



Application of the Global Warming Learning System (GWLS) as an Effort to Improve Student's Learning Outcomes and Critical Thinking Ability

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Article Info

Article history:
Submitted 15 November 2023
Revised 20 February 2024
Accepted 22 February 2024

Keywords:
Critical thinking, learning outcomes, global warming learning system

Abstract

This Classroom Action Research (CAR) aims to improve learning outcomes and critical thinking skills of class X-K SMA Negeri 6 Semarang, through the application of adaptive teaching materials Global Warming Learning System. The learning model used is Problem Based Learning with group investigation method (cycle I) and Project Based Learning with product differentiation (cycle II). CAR is carried out in two cycles, where each cycle consists of four activities, namely action planning, action implementation, observation and reflection which adopts the Kemmis and Taggart models. Data collection techniques used in this study were observation, tests, questionnaires and interviews. Data analysis used a qualitative descriptive approach based on educational outcomes and improving students' critical thinking skills. The results show that there has been an increase in educational outcomes and critical thinking skills (pre-cycle to cycle I) and (cycle I to cycle II). Evidenced by the results of studying at first cycle, which was completed by 15 students (41.67%) and the students' critical thinking skills, the average 71.59% was high category. Meanwhile the educational outcomes of physics cycle II which were completed were 28 students (77.78%) and the ability to think critically with an average 78.88% was high category.

INTRODUCTION

Global warming is a serious problem that affects Indonesia and other countries around the world (Mukono, 2018). Global warming refers to the increase in the average temperature of the earth's atmosphere due to increased greenhouse gas emissions. Greenhouse gases include H₂O, O₃, CO₂, NH₄, CFC, NO_x, etc. Some of the factors that contribute to global warming include the burning of fossil fuels, deforestation and increased human consumption patterns. With 2,563 MtCO_{2e}, Indonesia is ranked third as the largest emitting country in the world after America and China (Wahyuni *et al.*, 2021). High emissions can cause serious impacts, including: (1) temperatures have increased since 1990 by around 0.30 °C. (2) an increase of 2 to 3 % of annual rainfall intensity and a significant increase in the risk of flood disaster. (3) poses a food threat from the consequences of extreme climate change. (4) rising sea levels can certainly cause coastal productive areas to inundate and affect livelihoods in coastal areas. (5) warmer sea water affects marine life and poses a threat to coral reefs. (6) causing various diseases that can reproduce through water and vector media, namely malaria and dengue fever (Directorate of Technical Education, 2017).

In overcoming this global warming problem, many efforts need to be made, namely reducing greenhouse gas emissions through the transition to renewable energy sources, protecting and restoring natural ecosystems, developing sustainable agriculture, as well as awareness and collective action from individuals, governments and society as a whole. It is important for Indonesia to be involved in international efforts to reduce greenhouse gas emissions and maintain environmental sustainability.

For UNESCO, education, especially if it is focused on children and youth, is a key factor in helping to minimize the impact of global warming (Kodama, 2019). Education encourages changes in students' attitudes and behavior to help them adapt to global warming (Nidatya, 2023) so that the character of caring for the environment is formed so that in acting later they hope to be wise. Learning about global warming brings the following benefits: awareness about environmental issues, scientific knowledge, development of critical thinking skills, encourages responsible action, collaboration and leadership (Fitriyyah, 2019). Learning about global warming can be done in various ways, such as materials in the school curriculum, research projects, group discussions, field activities, and involvement in environmental initiatives. This helps prepare future generations with a solid understanding of global warming and the motivation to act for environmental sustainability.

In some schools, they don't pay enough attention to global warming material, they even tend to ignore it because it's considered easy material, so students are often only assigned to just read it independently. This can be caused by several factors, such as time constraints, a busy curriculum, or a lack of understanding and adequate resources about the importance of global warming. However, it is important to remember that global warming is not a simple material and you can finish it just by reading it. This problem involves complex scientific concepts, multidimensional impacts, and broad social implications. In order for students to truly understand this issue, a more holistic and interactive approach to learning is needed.

Several alternatives to improve global warming learning in schools are field activities (Darusman, 2016), scientific literacy with group discussions (Alatas, 2020), practice (Kusmianty, 2020), introduction to real action (Amalia, 2022), project-based approaches (Nurhasanah, 2023), interactive resources (Manizha, 2023), and involving various subjects (Desiana, 2023). With a more holistic and interactive approach, students are expected to be able to understand global warming more deeply and develop a stronger attitude of caring for the environment.

The results of the diagnostic test that have been carried out show that many students experience misconceptions. Some of the misconceptions are that global warming only means hotter weather, global warming only occurs in certain places, humans do not play a role in global warming, there are no significant negative impacts, and global warming cannot be overcome. In fact, some students feel hopeless or believe that global warming cannot be overcome. This can make them less motivated to take preventive action. However, it is important to communicate that individual and collective action can make a difference, including reducing greenhouse gas emissions and maintaining environmental sustainability.

To address these misconceptions, it is important to adopt a learning approach that focuses on deep understanding, clarifying concepts, and providing relevant scientific evidence. Open discussions, real experiences, and clear visual presentations can help clarify concepts and overcome misconceptions. In addition, engaging students in practical activities and providing concrete examples of actions they can take can also help change their views on global warming.

One of the contexts tested in PISA is the material on global warming symptoms. Global warming is one of the physics concepts taught at the secondary school level in the 2013 curriculum and the independent curriculum. The concept of global warming requires students to be able to analyze the symptoms and their impact on life so that students can put forward ideas or ideas as a solution to these

problems (Kemdikbud, 2016). However, students still have difficulty achieving this, due to the abstract concept of global warming (Setianita, 2019). Research shows that only 5.1% of the 1035 students studied can explain the greenhouse effect completely and correctly, so in general students' knowledge of the symptoms of global warming is still minimal (Yazdanparast, 2013). The results of interviews with students at SMA N 6 Semarang stated that they tended to be unable to explain and relate the concepts of greenhouse gases, the greenhouse effect, global warming and climate change. This shows the low knowledge and understanding of students regarding the concept of global warming and results in the goal of studying global warming symptoms in schools not being optimal.

Students are familiar and understand use of digital technology in learning. Students also have gadget devices to support learning activities. Researchers need to pay attention to this potential to improve the quality of learning. One of them is by implementing a learning system in learning to remediate students' misconceptions.

Based on the problems and statements that have been disclosed, it is necessary to improve the concept by applying adaptive teaching materials. It is hoped that misconceptions will decrease, learning outcomes and students' critical thinking skills will increase. In addition to remediating students' misconceptions using a blended learning model with the GWLS so that it can reduce the students who have misconceptions and make students' conceptions consistent with scientific conceptions.

METHODS

This type of research is collaborative CAR with 2 cycles. The procedure for implementing each cycle includes planning, implementing actions,

observing and reflecting (Figure 1). The learning model applied is Problem Based Learning with the Group Investigation method (Cycle I) and Project Based Learning with product differentiation learning (Cycle II). The subjects of this CAR were class X-K students of SMA Negeri 6 Semarang for the 2022/2023 academic year. In the pre-cycle, class observations were carried out, profiling learning styles and student characteristics, and data on student educational outcomes in the previous material.

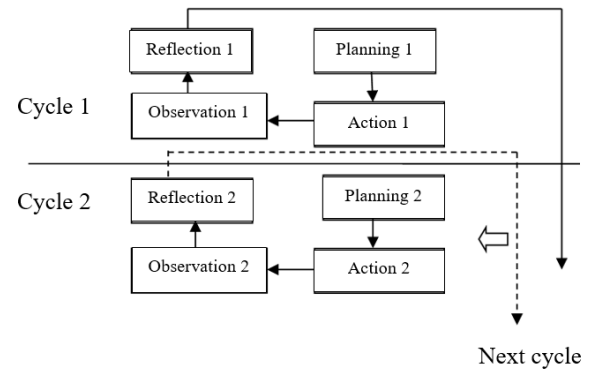


Figure 1. CAR design according to Kemmis and Taggart

CAR data analysis is quantitative and qualitative. Quantitative data collection techniques for educational outcomes are obtained from diagnostic tests and post-tests at the end of each cycle. Qualitative data obtained from observation and interviews. Critical thinking skills data obtained from questionnaires and interviews. Prepare learning tools in the form of teaching modules, worksheets, learning media, cognitive assessment and adaptive teaching materials in the form of a GWLS with the domain address: <https://globalwarming.edukati.com> (Figure 2).



Figure 2. Initial display of the Global Warming Learning System (GWLS)

RESULTS AND DISCUSSION

Pre-cycle profiling showed that there were 36 students in class X-K, with 19 male students and 17 female students. The characteristics of the learning styles are 22 kinesthetic students, 6 auditory students, 3 kinesthetic visual students, 3 kinesthetic auditory students, 1 auditory visual student and 1 kinesthetic visual auditory student. Based on the observations, X-K students had problems including low educational outcomes during the learning process in the previous material (Renewable Energy) as seen from the average score obtained by students,

which was 44 with an incompleteness percentage of 88.89% (Table 2). The average educational outcomes do not meet the Learning Objectives Achievement Criteria (LOAC). Based on the initial diagnostic results, the reason for the high percentage of students who passed was their interest in learning physics and their understanding of the material presented was still low, which was seen when the question and answer was carried out during the lesson. Based on observations and interviews with physics teachers, this class is dominated by students who like to talk. Therefore, in the initial hypothesis of this class a learning process was applied that involved discussion and presentation.

Table 1. The results of students' critical thinking for each indicator

	Give a simple explanation (%)	Build basic skills (%)	Conclude (%)	Provide further explanation (%)	Set strategy and tactics (%)	Average (%)
Pre Cycle	72.50	75.00	58.30	53.75	62.50	65.05
Category	Good	Good	Good	Good	Good	Good
Cycle I	69.00	75.00	73.00	69.00	71.00	71.59
Category	Good	Good	Good	Good	Good	Good
Cycle II	76.70	82.90	77.70	78.40	78.60	78.88
Category	Very good	Very good	Very good	Very good	Very good	Very good

In cycle I, students were divided into 6 groups with the distribution of members using peer tutors as the application of Teaching at The Right Level (TaRL). Students who have high scores join a group with students who still have learning difficulties. Each group investigates a different area. The group that gets the name of the continent, only needs to choose 1 country on the continent to be investigated. The coverage area is Africa, America, Asia, Australia, Europe and Semarang. The factors investigated are (1) the facts of environmental changes in the area, (2) the impact of environmental changes, (3) human activities that cause environmental changes and (4) solutions to overcome environmental changes from the parties. community, government and personal solutions resulting from group group discussions. The results of the investigation can be seen in Figure 3.

The test results show that there are still many students who experience misconceptions, including: (1) global warming only means hotter weather, (2) the most abundant greenhouse gas on earth, namely CO₂, (3) global warming only occurs in certain areas with emissions high, (4) global warming is caused by human activities and occurred recently, not a natural natural event (5) there is no significant negative impact, (6) difficulties in drawing illustrations of the transportation of sunlight/energy entering and leaving the earth (Figure 6), and (7) global warming cannot be overcome. Students are less motivated to take preventive action. Yet, it is important to communicate that individual and collective action can make a difference, including reducing greenhouse gas emissions and maintaining environmental sustainability.

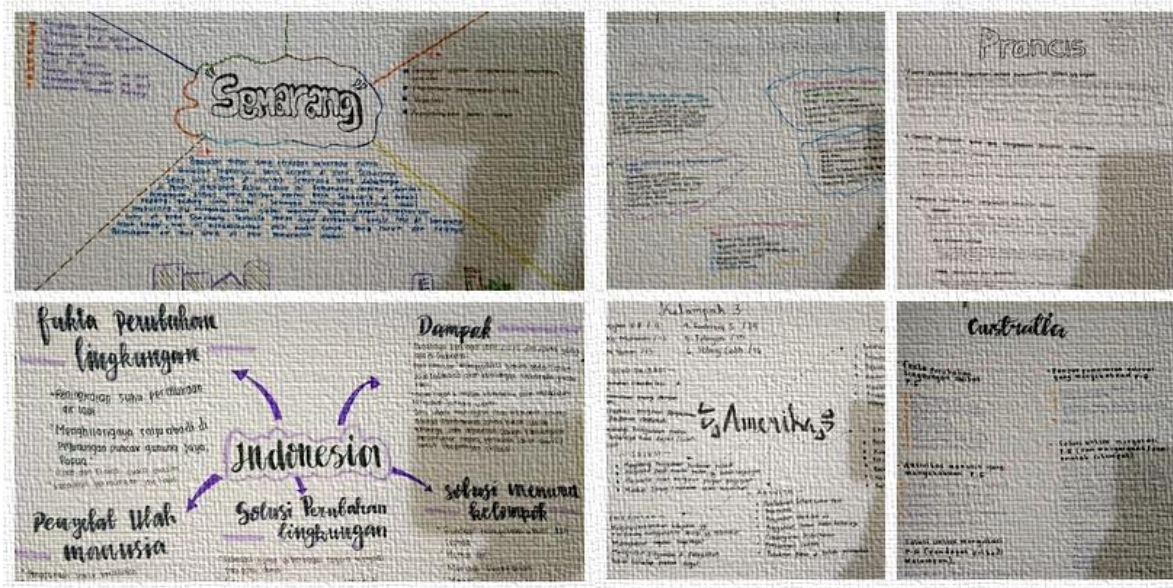


Figure 3. Results of area investigations by students

The average student educational outcomes in cycle I have increased to 59, but this value has not met the LOAC standard, which is 70 and there are still 58.33% of students who do not complete (Table 2). Students' critical thinking skills have increased to 71.59% in the good category. However, the

indicators for achieving competence in the sub-chapter on the impact of environmental change (47%) and human activities that cause environmental change (24%) have not met the completeness percentage (Table 3), so that the treatment is carried out again in cycle II.

Table 2. Students' learning outcomes

Category	Pre Cycle	Cycle I	Cycle II
The highest score	93	100	100
Lowest Value	14	30	60
Average	44	59	80
Completeness	6 people (16.67%)	15 people (41.67%)	28 people (77.78%)
Not Completed	32 people (88, 89%)	21 people (58.33%)	8 people (22.22%)

In cycle II, remediation efforts in the greenhouse effect sub-chapter were carried out by dividing students into 6 groups based on their learning styles, interests and needs. Where students are assigned to make a project in the form of a product with the theme of the greenhouse effect, each group makes a different type of product. The auditory-visual group made song lyrics by adapting music from various sources, the kinesthetic group made pop-up scrapbooks, mindmaps and dioramas, the audio-visual combination group made videos, and the visual-kinesthetic combination group made

dioramas. The following results of product differentiation can be seen in Figure 4.

The average students' learning outcomes in cycle II have increased to 80, although there are still 8 students who do not complete (Table 2). The learning process was completed because the learning outcomes had reached a completeness percentage of 77.78%. Students' critical thinking skills have increased to 78.88% in the very good category. Competency achievement indicators in the four sub-chapters have reached good criteria (Table 3).



Figure 4. The results of product differentiation "greenhouse effect"

Table 3. Reflection on the success of learning on each indicator

Indicators of Competence Achievement	% Completeness	
	Cycle I	Cycle II
Environmental change facts	70	83
Impact of environmental change	47	69
Human activities that cause environmental changes	24	93
Solutions to address environmental changes	78	88
Average	54.75	83.25

GWLS is an innovative Teaching and Learning Management System platform developed by researchers with the aim of being an adaptive teaching material. The advantages of e-learning include: a) many choices of resources, b) can accommodate the types of questions (question banks) that will be used during quizzes, c) attendance facilities attendance that is used to check student attendance, and d) analytical facility to check all student activities in each course, assignments, discussions and other activities prepared for students. Utilization of GWLS has provided student learning experiences, experiences

in utilizing technology and information are increasing. In addition, from the perspective of educators or teachers, this platform can make it easier for teachers to control student activities, as well as increase learning interactions between students and teachers, so that teachers can better know the abilities of each student. In this platform there are menus starting from self, concept exploration, collaboration space, contextual demonstrations, elaboration of understanding, connections between material and real action. The following display of this platform can be seen in Figure 5.

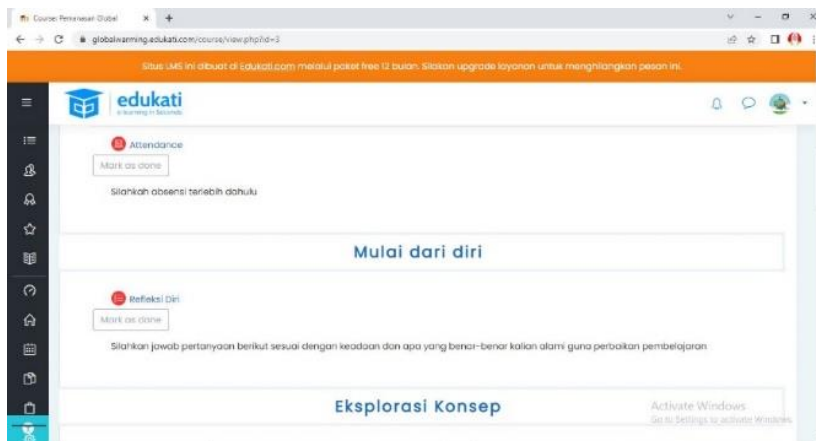


Figure 53. GWLS

GWLS includes: (1) projects involving research, data analysis, and presentations on the topic of global warming. Students are actively involved in understanding the issue and solving related problems. (2) group discussions in class forums and even across classes to share knowledge and consider various perspectives. This helps improve students' understanding and critical thinking skills. (3) Self-reflection in the local environment affected by global warming, through direct experience, students can see the real impact and understand the urgency of environmental protection. (4) utilize interactive educational resources, such as videos, simulations, or computer applications, which visualize the concept of global

warming in an engaging and easy-to-understand way. (5) students can participate in concrete actions, including activities to reduce carbon emissions in schools, reforestation, or environmental awareness campaigns. (6) Group Investigation involves various aspects of life, including science, mathematics, sociology, and economics. Integrating issues into various fields helps students understand the complex relationships between global warming and other fields. With a more holistic and interactive approach, students are expected to be able to understand global warming more deeply and develop a stronger attitude of caring for the environment.

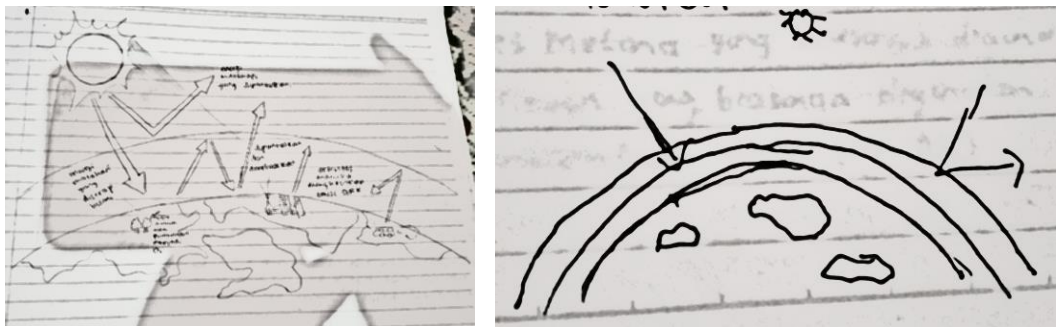


Figure 6. Painting the transformation of sunlight / energy to the earth. Already according to the concept (left) and not according to the concept (right)

Learning about global warming brings benefits. First, recognizing the importance of protecting the environment and how individual and collective actions can affect the environment. Second, involves an understanding of scientific concepts such as the carbon cycle, climate change, and ecosystems. Third, involving data analysis, understanding complex concepts, and assessing diverse information can help students develop the critical thinking skills needed to understand complex issues, compare different arguments, and make informed decisions. Fourth, encouraging students to take environmentally responsible actions. Fifth, Students can learn to work together on environmental projects, build community awareness, and develop leadership skills to address these issues effectively.

CONCLUSION

GWLS can be applied in physics learning, in an effort to improve students' learning outcomes and critical thinking skills. The application of the PBL with group investigation method (cycle I) and PjBL with product differentiation learning (cycle II)

creates active learning conditions. The learning outcomes after the implementation of GWLS increased the number of students' completeness to 77.78%. Students' critical thinking skills have increased with an average percentage of 78.88% in the high category.

GWLS is highly recommended in the physics learning process. Students' learning outcomes can be monitored through the system, including attendance, analytical facilities to view all student activities in each course, assignments, discussions. Students' critical thinking skills have increased, because the division of groups is based on the principle of peer tutoring and product differentiation learning based on student learning styles, so it is highly recommended for further research to divide groups based on learning styles, interests and needs of the students.

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