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Original Research Article

Effectiveness of Teaching and Learning Tools Based on Guided Inquiry Approach to Improve Science Process Skills and Scientific Attitudes

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Abstract

This research aims to evaluate the effectiveness of teaching and learning tools based on the guided inquiry approach. The guided inquiry approach is expected to be able to facilitate students to be active in exploring knowledge by using science process skills and to be scientific as the natural science learning process should be. The research design used is the Tessmer development design. The data analysis technique is quantitative descriptive. The research sample were 8th Grades students of SMPN 9 Banjarmasin and SMPN 23 Banjarmasin. The research subjects consisted of 2 experimental classes each with 30 and 25 students and 1 control class consisting of 30 students. The results showed effective learning tools to improve science process skills and scientific attitudes based on: 1) Student learning outcomes in the experimental class have exceeded classical completeness; 2) The science process skills of indicators observing, classifying, predicting, interpreting and communicating in both experimental classes are good and very good. N-gain scores in both classes of experiments are quite effective. ANCOVA results show that 78% of the learning tools developed are able to provide a better influence on the science process skills of experimental class students; 3) Completeness of indicators of scientific attitudes of curiosity, thorough and responsible categorized both in the two classes of experiments. Individual completeness in both experimental classes exceeded 75%, which means that classical completeness was achieved.

Keywords: Teaching and learning tools, guided inquiry approach, science process skills, scientific attitude.

INTRODUCTION

The development of an increasingly rapid and modern era requires the world of education to be able to produce capable human resources in various competencies. Students are expected to have 4C learning skills; Critical thinking, Creativity, Communication and Collaboration [1]. Learners will be easily to have 4C learning skills if students play an active role in the learning process, find out and do it themselves so as to get a deep understanding of science. Teachers as professionals who implement the curriculum play a major role in the process of achieving these educational goals. The teachers must be able to plan, implement and assess the learning process contained in the learning kit in order to achieve effective and efficient learning. Teaching and learning tools consist of syllabus, lesson plans, assessment instruments, teaching materials and LKPD (student worksheets).

The science learning process should be carried out by inquiry to foster thinking skills and scientific process skills and scientific attitudes and be able to apply them in everyday life. The guided inquiry approach is a series of learning activities that emphasize students experiencing mental and physical processes to find the answers themselves to a problem directly and the teacher acts as a facilitator and mentor. The process of implementing learning through the guided inquiry approach always involves students in the activity of collecting knowledge by exchanging opinions or discussions [2]. The development of science process skills and scientific attitudes should be applied to junior high school science learning through direct learning experiences.

Science process skills is a set of skills used by scientists in conducting research to find knowledge [3]. Science process skills are the ability of students to apply scientific methods in understanding, developing, and discovering knowledge with a variety of skills. Basic science process skills include observing, classifying, predicting, interpreting and communicating. Science process skills provide opportunities for learning while doing, fostering the ability to think, working, be scientific and communicating as important aspects of life skills [4]. Scientific attitude is the attitude held by scientists or participants in exploring and developing new knowledge or when facing scientific problems [5].

Science learning should be carried out by involving students actively involved in the learning process. The learning process of science that occurs in the field tends only to master knowledge as a product that is memorizing concepts, principles, laws, and theories. Science learning has not provided sufficient opportunities for students to foster scientific attitudes, practice doing the problem solving process, and the application of science in real life.

The study result of 2015 TIMSS (Trends in International Mathematics and Science Study) in science shows that Indonesia ranks 45th out of 48 countries. The results of the 2015 PISA (Programmed for International Student Assessment) Indonesia are ranked 69 out of 79 countries with a score of 403 out of 493 international scores. The results of the national exams have decreased over the past three years with an average of 56 Natural Sciences exam scores in the 2015/2016 academic year, 52 in the 2016/2017 academic year and 47 in the 2017/2018 academic year [6]. The research results explain that the decline is due to the fact that most of the natural science learning is still sourced from teachers and students have not been able to solve high-level questions [7]. Students are not accustomed to confront with problems directly so they have not been able to perform science process skills such as interpreting data, scientific procedures, applying complex and abstract concepts and communicating them.

Based on reports on the observations of the absorption of the material interaction of living things and their environment (ecosystems) in the national exam Puspendik [6] showed a declining trend from 2012 to 2015. The decline continued in the 2016/2017 academic year with an average of 67 achievements and the academic year 2017/2018 on average becomes 59. This decrease in absorption indicates there are problems in learning this material. Dewi, and friends [8] mentioned several problems as the cause of the low absorption of ecosystem material, they are: 1) students generally only use the science books from the Ministry of Education and Culture as a learning resource, students have not been given media and other learning resources to facilitate learning of science. Like LKPD and modules or teaching materials that are more complete and interesting so that it increases students' interest in reading; 2) Learning in the laboratory is still less optimized; 3) Learning outside the classroom to observe phenomena that exist in the surrounding environment is rarely even done, students only learn in the classroom with the lecture method and minimal use of a positive or inquiry approach. Teachers can overcome these problems by developing learning tools as the teacher's task as a planner, implementer and assessor.

METHOD

The type of research is development research. The development design used is the Tessmer design which includes stages of self-evaluation and prototyping (expert review, one-to-one, small groups and field tests). Data collection techniques were done through observation, documentation, and tests. Data analysis techniques to determine the level of effectiveness were done descriptively quantitative by converting scores obtained based on tests of learning outcomes of science process skills and the scientific attitude of students. The completeness criteria for each indicator of science process skills and scientific attitude that is if the value obtained is 86-100%: very good, 71-85%: good, 56-70%: Fair and ≤ 55: Poor. Science process skills of students are complete in each indicator if the categories are at least good [9]. The completeness of individual students is declared complete if the categories are at least good [10]. Classical completeness is achieved if ≥ 75% of all students who achieve individual completeness [11].

The success rate of improving students' science process skills is determined by calculating the normalized gain index (N-gain). N-gain value is categorized as effective if > 76%, Fair effective if 56-75%, poor effective if 40-55% and not ffective if <40% [12]. The success rate of improving science process skills is said to be successful if at least categorized as effective or moderate [13]. The results of science process skills tests were also analyzed using covariance analysis (ANCOVA) to determine the effect of the use of learning tools developed in the experimental class and the control class. If the results of the science process skills test in the experimental class are better than the control class, it can be stated that the tool developed is effective [14].

RESULTS AND DISCUSSION

Science Process Skills (SPS)

Science process skills of students are determined from the results of LKPD that students work in groups and student learning outcomes tests developed according to indicators of science process skills at the end of learning. The results of completeness of SPS indicators from LKPD work by students in groups during 5 meetings are in Table 1 and 2.

Table-1: Completion of SPS Indicators in class VIIE of SMPN 9 Banjarmasin

No	Assessment	Average indicator				
		1	**2**	**3**	**4**	**5**
1	LKPD 1	3,12	3,37	2,79	3,04	3,17
2	LKPD 2	3,25	3,12	2,92	3,25	3,20
3	LKPD 3	3,50	3,46	3,50	3,54	3,37
4	LKPD 4	3,75	3,50	3,58	3,58	3,46
5	LKPD 5	3,92	3,83	3,70	3,62	3,70
Average		3,51	3,46	3,30	3,41	3,38
%		87,70	86,40	82,45	85,15	84,50
Category		Very Good	Very Good	Good	Good	Good

Table-2: Completion of SPS Indicators in class VIIA SMPN 23 Banjarmasin

No	Assessment	Average indicator				
		1	**2**	**3**	**4**	**5**
1	LKPD 1	2,70	3,10	2,65	2,55	2,85
2	LKPD 2	3,10	3,33	3,10	2,95	2,85
3	LKPD 3	3,55	3,45	3,45	3,25	3,40
4	LKPD 4	3,75	3,60	3,60	3,50	3,55
5	LKPD 5	3,85	3,75	3,80	3,75	3,70
Average		3,39	3,45	3,32	3,20	3,27
%		84,75	86,15	83,00	80,00	81,75
Category		Good	Very Good	Good	Good	Good

Information:
Indicator 1: Observing
Indicator 2: Classifying
Indicator 3: Predicting
Indicator 4: Interpreting
Indicator 5: Communicating

Table 1 and 2 show a relatively stable upward trend. In general, all students are able to perform science process skills well in groups. The five SPS indicators are declared to be complete with very good and good categories. This completeness is obtained because students go directly into nature or the environment to observe, do, solve problems and find knowledge directly by interacting and discussing groups. Learners are trained to ask questions and try to answer questions through a discussion process. In line with this, Ristanto [15] stated there are differences in learning based on guided inquiry with multimedia and the real environment on the learning achievements of the subject matter of the ecosystem. Learning with the real environment gives a more positive influence on achievement compared to multimedia. Learning by applying the real environment as a vehicle for learning ecosystems tends to be better than using multimedia [16].

Science process skills are also determined from student learning outcomes tests that are developed according to indicators of science process skills. Comparison of learning outcomes of students' science process skills tests in both the experimental class and the control class are in Figure 1 and Table 3.

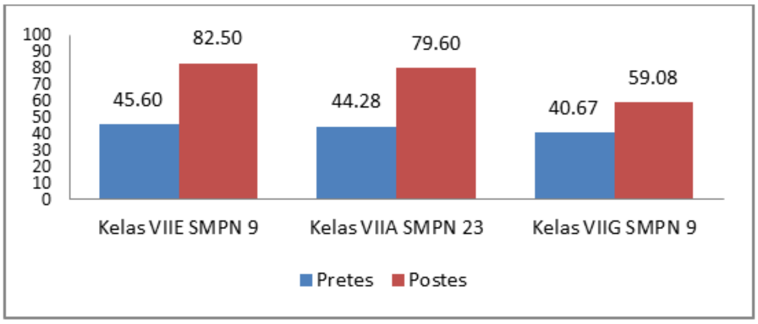

Fig-1: Comparison of learning outcomes of students' science process skills tests

Information:
86-100: Very good; 71-85: Good; 56-70: Fair; ≤ 55: Poor
Model teacher experimen class : Class VIIE SMPN 9 Banjarmasin
Researcher experiment class : Class VIIA SMPN 23 Banjarmasin
Control class : Class VIIG SMPN 9 Banjarmasin

Table-3: Comparison of learning outcomes of the science process skills test

Aspect of Evaluation	Model Teacher Experiment Class		Researcher Experiment class		Control Class		Info
	Value	Criteria	Value	Criteria	Value	Criteria	
Observing	3,81	Good	3,73	Good	2,73	Fair	
Classifying	3,68	Good	3,77	Good	2,53	Fair	
Predicting	3,35	Good	2,87	Fair	2,22	Fair	
Interpreting	3,24	Good	3,31	Good	2,22	Fair	
Communicating	2,77	Fair	2,69	Fair	2,12	Fair	
Number of Students	30		25		30		
Individual completeness	6 students	Very Good	5 students	Very Good	0	Very Good	Completed if ≥ 70 (good)
	22	Good	17	Good	3	Good	
	2 students	Fair	3 students	Fair		Fair	
	0	Poor	0	Poor		Poor	
Classical completeness	93%	Completion	88%	Completion	10%	Completion not yet	Completed if ≥ 75%
Average of pretes	45,6	Poor	44,28	Poor	40,67	Poor	
Average of postes	82,5	Good	79,6	Good	59,08	Fair	
N-gain	68%	Fair	64%	Fair	30%	Not effective	
Kolmogorov-Smirnov (Normality Test) N >50	0,200	Normally distributed	0,200	Normally distributed	0,200	Normally distributed	Sig> 0.05 Normally distributed data

Table-3 shows that the two experimental classes have reached classical completeness while the control class has not. This shows that the learning tools developed using the guided inquiry approach in the experimental class are able to give better values to the results of the posttest and completeness of students. Classical completeness is achieved if ≥75% of all students who achieve individual completeness [11]. Comparison of normalized gain index (N-gain) of science process skills of students in both the experimental and control classes shows that in the experimental class the model teacher and the research teacher are quite effective while the control class is not effective.

The effectiveness of the learning tools using the guided inquiry approach in the experimental class and the control class were also analyzed using ANCOVA (covariance analysis). The results of normality and homogeneity tests are met for the ANCOVA test. This ANCOVA analysis shows the effect of the use of learning tools using the guided inquiry approach in the experimental class and the control class on the posttest value after being controlled by the pretest covariable. ANCOVA test analysis results are presented in Table-4.

Table-4: Results of Covariance Analysis

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12008,866[a]	3	4002,955	96,429	,000
Intercept	4613,960	1	4613,960	111,148	,000
Pretest	2414,584	1	2414,584	58,166	,000
Class	6581,595	2	3290,797	79,274	,000
Error	3362,457	81	41,512		
Total	473093,750	85			
Corrected Total	15371,324	84			

R Squared = 0,781 (Adjusted R Squared = 0,773)

Based on Table-4 it can be seen that the significance number for the pretest variable is 0,000. Furthermore, testing is carried out to determine the effect of class differences on the post test scores. Based on the results of data processing it appears that the significance for the class variable is 0,000. Sig <0,05, it can be said that there are differences in the value of posttest for class treatment. The next test is to see which different classes are presented in Table-5.

Table-5: Comparison between Classes

(I) Studied class	(J) Studied class	Mean Difference (I-J)	Sig.	Conclution
Research teacher experiment class	Model teacher experiment class	-1,969	,790	Same
	Control class	17,969*	,000	Different
Model teacher experiment class	Research teacher experiment class	1,969	,790	Same
	Control class	19,939*	,000	Different
Control class	Research teacher experiment class	-17,969*	,000	Different
	Model teacher experiment class	-19,939*	,000	Different

Based on Table-5 with a significance level of 5%, it can be seen that there are differences in the posttest scores between the control class that does not use the learning tool with the experimental class of the model teacher and the experimental class of researchers who use the learning tool. Table-4 shows that there is no difference between the teacher's experiment class model and the researcher's experiment that both use the guided inquiry learning tool that was developed.

ANCOVA analysis results in Table 4 and 5 show that statistically there are significant differences between students' learning classes and learning tools developed using the guided inquiry approach with conventional learning in the control class. R-Square value of 0.781 which means that 78% is able to explain the effect of the use of learning tools that were developed on the students 'post-test scores while the other 22% is the influence of other factors such as students' basic abilities, family background and social or environmental influences. These results can provide an illustration that the learning tools developed provide a better influence. This is because the use of guided inquiry tools in the experimental class focuses on the thought processes that build experience from the active involvement of learners in learning. This is in line with research conducted by Salmiati [14] who conducted research on the use of guided inquiry models on additive and addictive material stating that students build their own understanding based on the experience they have gained.

The results of this study support the research of Villagonzalo [17] which compared the effectiveness of guided inquiry learning in the experimental class with the control class using conventional learning. Villagonzalo used the results of the pre-test and post-test, then analyzed using ANCOVA, the results showed that there were differences in the academic achievement of the experimental class students better than the control class. Nuangchalerm's research [18] which examined inquiry learning in China shows the results that inquiry applied in the classroom is able to help students achieve science learning goals. This can be known from the improvement of science process skills, scientific nature and scientific literacy of students. Based on these results it is concluded that inquiry learning is not only used when learning science, but also in various things in life. In line with Nuangchalerm's research, based on this research also assesses the science process skills and scientific attitudes of students.

Learning tools developed using the guided inquiry approach have been able to train students' science process skills in exploring knowledge. Akcay and friens [19] stated that inquiry is known as a process or activity that scientists use when conducting scientific processes and ways related to the search for meaning of knowledge. Inquiry does not only involve activities and skills but also focuses on an active search for increased understanding [20]. Stages in the guided inquiry approach can train students to work and act systematically or scientifically [21]. The guided inquiry approach has gained recognition and is often suggested as an answer to various teaching and learning problems [22].

Scientific Attitude

Scientific attitudes of students are obtained by giving questionnaires to students after the learning process takes place. The completeness of each indicator of scientific attitudes in the model teacher experiment class, experiment teacher experiment and control class can be seen in Table-6.

Table-6: Completeness of Scientific Attitude Indicators

No	Indicator of Scientific Attitude	Model Teacher Experiment Class		Researcher experiment class		Control Class	
		Value (%)	Category	Value (%)	Category	Value (%)	Category
1	Curiosity	80	Good	79	Good	54	Poor
2	Accuracy	79	Good	78	Good	55	Poor
3	Responsibility	80	Good	78	Good	55	Poor
Average		80	Good	78	Good	55	Poor

The completeness of individual students of the teacher model experiment class, the experiment researcher and the control class can be seen in Table-7.

Table-7: Completeness of Individual Scientific Attitudes

No	Category of Scientific Attitudes	Model Teacher Experiment Class		Researcher experiment class		Control Class	
		Number of Students	%	Number of Students	%	Number of Students	%
1	Poor	0	0	0	0	19	63,33
2	Fair	1	3,33	2	8	4	13,33
3	Good	23	76,67	19	76	7	23,33
4	Very Good	6	20	4	16	0	0
Sum		30	100	25	100	30	100

Information:

Model teacher experiment class : Class VIIE SMPN 9 Banjarmasin
Researcher experiment class : Class VIIA SMPN 23 Banjarmasin
Control class : Class VIIG SMPN 9 Banjarmasin

Table-7 shows the completeness of individual scientific attitudes in the experimental class model teachers and researchers mostly categorized as good and very good while in the control class categorized as poor. The achievement of completeness of individual scientific attitude is comparable to the achievement of completeness of scientific attitude indicators. Classical completeness of the scientific attitude of students in the experimental class teacher model, researcher experiment and control class can be seen in Table-8.

Table-8: Classical Mastery of Scientific Attitudes

No	Category	Model Teacher Experiment Class	Researcher experiment class	Control Class
1	Good	23 Students	19 Students	7 Students
2	Very Good	6 Students	4 Students	0
Sum		29 Students	23 Students	7 Students
Classical completeness (%)		96,67	92,00	23,33

Table-6 shows that the three indicators of scientific attitudes were declared complete and categorized both in the experimental class of the teacher model and the experimental class of the research teacher, but not yet completed in the control class because of the lack of category. On the indicator of curiosity most of the students in the experimental class model teachers and researchers agree that through learning using guided inquiry tools can make them enthusiastic, curious and want to find out many things related to ecosystem material. Through guided inquiry learning can also train the accuracy of students even though some students have not been accustomed to always be thorough. On indicators of scientific attitude towards responsibility, students agree that whatever results they get during observation or experiment are their responsibility.

The scientific attitude in the experimental class is higher than in the control class because the learning process in the experimental class uses guided inquiry learning tools that are not used in the control class. Guided inquiry learning on ecosystem material through group discussion activities and given LKPD at each meeting. In the initial learning activities the teacher gives a phenomenon that occurs in the surrounding environment that can motivate students to pay more attention so that a wider curiosity arises and triggers group discussion. Discussion activities provide space to foster curiosity that begins with the emergence of curiosity in students [23]. The chosen ecosystem phenomenon is in the form of real problems that have a causal connection so that it stimulates students to reason, make predictions and provide arguments for the proposed predictions. In line with the opinion of Hefter, and friends [24] that the process of argumentation can build and evaluate students' thoughts, ideas and understanding in depth. Arguing can encourage students' curiosity about things that are not yet known and encourage students to investigate [25].

In learning activities observing, conducting investigations, predicting and interpreting data have been able to foster a meticulous attitude and responsibility with both students. Learning activities carried out routinely can make students accustomed to make detailed observations of an object. Be careful when analyzing data by re-examining observations or answers and paying attention to facts before drawing conclusions. The attitude of students' responsibility arises by getting them used to completing observations or investigations in a timely manner according to the given LKPD. In the activity of communicating or delivering the results of observations and group discussions are also able to train students to behave responsibly for the results of their work and the facts they get during the learning activities. This is consistent with the opinion of Bilgin [26] which stated that learning activities through a guided inquiry approach can help students to develop responsibilities, be thorough, make reports, solve problems, and think ability.

Achievement of better scientific attitudes of students in the experimental class is also obtained because they feel happy with the learning that is applied. The statement is based on students' responses to learning. Learning with the existence of scientific work such as in guided inquiry learning makes students actively involved. Active involvement of students in all steps of observation activities, helps develop scientific attitudes in students. This is in line with the statement of Lee [22] and Kubicek [27] that learning science through guided inquiry has the potential to increase motivation to learn, think, and act scientifically.

Learners have proven their performance in conducting learning activities and experimenting with learning by using guided inquiry. Students are also able to prove scientific well by showing an attitude of curiosity, conscientiousness, and responsibility during the learning process takes place. This is in line with Nisa [28] which stated that learning products are changes in student behavior during and after following the learning process. Changes in behavior include the cognitive domain, the psychomotor domain, and the affective domain.

CONCLUSION

The teaching and learning tool developed is declared effective because it is able to train students in the science process skills and scientific attitude. In other words, it has been able to achieve learning objectives in the cognitive, psychomotor and affective domains.

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