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The Effect of the Evidance Based Reasoning Model in the Inquiry Approach on Students' Science Scientific Reasoning Ability

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Abstrak

Scientific reasoning is the ability to think logically based on concepts and scientific evidence to gain new knowledge. This ability is a demand that must be trained in science learning. The fact is that students' scientific reasoning abilities, especially at the junior high school level, are still relatively low, one of which is at SMPN 1 Tanggulangin based on the results of preliminary observations made by researchers. One learning model that can be applied to overcome this problem is *Evidence Based Reasoning* which is inquiry-based learning. The purpose of this research is to describe the effect of *the Evidence-Based Reasoning* model in the inquiry approach to the scientific reasoning abilities of junior high school students and to describe the increase in scientific reasoning abilities for each indicator. This type of research is *a pre-experiment* with *a one group pretest-posttest design*. This research was conducted at SMPN 1 Tanggulangin. The sample used was 102 students of class VIII, who were taken by *purposive sampling technique*, and obtained 1 experimental class and 2 replication classes. The instrument used is a *two tier multiple choice test* based on scientific reasoning indicators. The research results were analyzed using the N-gain score and ANOVA. The result of the N-gain test is 0.6 or it can be concluded that there is an increase in the ability of students' scientific thinking in the moderate category. The results of the ANOVA test have a significance value of 0.258 > 0.05, which means that there is no significant difference between the three classes or the increase in scientific reasoning ability is really influenced by the *Evidence Based Reasoning model*. Besides that, every indicator of scientific reasoning has an increase in the moderate category.

Keywords: Evidence Based Reasoning, Inquiry, Scientific Reasoning

INTRODUCTION

Scientific reasoning is a person's ability to think logically based on scientific concepts and evidence already possessed to acquire new knowledge (Sari et al., 2020) . In line with this, Hanson defines scientific reasoning as the ability to apply logical principles to a scientific process, starting from finding problems, formulating hypotheses, determining predictions, solutions, determining variables, applying experiments, to data analysis (Hanson, 2016) . Based on the opinion of several scientists, scientific reasoning skills are needed in learning Natural Sciences (IPA) to understand and construct draft in a manner independently (Tala & Vesterinen, 2015) (Basri, 2019) . This is because IPA is knowledge Which learn all phenomenon or symptom natural in the form of facts, concepts, and laws based on experiments or research to obtain a truth. Ability scientific reasoning included in Wrong One part from Skills thinking in the 21st century, which can be implemented in science learning as a provision for students to adapt challenges of globalization (Yulianti & Zhafirah, 2020) . In line with this opinion, it is known that in the 2013 curriculum, abilities reasoning scientific become demands Which must trained in learning IPA through approach scientific (Fitriyani et al. , 2017) .

According to Karplus et al., scientific reasoning has The 2 patterns of reasoning are concrete reasoning and formal reasoning. In concrete reasoning consists of 4 dimensions namely *Class Inclusion*, *Serial Ordering*, and *Reversibility*. In formal reasoning consists of 5 dimensions, namely *Theoretical reasoning* , *Combinatorial reasoning* , *Functionality and Proportional reasoning* , *control variables* , And *Probabilistics and Correlational Reasoning* (Karplus, 1977) . Based on Piaget's theory of cognitive development, the operational stage Concrete reasoning is owned by children aged 6-12 years, while the operational stage of formal reasoning owned by child on vulnerable 12 years old to the top (Ibda, 2015) . In this study, scientific reasoning is defined as students' cognitive abilities in five dimensions, namely *Class Inclusion* (ability to classify data), *Serial Ordering* (ability to sort data sets), *Theoretical Reasoning* (ability to interpret data based on relevant theories), *Functional and Proportional Reasoning* (ability to analyzing a functional relationship), *Control of Variables* (ability to determine and control variables).

The ability of scientific reasoning has an important role in learning science. There is scientific reasoning Which owned student, will influence performance Study in field science And physics (Rimadani et al., 2017) . Student with ability high scientific reasoning can explain concepts correctly, students are able to create an argument in developing understanding as well as active in principle use scientific For explain something phenomena in the real world. This makes students' understanding and mastery of concepts can be owned in depth (Rimadani et al., 2017) . This is inversely proportional to the level of ability reasoning scientific students who low, where students will experience difficulty in understand and control draft with appropriate, which can influence performance Study student. It's the same when students Whichhaving high scientific reasoning abilities can be better at solving a problem that is complex compared to with students in general (Musyaffa et al., 2019) .

The importance of scientific reasoning is not in line with the existing reality. As with research from Firdaus *et al*., the results showed that the scientific reasoning abilities of SMPN 15 Sukabumi students were still relatively low, especially in the deductive-hypothesis abilities (Firdaus et al., 2021) . The same thing with Handayani's research et al., Also find that ability reasoning scientific student class IX SMA N 1 Sukabumi are in the realm Which not enough (Handayani et al., 2020) . Problems the, Also found in JUNIOR HIGH SCHOOL Country 1 Tanglelangin. Matter This, provenby the results of a preliminary scientific reasoning test with 6 indicators given to class VIII students of SMPN 1 Tanglelangin. Obtained results show that as many as 81% of students have the ability on the *Reversibility* indicator, 50% of students have the ability on the *Class Inclusion indicator*, 29% of students

have the ability on the *Theoretical Reasoning indicator*, 28% of students have the ability on the *Functional and Proportional Reasoning indicator*, as many as 8% of students have the ability on indicator *Serial Ordering*, and 0% or none of the students have the ability on the *Control of Variables indicator*. This shows that there is only one indicator of scientific reasoning which is mastered by more than 50% of students. Students stated that they felt difficulty in completing the test, due to not having trained scientific reasoning abilities full. Teacher expected can choose a model learning Which appropriate to train scientific reasoning abilities.

Inquiry is one of the lessons that can improve students' scientific reasoning abilities, because oriented to the scientific method (Sutarno, 2014) . In line with this, the results of Daryanti's research show that happen enhancement in a manner optimal on ability reasoning scientific student SMPN 1 Poor after the application of inquiry learning is characterized by an *N-gain value* of 3.56 or in the high category (Daryanti et al., 2015) . In study the explained that with learning inquiry student given chance For active build his knowledge Alone, like someone researcher (Daryanti et al., 2015) . Behind That, Zimmerman et al., state that still there student Which experience difficulty in application method scientific on learning inquiry, like formulating hypotheses also combines these hypotheses and their knowledge with evidence or data that has been obtained (Anjani et al., 2020) . In this case, a learning design is needed that is able to coordinate between theory and evidence (*Evidance*), which is a set of scientific reasoning skills (Schiefer et al., 2019) . *Evidence Based reasoning* (*EBR*) presumably can become solution from these problems.

The Evidence Based Reasoning (EBR) learning model is a learning model by applying a framework based inquiry Which capable produce reasoning scientific in activity experimental And predictive (Erlina et al., 2018) . ModelThis study shows two inputs in the form of statements (predictions) and data that are processed through three processes, namely analysis, interpretation and application to make a claim. Process the loaded in 5 phase learning *EBR*. Phase First that is *define a problem*, the teacher involves students to make a statement of a real phenomenon, then it is developed by creating a problem statement. In the second phase, *develop a hypothesis*, the teacher involves student for make hypothesis and determine variable before done proof. On phase third, *search for evidence,* teachers involve students to look for evidence of predictions made through experimental activities as well as analyze results Which obtained. On phase fourth, *draw a conclusion*, student along Teacher make *a conclusions*, and state the claims of statements (predictions) And proof (*Evidence*). On phase fifth, *test the adequacy of the conclusion*, enable students apply knowledge or draft Which has on something phenomenon or problem new for test achievement conclusion. Based on study Hardy, *et.al.*, state that learning model *EBR* can develop scientific reasoning based on phenomena (Hardy et al., 2010) . Similar to this, the results of research by Erlina *et al* ., state that application model learning *EBR* is effective increase ability scientific reasoning of SMAN 3 Jember students, especially in learning physics, as evidenced by improvements students' scientific reasoning abilities that are in the medium to high criteria (Erlina et al., 2018) . Such research, only focuses on formal pattern scientific reasoning, which is adapted to the research subjects used. Reason That is what underlies researchers to conduct research with several updates, namely reasoning indicators scientific method that is used not only in formal patterns but also in concrete patterns, the natural science material used different, as well as different research subjects. Based on the existing background, the purpose of this study to (1) describe the effect of the *EBR* learning model in the inquiry approach to students' scientific reasoning abilities at SMP and (2) describe students' scientific reasoning abilities based on the improvement of each indicator.

METHOD (15%)

Study This including study quantitative, that is is Wrong One type study structured And

identicalwith use number in collect, define, And serve data from results study (Siyoto & Sodik, 2015) . Type study Which used i.e. *pre-experiments* with design *One Group Pretest-Posttest Design* (Sugiyono, 2022) .

Table 1. Research Design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Replication 1	O_1	X	O_2
Replication 2	O_1	X	O_2

Information:

O 1: *Pretest (ability before being given the* EBR learning model treatment) in the experimental class, replication 1, and replication 2

X: Application learning model *EBR* on class experiment, replication 1, and replication 2

O 2: *Posttest (ability after being given the* EBR learning model treatment) in the experimental class, replication 1, and replication 2

This research was conducted from 21 February to 18 March 2023. The research population used was class VIII students at SMPN 1 Tanggulangin Sidoarjo, with a total of 324 student. The sample was taken using a *purposive sampling technique* , with a total sample of 10% of the population calculated using the Slovin formula (Sugiyono, 2019) , so that three class groups were obtained, namely the experimental class of 34 students , replication class 1 of 35 students and replication class 2 of 33 students .

The technique of collecting data is done by administering a test. The test instrument is in the form of 20 *two-tier multiple choice questions* on substance pressure material, with five indicators of scientific reasoning namely *Class Inclusion*, *Serial Ordering*, *Theoretical Reasoning*, *Functional and Proportional Reasoning*, and *Control of Variables*. Each of these indicators consists of 4 question. The instrument was validated by two expert validators, then tested for validity and reliability before used. The research procedure starts from giving *a pre-test* in each class, then treatment with applying the *EBR* learning model to each class, as well as giving *post-tests* to each class. The results of *the pre-test* and post *-test* analyzed with *N-gain* for know ability reasoning scientific student on each indicator. The following table shows the criteria for increasing *N-gain*

Table 2. Criteria for *N-gain Increase*

Average	Criteria
$g > 0.7$	Tall
$0.3 \leq g \leq 0.7$	Currently
$0 < g < 0.3$	Low
$g \leq 0$	Fail

Source: (Wahab et al., 2021)

In addition, *One Way ANOVA statistical test was carried out* to determine whether there was a significant effect from the application of the *EBR learning model* in each group. There is a prerequisite test before the Anova test is carried out which includes the normality test and homogeneity test of variance. The statistical test was carried out using SPSS.

RESULTS AND DISCUSSION

Results

1. Test the Effect of *EBR* in Inquiry Learning on Students' Scientific Reasoning Ability

EBR learning model on scientific reasoning, the *N-Gain* and Anova tests were carried out from the results of *the pretest* and *posttest* that had been carried out.

Table 3. *N-Gain Results* for All Samples

N	Pre-Test	Post-Test	N-Gains	Category
102	19,6	73,1	0.6	Currently

Based on Table 3, the average score of students before the implementation of the *EBR model* (*pretest*) was 19.6 and the score increased after the implementation of the *EBR model* (*posttest*), namely 73.1. The N-gain score also shows an increase in the moderate category with a score of 0.6. This shows that *EBR* in inquiry

learning has a positive influence on students' scientific reasoning abilities.

In addition to the N-gain test, an ANOVA test was also carried out to determine whether *EBR* had a significant effect. This Anova test uses SPSS. The prerequisites for the Anova test are the normality test and homogeneity test.

Table 4. Normality Test Results

Data	Class	Significance Value
Score N-Gains	Experiment	0.296
	Replication 1	0.140
	Replication 2	0.110

N-gain score for all samples, show that the significance value obtained or *p-value* > α (0.05), so it can be concluded that the data are normally distributed.

Table 5. Homogeneity Test Results

Data	Class	Significance Value
Score N-Gains	Experiment Replication 1 Replication 2	0.701

The homogeneity test results in table 5, from the results of the N-gain scores for all samples indicate that the significance value obtained or p-value > α (0.05), so it can be concluded that the data comes from a homogeneous population. The results from tables 3 and 4 can be concluded that the data meets the prerequisite test for the ANOVA test.

Table 6. ANOVA test results

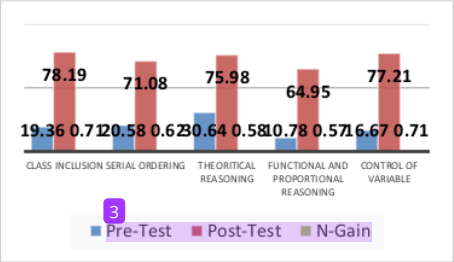
Data	Class	Significance Value
Score N-Gains	Experiment Replication 1 Replication 2	0.258

The results of the Anova test in table 6 from the results of the N-gain scores of the three classes show that the significance value obtained or p-value > α (0.05), so it can be concluded that there is no significant difference between the three classes tested or it can be said that the increase scientific reasoning ability is really influenced by the *EBR learning model* with an inquiry approach.

2. Improvement Test for Each Indicator of Scientific Reasoning

The increase in each indicator was tested by calculating the average *pretest*, *posttest*, and *N-gain values* of the three classes on five scientific reasoning indicators, namely *Class inclusion* , *Serial Ordering* , *Theoretical Reasoning* , *Functional and Proportional Reasoning* , and *Control of Variable* .

Graph 1. Improvement of Scientific Reasoning Ability for Each Indicator



Based on graph 1, it shows that each indicator has increased both from the *pretest - posttest scores* and the *N-gain score*. The average *N-gain score* for each indicator shows that the increase in students' scientific reasoning abilities is in the medium category.

Discussion

1. Description of the Influence of the EBR Learning Model in Inquiry Learning on Students' Scientific Reasoning Ability

EBR learning model in the inquiry approach is proven to have a significant effect on improving students' scientific reasoning abilities. This shows that students are able to have the skills to think logically based on the concepts and evidence they already have. This is in line with (Slavin, 2009; Erlina et al., 2018) that inquiry-based *EBR* assists students in knowing the relevance of evidence and theory or concept, so they are able to solve a problem easily.

the search for evidence phase of the *EBR* learning model in this inquiry approach, students are asked to look for evidence through an

experiment and analyze it. As a result, providing opportunities for students to be actively involved both physically and students' minds in understanding a concept. This is in line with the research results of Rimadani et al., (2017) that by implementing learning that actively involves students in constructing conceptual understanding can improve students' scientific reasoning abilities. It is further explained that activities that involve physical activity (*hands-on*) can motivate students' sensorimotors in concretizing their concepts (Tajudin & Chinnappan, 2016) .

In the *Test phase the adequacy of the conclusion, the EBR* model also provides an opportunity for students to test the adequacy of their understanding, by completing or providing a solution to a new problem accompanied by relevant reasons based on evidence and conceptual understanding that has been previously obtained. As a result students will have a deeper understanding.

2. Description of Increasing Students' Scientific Reasoning Ability for Each Indicator

Students' scientific reasoning abilities can be based on the achievement of each indicator. Overall, the five indicators of students' scientific reasoning experienced a significant increase based on the average N-gain score (0.6) which was in the medium category.

Class Inclusion indicator is the indicator with the highest posttest score among other indicators. This shows that students are already able to classify a data. The resulting N-gain score is also included in the medium category (0.71). Basically *Class Inclusion* is an initial ability to concrete patterns in scientific reasoning. Thus students at the junior high school level have actually passed the concrete reasoning stage. Where, according to Piaget, concrete reasoning stages are owned by children aged 6-12 years (Ibda, 2015) .

Similar to the *Class Inclusion indicator*, the *Control of Variable indicator* is also the indicator with the highest increase in both the pretest, pottest, and N-gain scores, which shows that students are able to determine or control variables. This is because *EBR* presents an initial statement through a phenomenon that has a relationship between variables (Erlina et al., 2018) . In addition, the *Develop a Hypothesis phase* in the *EBR model* trains students to determine variables in seeking evidence through an experiment.

Functional and Proportional Reasoning indicators are indicators with the lowest pretest and posttest scores among other indicators. This shows that students have not maximized in analyzing a functional relationship. The underlying reason is that students are not used to it so they are less sensitive in determining the relationship of a concept (mathematical equation) with the right reasons. (Hariyanti et al., 2017) states that proportional reasoning ability refers to students' sensitivity to situations that involve proportional relationships. This ability is an ability that can be built, not purely from one's expertise.

Besides that, when viewed from the N-gain score students have experienced an increase in understanding of scientific reasoning in the medium category. Where basically *EBR* facilitates students to make proportional and probabilistic predictions by asking questions as an elaboration of premises. The activity of asking questions can attract students' attention to focus and can effectively support continuous reasoning (Lustick, 2010) .

CONCLUSION

Based on the results of the research that has been done, researchers can conclude that:

1. There is a significant effect of the application of the *EBR* learning model in the inquiry approach to students' scientific reasoning abilities at SMP, with an average N-gain score (0.6) which is in the medium category and the results of the ANOVA test with a sig value (0.258).
2. There is an increase in the ability of each indicator of students' scientific reasoning in the medium category after the application of the *EBR learning model* in the inquiry approach.

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