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Practical Guide Based on Learning Cycle 5E to Enhance Students' Cognitive Learning Outcomes

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Abstract

The practical guide is a teaching material that students use in labwork activities. This learning cycle 5E (Engangement, Exploration, Explanation, Elaboration, Evaluation) on practical guide is expected to be used as an alternative choice for teacher in improving students' cognitive learning outcomes in concept of pressure and symptoms of capillarity in plants. The aim of this study was : 1) to describe the feasibility of develop practical guide based on learning cycle 5E and 2) to analyse the improvement of the practical guide based on learning cycle 5E to enhance cognitive learning outcomes of eight graders of junior high school in science lesson. Here, we used the Research and Development refers to the procedural steps of the 4D models by Thiagarajan. To test the efficacy, pretest and posttest were employed. This is a quasi-experiment research conducted in MTsN 3 Ngawi. Research subjects were all students of grade 8 by taking class 8A as the experimental class and 8B as the control class. Samples were taken by cluster sampling technique. The result of the feasibility test showed that practical guide included in the excellent category. T-test analysis suggests that the practical guide based on learning cycle 5E could improve students' cognitive learning outcomes significantly. In addition to contributing to the improvement of students' cognitive learning outcomes in MTsn 3 ngawi, the development of science cycle-based learning guide based on learning cycle 5e can also provide students practice skills in learning so that it is expected to contribute posotif in the community.

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INTRODUCTION

Education is defined as an effort to evolve a perfect Indonesian human being. To improve the quality of education in Indonesia, one way is to implement an effective learning process so that the results of learning can be achieved optimally. Learning is a factor that plays important role to influence the process of self-formation and the behavior of an individual. Part of individual developments take place through learning activities in which after learning the students get the learning outcomes (Purwanto, 2013).

The results of student behavioral learning can be changeds that occur in the cognitive, affective and psychomotor domains (Mundilarto, 2010). Bloom's cognitive domains of revised Bloom's taxonomy are included six categories: remembering, understanding, applying, analyzing, evaluating and creating (Anderson & Krathwol, 2010).

Gagne (1984) in Schunk (2008) argues that learning is complicated and learners get real abilities in themselves with different results. Different results when learning are caused by various types of cognitive information processing and when learning allows various types of performance. Some types of learning outcomes are intellectual skills, verbal information, cognitive strategies, motor skills and attitudes.Cognitive domains describe the level of thinking ability that students must master. Piaget classifies cognitive developmental levels by age. Cognitive development is the growth of logical thinking from infancy to adulthood (Ibda, 2015) and is classified into four major periods or developmental stages (Galotti, 2004).

Verb at lower levels of Bloom's taxonomy describe acquisition of knowledge and facts whereas verbs at higher levels of Bloom's taxonomy describe complex thinking skills, including application of knowledge to practical problems, analysis of competing interpretations, and creation of new knowledge or alternative interpretations of existing findings. (Stanny, 2016)

Science or commonly known as IPA in Indonesian context is one of the subjects that becomes part of the curriculum in junior high school. Generally, science has three components, namely: (1) scientific processes; (2) scientific products, and (3) scientific attitudes. The three components are related to each other (Bundu, 2006). Student-centered learning happens when students are actively engaged with activities that make them gaining real experience in understanding the material. Science is constructive learning, because it emphasizes the process of assimilation and fusion associations, so that students' knowledge must always be updated and constructed continuosly (Hayati *et al.*, 2013). IPA consists of two components, namely 1) scientific knowledge and 2) acquisition of scientific knowledge. Facts, laws, hypotheses, and theories are scientific things as well as knowledge. The acquisition of scientific knowledge also has two dimensions, namely the affective and cognitive domains (Ozgelen, 2012).

One of the activities that can assist students in trying to gain their practical experience in understanding science materials is out-of-class activities, such as laboratories. Learning with lab work is a very effective way to reach the entire realm of knowledge simultaneously, among others train that theory can be applied to real problems (cognitive), exercise planning activities independently (affective), and train the use of certain instruments (psychomotor) (Rahayuningsih *et al.*, 2005).

Teaching materials or learning resources which are commonly used in practical activities on science lesson is a practical guide. Currently, the school provides Student Worksheet (LKS) which contains material summaries, sample questions, exercise questions and some guidelines of practical activities that students can do in relation to the material. but the LKS is not sufficient to improve student cognitive learning outcomes.

Practical guides can be classified as teaching materials that are arranged systematically in order to improve the quality and quantity of teaching and learning according to the planned instructional objectives. Practical guide can serve as a learning resource support current learning experiment, increasing the interest of students in the lab, helping students become familiar with how to implement practical help students recognize systematic in making practical reports (Maya *et al.*, 2014). Designed instructional materials should also be accompanied by guidelines for students and teachers or trainers (Handayani, 2015). Development of learning tools adapted to the understanding the character of the students classroom (Boleng *et al*, 2018). *Learning cycle 5E* models is one of the constructivist-based learning models with the characteristics of Reviews their stage of systematic and sustained activity includes five phases: engangement, exploration, explanation, elaboration, evaluation (Renner *et al*, 1998). In the beginning, learning cycle, as a teaching method, consisted of three stages: exploration, reaching a concept and application. However, as the objectives of science teaching de-

veloped further, learning cycle consisted now of four stages: exploration, explanation, elaboration and evaluation (Qarareh, 2012)

Better performance of students in the 5E learning cycle model–based, interactive multimedia-supplemented group were consistent with the view claiming that correct use of the 5E learning cycle instruction accomplished both effective learning of concepts and an ability to apply concepts (Piyayodilokchai *et al*., 2013). The Biological Science Curriculum Study (BSCS) developed a research method constructivist called The Learning Cycle 5E , which consists stage of Engangement, Exploration, Explanation, Elaboration and Evaluation (Bybee, 2006). The learning cycle 5e model used to construct a practical guide can help students improve cognitive learning outcomes. The purpose of this research is to know the effectiveness of practical guide based on learning cycle 5E to improve students' cognitive learning outcomes.

METHOD

This research was conducted in MTs Negeri 3 Ngawi for three months (January-February 2018) in even semester of academic year 2017/2018. The subjects of this study are students of grade 8 and the object of research is a science-based practical guide based on learning cycle 5E to improve students' cognitive learning outcomes. The samples were selected by using cluster sampling technique. 33 students of class 8A became an experimental class using science-based practice guides based on learning cycle 5E and 32 students of class 8B became a control class using conventional practicum guide.

This research is a development with a quasi-experimental methods (quasi-experimental research). To test the effectiveness of the product pre-test post-test control group design was employed.

Practical guide based in learning cycle 5E was developed by the Research and Develpoment methods. R&D used to produce a particular product, and to test the efficacy of the product (Sugiyono, 2012). IPA practical guide development procedures in this study refers to measures development four-D models. The instrument used to assess the feasibility of practical guide IPA based on learning cycle 5E was the validation sheet. Practical guide IPA rated by 4 rater which consist 2 expert lecturers and 2 teachers IPA.

IPA practical guide based 5E learning cycle was used to improve cognitive learning outcomes of students.The data collected was the result of students' cognitive learning result tes. Assessment instruments include test questions consisting of 20 multiple choice questions and 5 description questions. The improvement of cognitive learning outcomes could be seen and measured with the same pre-test and post-test test questions.

Data analysis technique of cognitive learning outcomes was done by doing inferential analysis with SPSS version 22 program. Inferential analysis technique in this research used *Independent t-test*. *Independent t-test* was conducted to test data generated from the students' cognitive learning outcomes test in the experimental class and control class. Before conducting the *Independent t-test*, the normality and homogeneity test were conducted on *n gain* of students' cognitive learning outcomes. The *n gain* was calculated using the following equation:

$$g = \frac{Post-test\ score - Pre-test\ score}{Max.score - Pre-test\ score}$$

with *g* as normalized gain score. The result of cognitive learning outcomes is categorized into three types (Hake, 1998) as seen in Table 1.

Table 1. The Criteria of Normalized *n gain* Average

Normalized Gain	Category
$g > 0.7$	High
$0.3 \leq g \geq 0.7$	Moderate
$g < 0.3$	Low

RESULTS AND DISCUSSION

The products developed in this study is a practical guide IPA based learning cycle 5E. Practical guide in the form of teaching materials used by students during the practicum material substance pressure. Practicum guide consists of the introduction, contents and cover.

Part of the contents on this practical guide contains 3 activities where on the content to load titles and practical objectives and the stages on learning cycle 5E as in Figure 1. Practical guide was developed with 4D methods as in Figure 2.

Practical guide compiled based on the phases of 4D then test the validity. Ratings validity of IPA-based products practical guide *5E learning cycle* components rated for feasibility based on aspects of practical guidelines, eligibility content, language, presentation, graphical and characteristics of science-based guidelines is practical *learning cycle 5E*.Validity recapitulation data show that the assessment by 4 validator consisting of two faculty experts and two science teachers

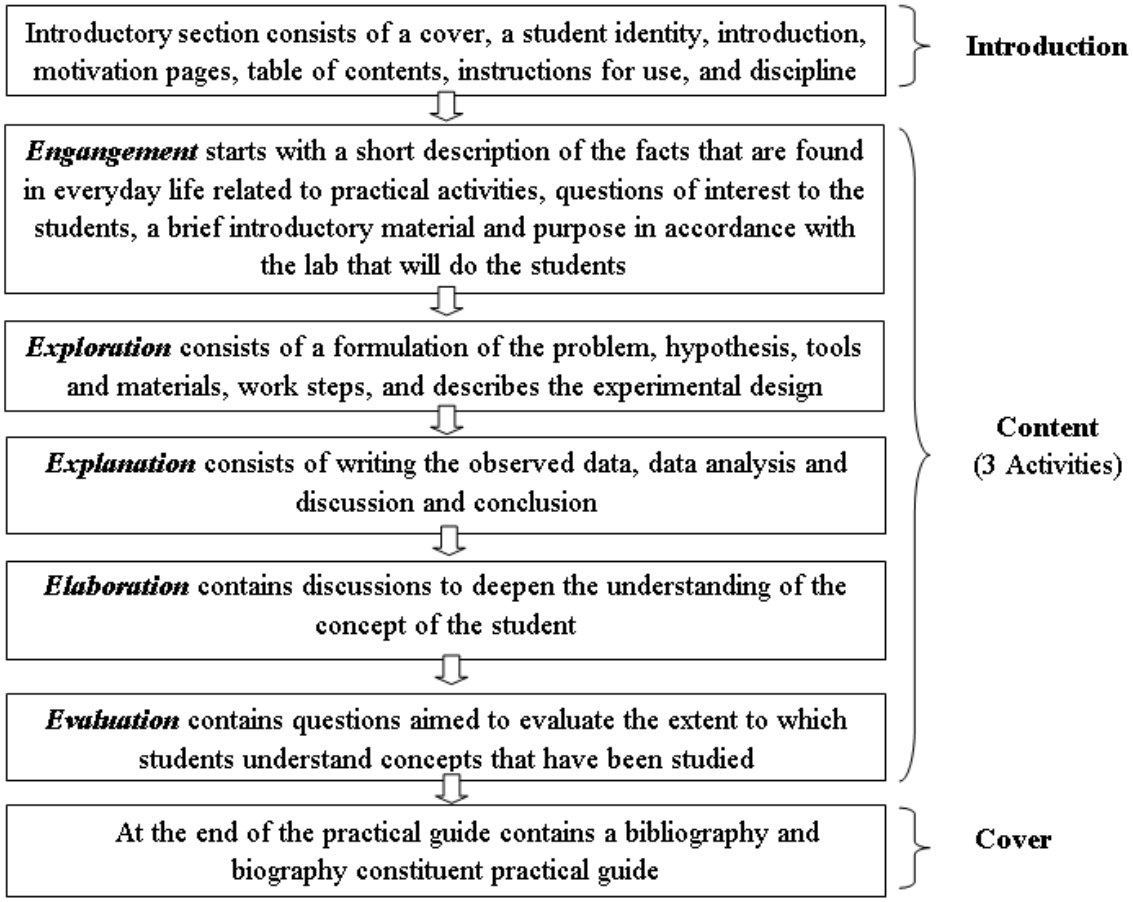

Figure 1. Part of Practical Guide Based on Learning Cycle 5E

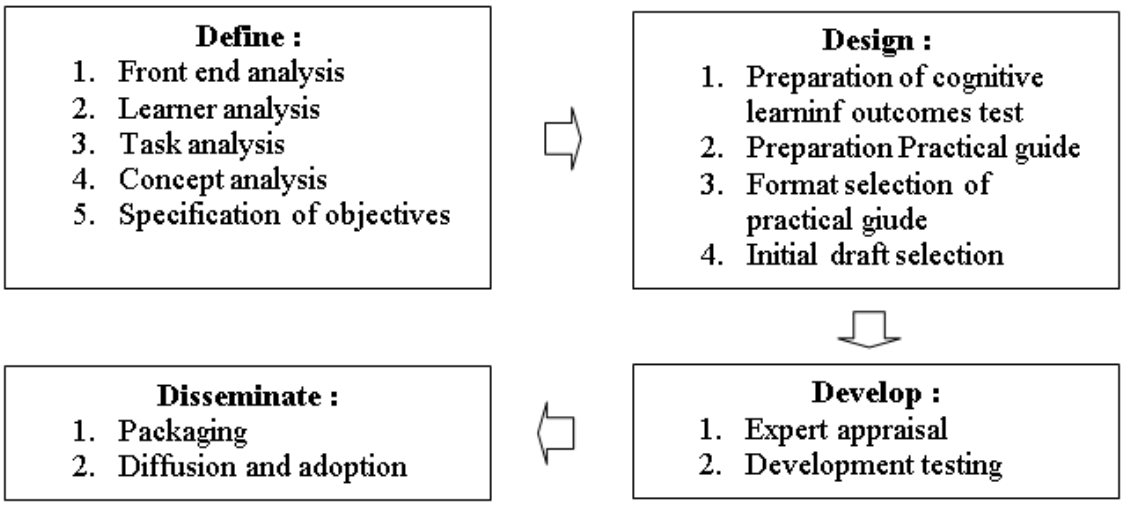

Figure 2. Research development with four-D models

show the data as shown in Table 2.

Ratings by some experts is important undertaken to provide an assessment of the practical guide was developed to be a decent IPA money is used as a source of student learning. Expert lecturers and science teacher at the depth of material to suggest improvements, grammar, presentation, and so forth. Researchers conducted an analysis of recommendations for improvement and revisions as a reference input for improvement of practical guides.

Feasibility of IPA-based practicum guides

5E learning cycle in addition based on the assessment of experts also supported by the results of questionnaires legibility students on limited testing. Legibility questionnaire given to 12 students of class VIII MTs 3 Ngawi. The mean score for each aspect of legibility student questionnaire results are presented in Table 3.

Rating practical guide that has been valid then used for further research is to improve the cognitive learning junior high school students.

This research was conducted in MTs Negeri 3 Ngawi by taking two classes as sample, they are class 8A as the experimental class and class 8B as the control class. The experimental group used the practical guide based on learning cycle 5E for learning, while the control group used conventional practical guide. The lesson consists of 5 meetings, the first meeting taking the pre-test used as data to assess the students' initial ability of the experimental and control group. The second, third and fourth meetings are the science lesson with the material of pressure substance and its application in daily life by applying the practical guide based on learning cycle 5E in the experimental group. The fifth meeting was used to take the final score (post-test) to find out the students' cognitive learning outcomes after treatment.

Practical guide based on learning cycle 5E consists of 5 stages, namely engagement, exploration, explanation, elaboration, and evaluation. The practical guide based on learning cycle 5E is used to improve students' cognitive learning outcomes that include the ability to remember (C1),

Table 2. Results of Validity Free Practice-based *Learning Cycle 5E*

No.	Aspects	Score Rated			Category
		Lecturer	Teacher	Average	
1	Component of practical guide	54.50	56.50	55. 50	Excellent
2	Eligibility of contents	25.00	28.50	26.75	Excellent
3	Languange	18.50	18.50	18.50	Excellent
4	Presentation	21.00	24.00	22.50	Excellent
5	Graphical	19.00	19.00	19.00	Excellent
6	Characteristics of Practical guide based on *Learning cycle 5E*	22.00	23.50	22.75	Excellent
	Total			165.50	
	Value			A	
	Category			Excellent	

Table 3. Results of student responses to Readability Practical guide IPA

No.	Aspects	Mean Score	Category
1	Display image	91.67	Excellent
2	Image layout, tables and questions	97.22	Excellent
3	Display the title, description, instructions, pictures, tables, and questions	94.44	Excellent
4	The use of language	88.89	Excellent
	Score average	93.06	Excellent

Table 4. The Results of Cognitive Learning of Each Aspect

No.	Cognitive Aspect	Experimental Class		Control Class	
		Pre-test	*Post-test*	*Pre-test*	*Post-test*
1	Remembering (C1)	47.16	78.71	39.95	65.84
2	Understanding (C2)	49.73	77.49	45.58	59.25
3	Applying (C3)	29.65	61.95	23.21	35.72
4	Analyzing (C4)	36.91	70.56	32.71	43.34
	Average	40.86	72.17	35.36	51.04

understand (C2), apply (C3) and analyze (C4). The data of cognitive learning improvement is taken by comparing the pre-test and post-test results in the experimental and control group. Data of each cognitive aspect are then converted to scores of 100 as follows.

Table 4 shows the improvement of cognitive learning outcomes of the experimental and control groups in terms of each cognitive aspect. In the table, it shows that there are differences in cognitive learning outcomes between experimental group students and control groups. It can be observed from the achievement of the average value obtained by students of experimental group in which *pre-test* is *40.86* and *post-test* is *72.17*. While the improvement of the average score obtained by control group students in *pre-test* is *35.36* and *post-test* is *51.04*.

The difference in mean outcomes of the experimental and control group cognitive learning outcomes is presented in Figure 3

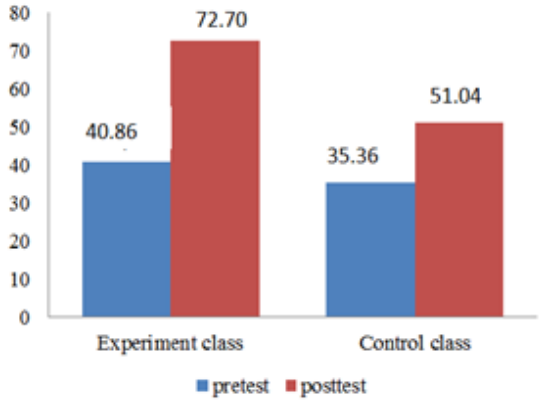

Figure 3. Graph of average Cognitive Learning Outcomes

The *n gain* data was obtained from the difference between each pre-test and post-test normalized values tested in the experimental and control group based on the students' cognitive learning outcomes. Description of increasing *n gain* cognitive achievement experimental class and control in every aspect are presented in Table 5.

Based on Table 5 it can be seen that there are differences in the value of *n gain* every aspect cognitive learning in experimental and control groups. The gain on the overall aspects of the rise, both in the experimental group and the control group. However, there are differences in improvement between the two groups. In considering the aspect, the value of the gain the experimental group and the control group 0.60 and 0.43 two groups categorized as "moderate". In the aspect of understanding (C2), applying (C3) and analyzed (C4) the value of the gain in the experimental group categorized as "moderate" category, while the control group was very low. The description of the increase of *n gain* of cognitive learning outcomes of the experimental and control classes is presented in Table 6.

Based on Table 6, it can be seen that there are differences in the value of *n gain* between experimental group and control group on cognitive learning outcomes. The normalized gain value in the experimental group is 0.5299 with the "medium" category, while in the control group is 0.2366 with the "low" category. It shows that learning by applying science practical guide based on learning cycle 5E can improve cognitive learning outcomes of Junior High School students at grade 8.

To analyze the effectiveness of the use of the Science Practical Guide based on *learning cycle 5E* and conventional practical guide, it is done by conducting *independent t-test*. Before performing an *independent t-test*, the normality and homogeneity test were conducted first by using SPSS version 22 program.

Table 5. Analysis Gain score for each aspect of the cognitive learning

Aspects	Experimental group		Control group	
	Gain	Category	Gain	Category
Remembering (C1)	0.60	Moderate	0.43	Moderate
Understanding (C2)	0.55	Moderate	0.25	Low
Applying (C3)	0.46	Moderate	0.16	Low
Analyzing (C4)	0.53	Moderate	0.16	Low

Table 6. The Analysis of Gain Score on Cognitive Learning Outcomes

Group	The number of students	Pre-test	Post-test	Gain	Category
Experiment	33	40.86	72.17	0.5299	Moderate
Control	32	35.36	51.04	0.2366	Low

Figure 4. Graph of difference gain cognitive learning outcomes

The normality test aims to determine whether the data is normally distributed or not. The normality test employed the kosmolgorov-smirnov statistical test obtained results as seen in table 10, the significance value for the experimental group is 0.200 and for the control group is 0.200. It shows that the data is normally distributed because of Sig. > 0.05.

The homogeneity test is used to know that two or more groups of sample data come from populations having the same variance. The homogeneity test in this study was conducted with the help of SPSS version 22 program using Levene statistic test, the cognitive learning achievement of students in the experimental group and control group is 0.406. The result of significance value shows that it is greater than 0.05, so it can be said that both groups are homogeneous.

After the results obtained that the sample meets the prerequisite test that it has normal and homogeneous distribution, then the next test to be conducted is an *independent sample t-test*. The result of *independent t-test* on mean score of students' cognitive learning outcomes is presented in Table 7.

Based on the data in Table 7, the independent sample t-test of the normalized *n gain* score of students' cognitive learning outcomes obtained a significance value of 0.000 <1.05 so that H_0 is rejected. It proves that the science practical guide based on learning cycle 5E is effective to improve the cognitive learning outcomes of students at grade 8 Junior High School.

The results obtained in this study correspond with some studies been done before. Based on research that has been done Soeprodjo *et al*. (2008), there is a positive effect of the use of models of learning cycle to the study of students in the material solubility and solubility product. Sumarni (2010) research results also stated learning learning cycle can improve the mastery of basic chemistry concepts and skills of logical inference for generic science chemistry teacher candidates. Furthermore, the research results Rahayuningsih *et al*. (2012) states, application of learning models accompanied learning cycle concept maps can enhance the quality of the learning process in the form of attitudes, interests, self-concept, values and morals as well as the study of students on the material solubility and solubility product. Then research Tuna & Kacar (2013) also showed that learning model of learning cycle not only affects learning achievement but also the permanence of knowledge of learners in trigonometry lesson.

Learning cycle 5E is a model student-centered learning. This model can be used to develop teaching materials in the form of practical guidelines IPA. In phase *engangement* students presented a short description of the facts that are found in everyday life related to practical activities. In this phase there are questions relating to the initial information to entice students explore students' prior knowledge. Introductory material and objectives of the activity are also presented in this phase to increase students' knowledge.

In the phase *exploration* presented the information on the relationship of the facts presented phase *engangement* with practical activities to be carried out. In this phase the students formulate the problem, hypothesis and experimental design drawing according to the direction that has been written in practical guidelines and tools, materials and experimental measures available. By preparing their own formulation of problems and hypotheses, students are expected to find their own initial description of the lab that will be done so that becomes more meaningful. The involvement of these students makes practicum activities more meaningful thus providing a deeper understanding of the concept for students.

In the explanation phase students write the results of observations on practical activities. Students together in the group draw a table of experimental results and fill it with data according to the observed results obtained. The data were analyzed by answering the questions presented in

Table 7. The Result of *independent sample t-test*

Variable	t	df	Mean Difference	Sig. (2-tailed)
Cognitive Learning Outcomes	10.236	63.000	21.12027	0.000
	10.254	62.574	21.12027	0.000

the data analysis section. Questions in data analysis and discussion are arranged in such a way that can help students construct concepts that must be mastered by students. In the conclusion section are given some initial conclusions. Students are then asked to complete the conclusions according to the formulation of the problem.

The elaboration phase contains discussion activities to deepen students' understanding of concepts. In the discussion activities, students presented the facts on different situations to test students' ideas and ideas about the facts.

The evaluation phase contains questions that aim to evaluate the extent to which students understand the concept in practice. Problems in the evaluation section can be either a multiple choice or a description. The selection of evaluation questions is adapted to the breadth and depth of the practicum material

The control group used a conventional practicum guide in the absence of a 5E cycle of learning in it. Students are less active in practical activities and difficulty in designing experiments. As a result, students in the control class lack understanding of the process and outcomes of practicum activities.

Based on the description, it can be seen that the use of science cycle 5 practice guide based on learning cycle 5E during the experimental activity in the experimental group gives an average increase in the value of higher cognitive learning outcomes compared with conventional practice guides in the control group. In addition to contributing to the improvement of students' cognitive learning outcomes in MTsn 3 ngawi, the development of science cycle-based learning guide based on learning cycle 5e can also provide students practice skills in learning so that it is expected to contribute posotif in the community.

CONCLUSION

Based on the results of the experiment of science-based learning cycle 5E developed valid and the overall number of validity score scores is 165.50 with an A and very good category and based on students' questionnaire questionnaire on the overall science manual practice average score on all aspects is 93.06 with very good category; and the implementation of the science cycle-based learning guide 5e effective to improve the cognitive learning outcomes of grade VIII students MTsN 3 Ngawi

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