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Improving critical thinking skills of high school students through learning mini research projects on household waste management activities

Rifka Haerani*, Kusnadi, Taufik Rahman

Department of Biology Education FPMIPA Universitas Pendidikan Indonesia, Dr. Setiabudi Street No. 229 Bandung

*Corresponding author: rifkahaerani@upi.edu



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ABSTRACT

This study explores the effect of mini research project learning on high school students critical thinking skills in household waste management activities. To achieve this goal, this study used a pre-experiment method with one group pre-test post-test design. Data were taken from first-grade students in one of the senior high schools in Bandung as research subjects for the experimental class without a control class. The test instrument (essay) used to measure students' critical thinking skills. The results showed that there was an increase in students' critical thinking skills after learning the mini research project with an average N-gain score of 0.55 (medium). The criteria for critical thinking skills had also changed from the average critical thinking score achievement which was very low (not manifested) to high (strong) which was seen based on the results of the initial and final tests.



INTRODUCTION

The emergence of the aging society phenomenon in developed countries in the world contrasts with developing countries such as Indonesia, which are just entering the global demographic challenge. Education is the most critical investment tool for humans as capital in competing in the global era (Efendi, 2020). Global quality human resources in the sense of having talents with high competency standards in their respective fields and having a strong character that is able to compete at the global level (Tayibnapi et al., 2018). Improving the quality of human resources certainly starts from the world of education. A good and quality education system will produce quality human resources and be able to compete internationally (Pramana et al., 2021). Education is highly emphasized to improve human resources' quality and quality, such as skills, skills, and knowledge training about the business world to create competitive, competent, creative human resources (Efendi, 2020). In the classroom, the integrated relationship of century skills can be easily seen. Students are expected by their teachers to engage in motivational behaviors such as curiosity and perseverance, demonstrate social-emotional competence, and take part in cognition behaviors. With these abilities (Woods-Groves et al., 2021). Education in the 21st century is required to meet competency standards in accordance with current global trends.

The thinking process in students occurs during learning. In order for the thinking activities carried out by students to be appropriate and even improve, a reflection process is needed. Critical thinking is one of the 21st century skills that is important to apply in the knowledge construction process, namely the process of thinking and reflection. Critical thinking is also often said to be the practice of solving problems (Erdem, 2021).

The birth of social constructivism learning theory in relation to the teaching and learning process, there are basic characteristics of the learning environment in the role of the teacher as one of facilitator or guide (Bada & Olusegun, 2015). The student-centered learning approach makes students learn more effectively, students become more independent because students manage their own learning, besides increasing critical thinking activities (Bayram-Jacobs & Hayirsever, 2016). In reality, the use of these learning approaches does not always succeed in maximizing student learning outcomes. The accuracy of using both learning depends on the learning strategy used and the characteristics of the appropriate learning material.

Biology is a science that covers complex systems and is considered abstract by the student (Hadiprayitno et al., 2019). Learning biology is not merely memorizing the material, it needs a profound understanding (Syamsurizal et al., 2021). One of the biological concepts that is closely related as a system is the environment. Environmental biology is a discipline in science at the intersection of environmental science, ecology, evolution, conservation, and global change (Sadik et al., 2020). The environment is the sum of all social, economic, biological, physical or chemical factors that make up the living environment around humans, who are both creators and shapers of their own environment (Kumar, 2018).

Nowadays, environmental pollution due to biomass waste is increasing along with population growth. Environmental problems are currently being discussed by various countries, both developed and developing countries such as Indonesia (Yusuf, 2022). In 2020, it was recorded that the amount of national waste in Indonesia reached 67.8 million tons. Of all the national waste, waste from household waste is the most dangerous waste and the damage it causes is even greater than industrial waste (Hasibuan, 2016). For the emergency of waste originating from household waste, it is necessary to manage household waste by the community, especially at the household level. However, the lack of public concern and awareness is another obstacle, so it is necessary to think about solutions to increase public attention to the environment. This is certainly inseparable from the role of education which should help foster awareness and concern for the environment from an early age.

The increase and emphasis on thinking and solving an environmental problem in both research and education has become a challenge for scientists and students to understand. This is

also a challenge, both for students who study and educators who teach the concept of environmental pollution in environmental change materials. To achieve student understanding to problem solving, students need to be equipped with critical thinking skills. So that a reflective biology learning strategy is needed to be applied in the classroom or laboratory, one of which is through the application of mini research project learning that allows students to experience the process of thinking and reflection in solving a problem. Project learning is an effective way to develop 21st century skills by encouraging critical thinking and problem solving, interpersonal communication, information and media literacy, cooperation, leadership and teamwork, innovation, and creativity (Häkkinen et al., 2017). In addition, mini research projects are proven to bring out high skills described in another study regarding specific microbiology laboratory skills (Kusnadi et al., 2012). In the process, project-based learning fosters students' concern in building understanding of the concept of student exploration results before project work (Masdiana et al., 2020).

The material studied in this study is environmental changes studied in class X IPA. One of the studies on environmental change material that can be used as a learning resource for students is about environmental pollution, especially those related to household waste management. The environmental pollution material is biological material that is very contextual and very close to students' daily lives (Adhitama et al., 2018). The choice of material is based on the results of research by Izza et al. (2016) who found that students have difficulty in learning grade X high school biology material on the topic of environmental change which is considered difficult on the grounds that understanding it is not enough just to learn the facts.

Based on this description, a study was conducted to determine the effect of mini research project learning on critical thinking skills of high school students in household waste management activities. Learning using the mini research project learning model is expected to encourage students' critical thinking to overcome these difficulties and students can reflect on understanding through the project work process.

METHODS

The research method used is pre-experimental design. The research design used in this study was one group pre-test post-test design. The population of this study were students of class X IPA in one of the public high schools in Bandung City. By using purposive sampling technique, one class with 42 students was selected. The class was chosen because the students were already familiar with project-based learning activities.

The syntax of this mini research project learning includes start with the essential question, design a plan for the project, create a schedule, monitor the student and the progress of the project, assess the outcome, evaluate the experience. The critical thinking skills test instrument was adapted from Facione (2011) which consists of six indicators, namely interpretation, analysis, inference, evaluation, explanation, and self-regulation. The critical thinking skills test (TKBK) consists of 17 description questions. The initial critical thinking skills were taken before the learning was done (pre-test) while the final critical thinking skills were taken after the learning was done (post-test).

The improvement of critical thinking skills after mini research project-based learning was calculated and interpreted according to the N-gain formula. Meanwhile, data on students' responses to mini research project-based learning were analyzed descriptively using percentages.

RESULTS AND DISCUSSION

Data on students' critical thinking skills before and after mini research project-based learning on household waste management activities are presented in Table 1.

Table 1. Data on students' critical thinking skills before and after mini research project-based learning about waste management activities

Description	TKBK Pre-test	TKBK Post-test
Lowest Score	24	65
Highest Score	94	99
Average	54,36	79,69
Standard Deviation	16,16	8,26
Maximum Score	100	100

Based on Table 1. The highest score on the critical thinking skills test before learning is quite high at 94, presumably because students' initial knowledge or skills in logical and reflective thinking are already high as seen in the students' answers. This is in line with the opinion of Indria et al. (2019) which states that concept mastery and academic skills are two of the three factors that determine the level of students' critical thinking skills in addition to analytical skills. The width of the pre-test score range is more varied than the post-test score because the initial critical thinking skills test was conducted before learning so that it only relies on the initial knowledge of students with different skill backgrounds. Another factor is the lack of practice and limited resources as stated by Snyder & Snyder (2008) in their research.

The mini research project learning can affect the average value of students' critical thinking skills test where the average value of the final critical thinking skills test (post-test) is greater than the average value of the initial critical thinking skills test (pre-test). According to Chen et al. (2019), mini research project learning helps students find solutions through group discussions, problem analysis, solution construction and presentation of results so as to enable students to think more comprehensively from various points of view in solving everyday problems. In line with the research of Kusrudi et al. (2017) which shows that mini research project learning has a positive effect on scientific inquiry literacy skills which play an important role in understanding science.

From the acquisition of the initial critical thinking skills test scores (pre-test) and the final critical thinking skills test (post-test), an analysis is then carried out to prove whether there is an increase in students' critical thinking skills. The improvement of students' critical thinking skills can be seen through the calculation of the N-gain. The scores obtained by students on each indicator show a fairly good improvement, especially on the interpretation and evaluation indicators. These two indicators are important for students to master because they can help students recognize situations regarding environmental problems and evaluate the causes and impacts of these environmental problems. Thus, students are encouraged to critically think about ideas or ideas for solving environmental problems during the mini research project learning.

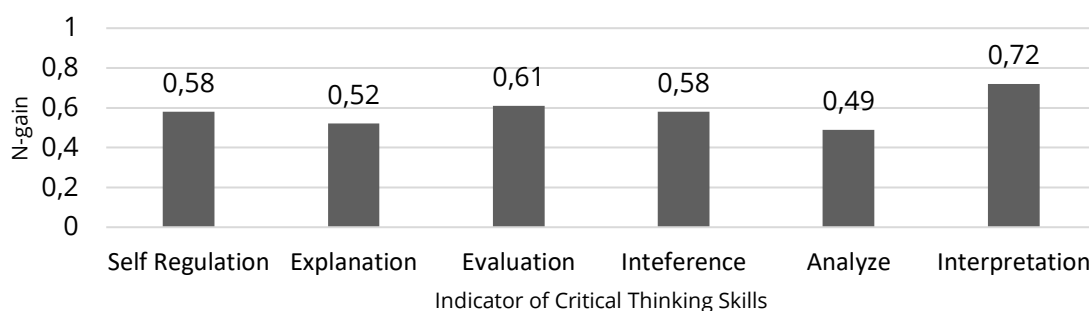


Figure 1. N-gain value of students' critical thinking skills on each indicator

Figure 1. Shows that the highest average increase in critical thinking skills is in the interpretation indicator of 0.72 (high). This is because during the mini research project learning takes place, students are required to be able to understand and express the meaning or significance of various kinds of experiences, situations, data, events, or procedures related to environmental pollution, especially household waste pollution. The improved critical thinking skills test results are in line with the research of Daulae et al. (2018) which states that mini research project learning requires students to collaborate in solving problems by constructing more meaningful knowledge and is proven to improve critical thinking skills. Another study mentioned that project learning can improve overall critical thinking skills because each step in project learning can encourage the achievement of critical thinking skills indicators (Santayasa et al., 2021). In this study, mini research project learning was carried out by raising the issue of environmental pollution through household waste management activities. Rajan et al. (2019) based on the results of their research determined that waste management activities and social problems such as environmental pollution can improve students' critical thinking skills.

Evaluation became the second indicator with the highest score increase achieved by students after the mini research project learning was conducted. Even so, the increase in evaluation indicators is classified as moderate. Research by Ismail et al. (2022) reported that students who have critical thinking skills must fulfill the evaluation indicator, namely being able to evaluate opinions or statements from others and themselves. In another study, it was stated that project learning can improve students' evaluation skills, because at the end of learning students are trained to evaluate the products made (Fitriani et al., 2019). Followed by Self-regulation and inference indicators which both have an increase of 0.58 (medium).

Research conducted by Mutakinati et al. (2018) also explained that project learning had an impact on critical thinking skills, namely on inference indicators and deciding on actions that experienced a significant increase, especially for female students. When associated with the results of the study, it can be said that the participants of this study who were dominated by female students were one of the causes of the high increase in inference skills.

The explanation indicator experienced a lower increase than the indicators previously mentioned. The n-gain score of the explanation indicator is 0.52. In learning mini research projects through household waste management activities, students are automatically trained to argue in explaining the results of mini research projects that have been carried out, where students are also trained to be able to prove the argument as the basis for the results of mini research projects claimed by students.

The effect of project learning on improving students' interpretive skills was discussed in Adiwijaya's (2017) research which revealed that project learning provides opportunities for students to improve interpretation skills. In addition, another study mentioned that collaborative project learning allows students to apply a more critical way of thinking. This occurs due to student participation in all proposed tasks, including one of them in the aspect of understanding and interpreting data (de la Torre-Neches et al., 2020). The low increase in analysis indicators contradicts the results of research by Efendi et al. (2020), where the analysis indicator increased significantly (0.77) after project learning was carried out. The low increase in analytical skills in the results of this study is due to the fact that students are free in finding issues regarding household waste problems that are used as background in problem formulation, so students tend to look for the easiest and most widely discussed issues. In this case, analytical skills are not optimally trained because students can easily formulate problems and then plan a mini research project as a solution to the problem.

The success of the implementation of mini research project learning based on students' views is measured through student response questionnaires with results as in Table 2. Based on the analysis of student response questionnaire data on mini research project learning presented in Table 2, it can be concluded that student responses are very good, where students dominantly give positive statements about critical thinking skills after learning, mini research project learning

syntax, group assignment strategies and the usefulness of material concepts. This is due to several factors, one of which is the project carried out in groups so as to increase student motivation and enthusiasm for learning. Another factor that raises students' good response to this mini research project learning is because students have fully realized the usefulness of the material being studied including environmental phenomena or issues that are happening such as environmental pollution from household waste. This issue is certainly very familiar and is considered quite easy to observe because it is very relevant to students' daily lives.

Table 2. Students' responses to mini research project-based learning about waste management activities

Indicator	Response Percentage (%)	Criteria
Response to critical thinking skills	81,85	Very good
Response to mini research project learning	79,37	Good
Response to group assignment	81,33	Very good
Response to the achievement of learning steps	75,72	Good
Response to the usefulness of the material concept	84,2	Very good

Even so, students' responses to the implementation of the syntax of the mini research project learning are lower than other indicators. It can be seen that two statement items produce quite good responses from the remaining 4 statements that produce very good responses. The two statements are "the monitoring done by the teacher during the project implementation made me confused" and "the product assessment strategy at the end of the lesson made me want to argue and ask questions". This is because during learning, the teacher has not briefed students well regarding the implementation of the mini research project or the directions given are not clear enough so that students feel confused. Then, during the product assessment at the end of the lesson, students were less active and tended to only listen to presentations from other groups, because students did not have enough knowledge related to the material content plus the question and answer strategy and discussion led by the teacher did not go well so that it did not raise students' curiosity to ask questions. In addition, due to the limited time, the teacher had to organize the learning quickly and precisely. As a result, not all learning syntaxes are well controlled.

CONCLUSION

Based on the research findings and discussion, it can be concluded that learning mini research projects on household waste management activities can improve students' critical thinking skills. The interpretation indicator has increased with the "high" category, while the other five indicators, namely analysis, inference, evaluation, explanation, and self-regulation have increased with the "medium" category.

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