, practical, and effective results. Sari et al. (2019) developed a guided inquiry-based practicum manual with valid results, and the implementation was in the very good category. Wahab & Sartika's (2021) research on the development of a guided inquiry-based acid-base titration practicum guide obtained results that were very suitable to support practical learning in the laboratory.

Overall, the implementation of the science practicum guide is very good. This means that the developed product can be used practically by

teachers and students in the learning process. Teachers are helped in carrying out critical thinking-oriented practicum, and students have a positive interest in participating in science practicum activities. Science practicum guides that have been declared practical can be continued to the next stage to test the effectiveness of the developed practicum guides.

2. The Effectiveness of the Science Practicum Guide

Based on table 6, the results of the N-gain test of students' critical thinking skills using the developed science practicum guide obtained different results. Indicators give simple explanations, make inferences, and make further explanations to get a high category in either the Small Group or Field Test. For example, the indicator for building basic skills gets a medium category on the Small Group or Field Test. In contrast, the indicator on strategy and tactics gets a high category on the Small Group test and a medium category on the Field Test.

Maolidah et al. (2017) reported a significant increase in the indicators of giving simple explanations, building basic skills, making further explanations, and setting strategies and tactics, while indicators of making inferences experienced a moderate increase. The results of Yuanita & Yuniarita's (2018) research show improved critical thinking skills through practical learning. According to Yani et al. (2021), critical thinking skills can help students solve problems independently. According to Khairunnisa (2021), indicators of critical thinking skills are described in several operational points so that they are easy to implement in learning activities.

According to Umah et al. (2014), practicum instructions are some of the necessary means so that learning activities in the laboratory run smoothly and the main objectives of learning can be achieved, minimizing the risk of accidents. This statement is supported by Waluyo & Parmin (2014); Darmayanti (2020), a practicum guide that supports learning activities with practicum methods and improves skills.

Table 6 N-gain Test Results for Students' Critical Thinking Skills

Indicator	*Small Group*		*Field Test*	
	<g>	Category	<g>	Category
Give a simple explanation	0,9	High	0,9	High
Building basic skills	0,6	Medium	0,7	Medium
Making inferences	0,9	High	0,9	High
Make further explanation	0,8	High	0,8	High
Set strategy and tactics	0,8	High	0,7	Medium

D. Conclusion

The science practicum guide developed was stated to be practical, with individual test results of 97.22% (very good), student responses of 98.57% (positive), and implementation of 100% (very good). In addition, the science practicum guide was declared effective with the results of the N-Gain categorization of increasing critical thinking skills of high students for three indicators in both the Small Group and Field Test stages, one indicator with a medium category in both the Small Group and Field Test stages, and one indicator obtaining high category on the Small Group stage but the medium category on the Field Test.

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