Jurnal Penelitian dan Pembelajaran IPA JPPI
Vol. 5, No. 2, 2019, p. 202-218 p-ISSN 2477-1422 e-ISSN 2477-2038

The Efforts to Improve Environmental Behavior and Critical Thinking of Students through Guided Inquiry-Based Learning on Environmental Education-Based Science

(Received 6 February 2019; Revised 28 November 2019; Accepted 29 November 2019)

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DOI: 10.30870/jppi.v5i2.4681

Abstract

This study aimed to determine the influence of guided inquiry-based learning toward the improvement of environmental behavior and critical thinking of students in environmental education-based science. This study used the Classroom Action Research method through two cycles each consisting of planning, action, observation, and reflection. The objects of this study were 35 students of the 3rd class of Junior High School of SMPIT Raudatul Jannah in Cilegon, Indonesia. The results showed that on the first cycle it has no a significant change in environmental behavior and critical thinking competence of students but then an increase in the second cycle. In general, it can be concluded that guided inquiry learning in science can increase environmental behavior and critical thinking of students.

Keywords: Critical Thinking, Guided Inquiry-Based Learning, Environmental Behavior, Environmental Education, Science Education.

INTRODUCTION

Science and technology development are like two sides of a coin. On the one hand, they contribute to facilitate the work and improve human welfare, on the other hand, they may lead to environmental degradation (Kroes, 2017).

Environmental damage is a manifestation of social and environmental issues that are interrelated. Therefore, solving the social issue in everyday life always associated to environmental problems. Anthropogenic climate change and increasing atmospheric CO_2 concentrations, for example, have the potential to transform almost all spatial and temporal aspects of plant-based aeroaller-gens (production, allergenicity, and distribution) (Ziska & Beggs, 2012). Also, Anthropogenic climate change is a driver of impacts throughout the world (Rosenzweig & Neofotis, 2013). Other cases show that rising global surface temperatures, internal variability, and coercive radiation-related and global warming-related to anthropogenic climate activity (Kaufmann et al, 2011). Besides that, the problem of fossil energy is closely related to the problem of anthropogenic climate change (Ziska & Beggs, 2012).

The results of the empirical study by Chawla & Cushing (2007), showed that education can improve attention and concern for the environment. Soemarwoto (2004) also stated that the weakness of environmental lessons are too focused on the concept of ecology and does not include things that are practical in everyday life. Whereas existing concrete reality in the learners is learning resources should be utilized in the learning environment.

Aminrad at al (2013) stated that environmental knowledge obtained from various sources can increase students' awareness and positive attitude. Some research results show that the short-term environmental education program influences students' environmental attitudes (Sellmann & Bogner, 2013); environmental physics learning that is carried out with a model of problem-based instruction can improve attitudes of environmental care and the ability of students to solve problems (Khanafiyah & Yulianti, 2013); and Problem Based Learning models can improve student competence and be useful for teachers in learning environmental education (Vasconcelos, 2012). Therefore, environmental learning can be integrated with subjects such as natural science, social science, and other subjects.

In this research, biological concepts are integrated with environmental education such as interactions between living things and the

environment, water pollution, and global warming.

Changing environmental behavior through integrated learning is not easy. Although much environmental education has been introduced to students since elementary school through integrated learning and teaching environmental education, environmentally sound behavior in students is low. The result of the study of Kumurur (2008) showed that concern for the environment of postgraduate environmental science students in Jakarta is still low. The results of research at Adiwiyata Mandiri High School Mojokerto shows that the attitude of caring for students' environment is still lacking after attending environmental education learning (Aini, 2014)

Nevertheless, environmental behavior can be intervened through environmental education and habituation known as pro-environmental behavior, a behavior that is formed from habits carried out by someone towards the environment. This behavior depends on many very complexes, such as making policies on environmentally friendly products, income, and time efficiency (Ertz, Karakas, & Sarigollu, 2016). Pro-environmental behavior can be improved in many ways. This is because pro-environmental behavior is a thing that can be done by giving an intervention in the form of treatment (Aguilar-Salinas at al, 2017; Buzov, 2014; Ertz et al., 2016; Truelove & Gillis, 2018). Learning is the most appropriate way to change pro-environmental behavior students (Ichsan at al, 2018; Tang at al, 2017).

Environmental education is an effort in changing human behavior to develop, understanding, skills, and public awareness regarding the environment so that people can care about the environment. Environmental behavior is very important because it will make environmental conditions to be maintained so that human can be passed on to the next generation. The environment is very suitable as a learning tool because natural environment provides a variety of materials for daily activities. The environment can be a source of learning because learning not only uses books. People can use the environment since it provides various benefits for students, namely (a) providing experience, (b) providing knowledge, (c) providing awareness about what people to do the environment, and (d) knowing the importance of the environment as our life (Ichsan et al, 2019).

Critical thinking skills can influence environmental behavior. Some research results show the relationship between critical thinking and attitude. Bulgurcuoglu (2016), for example,

concludes that critical thinking skills correlated with book reading behavior. Critical thinking skills also would be associated with more liberal attitudes toward women's roles in society (Loo & Thorpe, 2005). Therefore, critical thinking learning is important in developing environmental behavior.

Teachers need a breakthrough learning that can improve students' critical thinking skills and environmental behavior. The method that has been known but has not been widely implemented by teachers is guided inquiry. Inquiry-Based Learning is a student-centered, active learning approach focusing on questioning, critical thinking, and problem-solving (Barron & Hammond, 2008; Won, 2009; Alberta Learning, 2004; Sweeney, 2007; Warners & Myers, 2015). Guided inquiry offers integrated inquiry units, planned and guided by the school's structural team and teachers, which enable students to gain a deeper understanding of curriculum content in subject areas and the concept of information literacy (Kuhlthau et al, 2007). By inquiry learning methods, students can understand Environmental Education properly so that students can be more positive that will lead them to behave environmentally sound (Mulyasa, 2002).

Based on this background, the implementation of inquiry-based learning to improve students' critical thinking skills and environmental behavior is an interesting topic to study.

METHOD

The research was done in one of the 9th grade of SMPIT Raudatul Jannah, located in Cilegon City, Banten Province from September to November 2016. It has been trusted as a quality school by the community in Cilegon in particular, and Banten in general. The school accreditation value reaches 94.45 (A+). A program that is applied to the students of the school is a practical environmental education program. Through these activities are expected throughout the school community to have the attitude and the action which seeks to prevent damage to the surrounding natural environment and develop efforts to repair the environmental damage that has occurred. One of Class of 9th Grade selected as research subjects because they have the lowest critical thinking competence than other classes, based on critical thinking pre-test.

Classroom Action Research method used in this study according to Kemmis & McTaggart model. This method is used because this research aims to change environmental behavior. Gartland (2010) said that action research can change student behavior. Classroom Action Research consists of four stages: planning, acting, observing and

reflecting (Altrichter et al, 2002; Lingam, 2012; Kemmis et al, 2014). In this study, classroom action research is planned to take place in three cycles. The implementation of the three cycles is presented in Table 1.

At the pre-cycle, critical thinking and environmental behavior measurements are taken using the instrument of critical thinking competency (Watson & Glaser, 2002). It is composed of a set of five tests. Each test is designed to tap a somewhat different aspect of critical thinking: Inference, Recognition of Assumptions; Deduction; Interpretation; and Evaluation of Argument (Watson & Glaser, 2008). Critical thinking instruments after 1st and 2nd cycle in the form of questions that fit the topic, and contain five components of critical thinking.

Instrumental of environmental behavior arranged according to Chiras (1991) and Baron & Byrne (1991) consisted of eight dimensions: plant conservation, cleanliness, energy saving, water saving, reduce, reuse, and recycle. Environmental behavior data is collected in three ways: information from parents 'observations, teachers at school, and students' recognition using a Likert scale.

The guided inquiry model used according to Bybee (2006) in the following order: engagement, exploration, explanation, elaboration, and evaluation. The guided inquiry learning topic which is the integration of science and environmental education is "the effect of population growth on environmental problems" and "the effect of environmental pollution on living beings".

Critical thinking data is processed by converting raw scores to percentile ranks according to Watson & Glaser (2008). Meanwhile, qualitative data processing on environmental behavior is done by giving a scale score of 5 for Always; 4 Often; 3 Sometimes; 2 Rarely; and 1 Never for positive statements. If a negative statement will apply otherwise. The total environmental behavior scores are grouped into three categories. If the score is less than 50, the category is less; moderate if the score is between 51 - 75; and good if it is greater than 75 (Mardapi, 2008).

Classical mastery learning is the percentage of total students who have studied thoroughly divided by the total number of students. A class is categorized as complete classical learning if an average of 85% of students has mastered learning individually (Mardapi, 2008). Achievement

Indicators can be reached if (1) Eighty percent (80%) of students get a critical thinking score at least 75 points, and (2) Eighty percent (80%) of students get an environmental behavior at least "good" category.

Tabel 1. Planning Cycles of Classroom Action Research

Steps	1st Cycle	2nd Cycle	3rd Cycle
Planing • Lesson plan • The instrument of critical thinking • The instrument of environmental behavior	**Concept:** Interaction between Living thing and Environment **Topic Guided Inquiry:** The Effect of Population Growth on Environmental Problems	**Concept:** Pollution Impact for Life **Topic Guided Inquiry** The effect of population growth to the environmental problem	**Concept:** Global warming **Topic Guided Inquiry**: The Greenhouse Effect
Action • The guided inquiry learning process	**Activity 1**: The Effect Number of Population To The Household Waste **Activity 2**: The Effect The Number of Population To The Number of Air Pollution (Group Assignments)	**Activity**: The Effect of Environmental Pollution on Living Beings. (Laboratory Activity)	**Activity 1**: The Greenhouse Effect (Field Activity) **Activity 2**: Make a global warming model (Group Assignment)
	Observation Guided Inquiry process Critical thinking competence Environmental behavior		
	Reflection Discussion with observers about student's inquiry learning, evaluate student's critical thinking competence, and environmental behavior based on achievement indicators		

RESULTS AND DISCUSSION

The Initial Condition of the Research Subjects

Ninth grade-F is one of the six classes that have special characteristics to be developed. Especially in terms of critical thinking skills and environmental behavior

Critical thinking skills are not yet developed at this school. Therefore, in an attempt to start the development of critical thinking skills is started in 9th grade. Students of 9th Grade F selected as research subjects because they have high-level thinking skills are the lowest compared with the other classes.

The table 2 is the initial student's critical thinking competency tests using instruments Godwin & Glaser (2002).

Table 2. Initial Student's Critical Thinking Competence

Parameter	Mark
Students Number (n)	35
Minimum (max)	29
Maximum (min)	47
Average ($\bar{x}$)	36,8
Deviation Standard (δ)	5,2

According to the table 2, it can be seen that the competence of critical thinking is still very low because the average value reached 37, with a minimum and maximum value are 29 and 47 respectively.

Measurement result shows that the environmental behavior of the research subject still lows too. Figure 1 shows that in part of students have moderate environmental behavior, while others are 30% low and only 20% have good environmental behavior. Based on instrument analyses, environmental behavior is still low because they still weren't used to dispose of waste in place, using plastic food wrap, and not accustomed to maintaining the cleanliness of both at school and houses.

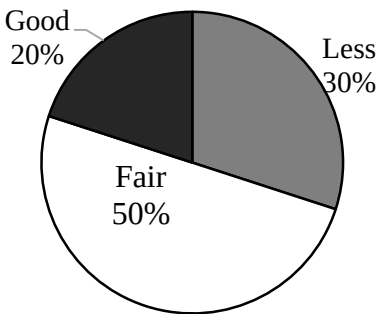

Figure 1. Initial Students' Environmental Behavior

Many attempts were made to change behavior in waste management and cleanliness. Some of them are through increased knowledge and habituation. Darmawan & Fadjarajani (2016) showed that there is a positive relationship between knowledge of environmental conservation and behavior in the conservation of environmental cleanliness. Other studies conclude that continuous habituation from an early age will be able to minimize the conditions of Indonesian people who lack awareness in terms of disposing of trash in its place (Rohmadheny & Yudiari, 2016).

Students of SMPIT Raudhatul Jannah have great opportunity in the development of critical thinking skills and increasing concern for the environment through guided inquiry learning because basically the students at this school possess good skills. Teachers play an important role in a challenging learning habit for students.

First Cycle of Classroom Action Research

Based on observations, it is known that the average value of critical thinking competencies of students has reached 72,4, with a minimum value of 55,0 and a maximum of 96,0 (Table 3), but based on mastery learning as shown that students who have completed learning (value greater than 75) as much as 64%.

Table 3. Student's Critical Thinking Competence of First Cycle

Parameter	Mark
Student Number (n)	35,0
Minimum (max)	55,0
Maximum (min)	96,0
Average ($\bar{x}$)	72,4
Deviation Standard (δ)	13,1
Students score ≥ 75	64%

Predetermined achievement indicator required eighty percent (80%) of Students must get a critical thinking score at least 75 points. The observation result has shown that the critical thinking mark has only reached 46%. It means students have not mastered the material yet.

According to table 4, the highest student's critical thinking competencies were inference, while the lowest is the competence of interpretation. Students' inference increases as a result of inquiry learning and other high order thinking based learning. The study of Aini & Suprapto (2012) shows that logic inference practice give a positive influence on student's critical thinking. Besides that, high order thinking based learning as problem-solving learning model has a large size of influence in increasing students' inference skills (Rudibyani, & Efkar, 2019).

Table 4. Aspects of Students' Critical Thinking Competence

Critical Thinking Aspects	Mark
Inference	76,8
Assumption	74,1
Deduction	75,4
Interpretation	68,0
Argument Evaluation	69,0

Therefore, to improve students' critical thinking competence refer to the above data that is by improving all competencies, particularly interpretation competency which has the lowest value.

The observation results of environmental behavior using a Likert scale have shown 71% in the good category, the remaining 26% moderate and 3% less. If it compared to environmental behavior between the initial conditions on the 1st cycle, it has increased by 51 points for good category. However, when it refers to the basic achievement indicator that requires 80% of students have a good attitude, it means students environmental behavior is not yet completed.

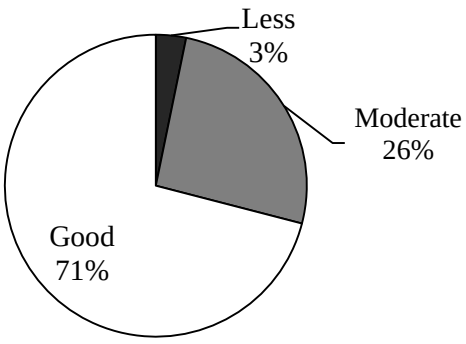

Figure 2 Percentage of Student's Environmental Behavior on 1st Cycle

Students' environmental behavior in detail can be seen in Table 5.

Table 5. Aspects of Student Caring Attitude the Environment Cycle-1

Environmental Behavior	Score	Category
Plant Conservation	396	Good
Cleanliness	222	Moderate
Energy Saving	225	Moderate
Water-Saving	173	Less
Reuse	226	Moderate
Recycle	333	Good
Reduce	372	Good

From the table above shows that the environmental behavior that is still low is water-saving. While the height is Plant Conservation, recycle, and reduce. To change the water-saving behavior requires a lot of treatment because it influenced by many variables.

Mondéjar-Jiménez, Cordente-Rodríguez, Meseguer-Santamaría, & Gázquez-Abad (2011), state that a lifestyle influence on water-saving behavior. Meanwhile, according to other research results, water-saving behavior is influenced by age, gender, income, education, and others (Gilg & Barr, 2006). Therefore environmental education can change conservative behavior (Asch & Shore, 1975). In general, the things that can cause learning objectives less than optimal and not as expected in learning goals are some things as follow.

First; students are most accustomed to following the guided inquiry learning so that some of them still have difficulty in learning. The role of the teacher as a supervisor is very important;

Second; inquiry activities through assignment cause students' difficulties in doing the group task because their schools are a full day from morning till evening. Although Saturday and Sundays are off, they still find it difficult to meet with a group of their friends; and

Third; changing attitudes takes considerable time for both at school and at home. As an example, plant conservation attitude does not necessarily appear when the surrounding environment does not allow for growing crops. Hungerford & Volk (1990) state that changes in environmental behavior require process and time. The knowledge possessed by students will change awareness and attitude, then it will lead to actions of concern for the environment.

Observations result of 1st cycle, known that guided inquiry learning is still not optimal. It cannot stimulate students to think critically. Students are less motivated to complete their inquiry tasks. Students also tend to always rely on teachers to complete their tasks. But, during the presentation, the students look so enthusiastic in presenting the results of their activities.

When working on the task of collecting household garbage data, most

students can do well. However, when measuring the level of particles of the causes of air pollution, some students have difficulty in making a trap of pollutant particles. It is also an instrument placed at the specified position, some are dropped or lost after settling all day.

Another condition, teachers find it difficult to engage students in inquiry work because students used to have activities through the worksheet. Of the few existing records in 1st cycle advantages of guided inquiry learning is as follows: (1) students are accustomed to learn to think on a high level despite the changes are still little; (2) inquiry-based learning environment will encourage students to interact with the environment, observing the things that cause environmental problems, to form a caring attitude towards the environment. However, it is not visible change in student's attitude as expected yet; and (3) making students active and creative in solving the issue through discussions and presentations (Yager & Akcay, 2010; Avsec & Kocijancic, 2014).

The existing weakness in the implementation of guided inquiry learning and needs improvement efforts in the next cycle are: The guided inquiry activities through the assignment seems not optimal, due to the lack of employment opportunities or difficulty of group coaching, although the task has been described in class; Besides that, guided inquiry assignment that takes days quite burdensome for students who that are not at school all day (Sanjaya, 2006).

Based on the results of a reflection on the first cycle, the research should be continued in the second cycle.

Second Cycles of Classroom Action Research

Guided inquiry process changes the more powerful it can change the way students learn and the ability to think and care about students' environmental behavior. Critical thinking skills students are presented in Table 6.

Table 6. Students' Critical Thinking Competence on 2nd Cycle

Parameter	Mark
Student Number (n)	35,0
Minimum	58,0
Maximum	100,0
Average	91,8
Deviation Standard	11,8
Students score ≥ 75	91%

Table 6 showed that the average student's critical thinking competence reaches the point 91,8, much higher than the ability of the first cycle, which only reached 72,4. The maximum value also increased from the initial reached 96 points in cycle 2 to achieve a perfect score of 100 points.

Mastery learning competencies critical thinking, value is greater than 75 has reached 91%. Achievment indicators

mean it meets the 80% mastery learning critical thinking competencies.

Based on the aspects of student's critical thinking competencies also had increased significantly as illustrated by Table 7.

Table 7.Aspects of Students' Critical Thinking Competence

Critical Thinking Aspects	Mark
Inference	91,7
Assumption	93,4
Deduction	93,7
Interpretation	94,0
Argument Evaluation	96,0

Table 7 showed that the average known aspects of student's critical thinking competencies already reached the range of 91 – 96 points. So, the competence of the students' critical thinking skills, learning to use action research inquiry has been completed.

Observation result shows that student's environmental behavior using a Likert scale shown 73% in the good category, the remaining 27 % fairly and 0% less. When compared with the initial conditions of the attitude of these students increased by 51 points for good category. However, when referring to the basic achievement indicator that requires 80% of students to have a good attitude, it means students caring attitude towards the environment is not yet completed.

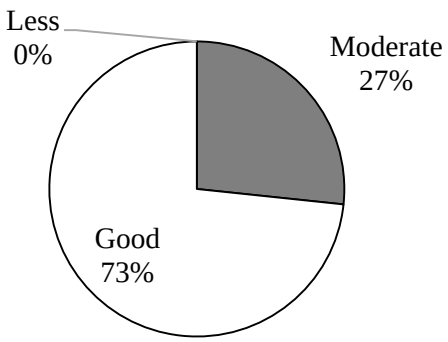

Figure 3. Percentage of Environment Behavior on 2nd Cycle

The aspects of student environment behavior on the 2nd cycle as shown on table 8 that are better aspects of plant conservation and reuse garbage. While others still tend to be rare and have never done.

The student has not changed in the attitude to plant and maintain plants and reuse garbage. The habit to reuse already stressed by the school that the students bring their drink and a meal. Table 8 shown aspects of student environmental behavior in the 2nd cycle.

Table 8. Aspects of Student Caring Attitude the Environment 2nd Cycle.

Environmental Behavior	Score	Category
Plant Conservation	369	Good
Cleanliness	226	Moderate
Energy Saving	214	Moderate
Water-Saving	248	Moderate
Reuse	304	Good
Recycle	207	Moderate
Reduce	280	Moderate

The increase in student caring attitude towards the environment has not met the criteria of a good 80% as indicated on the achievement indicators.

However, the increase in attitude has undergone a significant change.

The learning process in the 2nd cycle generally conforms with the required improvements result of 1st cycle. Thus, reflection on learning in 2nd cycle student inquiry activities has much progressed. Students become actively carry out the activities with the group, discussions, and presentations with a good result. The opinion also states that students learning by guided inquiry in motivating them to find new things that exist in everyday life.

However, since this indoor learning activities, students have to interact less with the environment. Therefore, it needs to be overcome by giving the issue through discussions associated with environmental issues.

Guided inquiry learning class action on material Population and Environment and The impact of population growth has been performed for two cycles. Summary of the results of these actions is as shown in Table 9.

Table 9. Increased of Student's Critical Thinking Competence

Mastery Learning	Percentage (%)		
	Pre-Cycle	1st Cycle	2nd Cycle
Mark ≥75	0	46	91
Mark < 75	100	54	9

Table 9 showed that mastery learning competencies of students' critical thinking improved significantly; from 46 points from pre-cycle to the 1st cycle, increased to 45 points from 1st cycle to 2nd cycle. This indicates that guided inquiry learning plays an important role in improving students' critical thinking competencies.

Wahyuningrum (2013) and Simonson and Sadle (2013) research found that process-oriented guided inquiry learning can trigger student activeness because process-oriented guided inquiry learning made learning stages more interesting. Sawadzki (2010) also said that increasing students' critical thinking skills occurred through process-oriented guided inquiry learning, students experienced meaningful learning. Besides, the research of Subarkah and Winayah (2015) concludes that process-oriented guided inquiry learning methods influence students' activeness, learning outcomes, and critical thinking skill to a certain extent, especially on the indicators of identifying, making hypotheses, and proving hypotheses.

In the same opinion, Johnson (2011) said that process-oriented guided inquiry learning provides an opportunity for students to practice problem-solving and critical thinking. According to Zawadzki (2010), the process-oriented guided inquiry learning model can improve student learning skills and the mastery of student content generally

exceeds that of the traditional model. Besides critical thinking, the increased in student environmental behavior also change.

Tabel 10. Increased Student's Caring Attitude to the Environment

Mastery Learning	Percentage (%)		
	Pre-cycle	1st Cycle	2nd Cycle
Less	30	3	0
Fair	50	26	27
Good	20	71	73

According to table 10, it can be known that increasing students' environmental behavior in the category of 51 points from the pre-cycle to 1st cycle, while from 1st cycle to the 2nd cycle only 3 points.

Although the achievement indicators have not met the target, the change students' attitudes to caring for the environment are significant. Achievement of this standard has not been possible because the standard is too high, while the change in attitude takes considerable time. Due to a change of attitude is influenced by many factors: the habits, knowledge, environment, and others.

Pusparini (2011) explains that inquiry learning by inviting students directly into the environment makes students able to find out for themselves problems in their environment to improve understanding and thinking ability. Several studies have shown that inquiry learning can foster attitudes toward the environment. Elsa, et al (2014) research results show that the application of environmental education character education by using the inquiry method can improve understanding and cause changes in students' attitudes and behavior so that they become aware and concerned about the environment in the concept of environmental pollution and damage.

Meanwhile, Ratnasari, et al (2015) also stated that the application of guided inquiry learning models can increase the attitude of caring for the environment in one of the scientific attitudes that can be developed through inquiry is caring for the environment. The results of Norhasanah and Zaini's research (2011) showed that with inquiry learning students get knowledge, skills, and inculcation of attitudes such as honesty, conscientiousness, perseverance, curiosity and responsibility, caring, cooperation, open and respecting friends in the category quite well on the concept of an ecosystem.

Therefore, efforts to increase the competence of critical thinking students and student's attitudes towards the environment on learning science can be done through guided inquiry learning.

CONCLUSION

The results of observations of the first cycle show that guided inquiry-based learning in environment-based

science makes students active and creative in solving problems through discussions and presentations. It can encourage students to interact with the environment, observe the things that cause environmental problems, to form an environmental behavior. Nevertheless, it is not a significant change in the critical thinking competence and caring attitude of students towards the environment. It caused by the students are not familiar with the inquiry learning by assignment and other variables.

While the results of the second cycle in mind that guided inquiry learning makes students become actively carry out the activities with the group, discussing and presenting the results properly. It can motivate to discover new things in everyday life. However, environmental behavior there was no significant increase may cause laboratory learning and not many activities in the outside environment. Thus, it can be concluded that guided inquiry learning in environmental-based science can increase student's critical thinking and student's environmental behavior.

SUGGESTIONS

The things that can be recommended concerning to the results of this class action research as follows:

1. Teachers should implement inquiry learning to develop high order thinking such as critical thinking.
2. Science and other subject learning should be integrated with environmental education to improve environmental behavior.

ACKNOWLEDGMENT

The writers' gratitude go to the director of SEAMEO QITEP in Science in Regional Bandung for the research Grant given and the principal of SMPIT Raudhatul Jannah for permission to research locations.

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