



Profile of High School Student's Scientific Literacy to Support SDGs'13 (Climate Action) on the Global Warming Phenomenon

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Abstract:

The low level of scientific literacy skills is attributed to the lack of application of scientific literacy principles, the inability to interpret tables and graphs, and students' limited understanding of basic scientific concepts related to the SDGs'13. This research aims to analyze the scientific literacy abilities of 10th-grade students at SMAN 1 Surabaya in relation to supporting SDGs'13 on the Global Warming Phenomenon. The research method used is descriptive and mixed method approach. The research design involves an explanatory sequential design. The research findings indicate that the average score of 10th grade students at SMAN 1 Surabaya is 65.2, which falls within the satisfactory category. Factors contributing to the suboptimal scientific literacy abilities include the inadequate application of scientific literacy competencies in teaching, teacher's not to familiarize students with scientific analysis of phenomena, and the continued use of conventional teaching methods. There is a lack of experimental activities that encourage students to engage with scientific data and produce experimental reports. Therefore, there is a need for innovative learning methods and tools, such as integrating the topic of global warming with the SDGs'13 climate action concept and

implementing a problem based learning model. These approaches aim to foster critical thinking and environmental awareness among students, enabling them to address global issues and contribute to environmental preservation in the face of climate change. Ultimately, the goal is to ensure that knowledge about preventing climate change can be applied by students in their daily lives in the long term.

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Introduction

The challenges of the 21st century are closely tied to global development, with the development of science, knowledge, and technology being one of the most complex challenges. The goal of this development is to improve the quality of life in modern society (Pratiwi, 2019). Achieving this requires mature thinking to analyze life's problems. Educators aim to enhance the thinking abilities of high-quality and intellectually motivated students by using scientific literacy. Instead of traditional memorization of scientific concepts, new approaches focus on meaning making and high-level thinking processes that connect scientific concepts to real life. For instance, the honing of scientific thinking involves five components: observing, asking, gathering information, associating, and communicating. This can be achieved through relevant learning models like Problem Based Learning (Kim So & Kim Deokson, 2021; Yusmar & Fadilah, 2023; Habibah & Ulya, 2024; Walipah et al., 2024). Understanding the interconnectedness of science, technology, and public practice empowers individuals to improve their scientific literacy on personal and global levels (Andriani et al., 2018; Aristovnik et al., 2020; Marlina, 2023; Redhana, 2019; Sutrisna, 2021; Rusilowati & Wahyudi, 2020).

The level of scientific literacy among students in Indonesia is still quite low compared to other countries. In the Program for International Student Assessment (PISA) conducted by the Organization for Economic Cooperation and Development (OECD), over 400,000 participants from 79 countries took part. The most recent survey was supposed to take place in 2021, but due to the Covid-19 pandemic, only PISA 2022 was conducted. The results, announced on December 5, 2023, revealed that Indonesia was ranked 68th out of 81 countries for scientific literacy. The scores were 379 in mathematics, 398 in science, and 371 in reading. There has been a significant decline in student performance scores, known as learning loss, in the three fields of science globally over the past four years due to the impact of Covid-19 (2018-2022). Despite the drop in scores, Indonesia's PISA ranking in 2022 improved compared to 2018 (Kemdikbud, 2023).

Research conducted by Takda et al., (2023) on high school students in Southeast Sulawesi found that scientific literacy skills were still low. The study indicated that process skills, such as observing, grouping data, interpreting scientific evidence, and drawing conclusions, were particularly lacking, with only 24.3% of students demonstrating proficiency. The research suggests that many students have not effectively applied scientific concepts and lack logical, systematic, and rational abilities in their everyday lives. This contributes to the low level of scientific literacy among students in Indonesia (Indrawati, 2018; Yusmar & Fadilah, 2023).

Apart from that, it's a low level of literacy student make lack responsiveness in overcoming existing problems and changes in their environment (Nofiana & Julianto, 2018). This occurs due to the lack of interest in understanding the student, who is not yet capable of grasping various theoretical concepts related to scientific topics and has not attained the necessary skills to support student development in literacy. (Hasasiyah et al., 2020). Another thing that happens is the lack of response to school policies in increasing scientific literacy shift attention to teachers in lesson preparation, and their motivation to work. This is in line with research which shows that teachers are one of the most important factors in the student learning process for their

motivation plays an important role in the way students learn engage and embrace their educational experience. Numerous studies show that motivated teachers are essential in creating a classroom environment that promotes improved student learning (Fong et al., 2018; Govorova et al., 2020; Mesa & Gomez, 2024). So the efforts are required to resolve the problem of low scientific literacy attainment and be able to compete effectively with other countries (Fadilah et al., 2020).

Scientific literacy is the self-capability to implement knowledge for identifying questions, building new knowledge, creating answers in a scientific, and discovering conclusions based on proof science until capable role share in overcoming issues and ideas related field scientific (OECD, 2019). The primary focus of large-scale science assessments is to create structured items based on the PISA framework, which is designed to evaluate scientific literacy using a comprehensive framework. The PISA assessment framework prioritizes essential skills required for future life. Scientific literacy in PISA is demonstrated in real-life contexts, where individuals need to apply their competencies in everyday situations, particularly in analyzing, reasoning, and communicating scientific ideas (Zhang et al., 2023). Therefore that's necessary to have the capability to manage draft-acquired science so that can be implemented inside life real (Armas et al., 2019). Scope capability scientific literacy related to the field of natural science, one of them is physics, which plays an role important in the development of science and technology (Millenia, 2022). Through learning physics students are expected capable manage the ability to think in a way analyzes in finishes problems that exist in the environment.

The problem environment is a must handled and linked with learning Physics is one of them is Global warming. According to Amani et al., (2021), it is important to teach students to care for the environment as a preventive measure against global warming. Educators can lead by example and provide direct learning experiences to instill environmental consciousness from an early age. The more effort educators put into fostering love for the environment, explaining the effects of and measures to prevent global warming, the better people will understand their surroundings in the future (Fitri & Ali, 2020). Global warming is defined as the increasing process of temperature atmosphere earth, sea and land.

Factors that can happen caused by people's activity from the use of material burn producing fossils house gas effect glass (Carbon Dioxide, Methane, Nitroxide) in the atmosphere earth (Fitri & Ali, 2020). Global warming is the impact that occurs because there exists a changing climate that becomes an obstacle to people for sustainable living (Nurhayati et al., 2020; Hartati & Haryono, 2020; Rahmadania, 2022; Syafitri et al., 2023). The Sustainable Development Goals (SDGs) are planning global action designed by United Nations Development Programme (UNDP) to reach well-being together (Khataybeh et al., 2010), and push awareness to behave friendly environment in a way sustainable (Kleespies & Dierkers, 2022). The focus of this research regarding SDGs'13 regarding climate action is efforts to reduce vulnerability to climate-related hazards and natural disasters. Climate action is not only about creating a low-carbon and climate-resilient world by reducing greenhouse gases emissions to investing in renewable energy alone. However, this also involves individuals, communities and countries to create a world that understands how to manage climate risks specifically which are applied to the learning process in schools

in introducing students to achieving SDGs'13 (Filho et al., 2023). The 13th SDGs issue regarding climate action can be linked with high school physics learning for participants to be more interested with the phenomena of nature that happen in the environment.

Physics is something part of knowledge natural science studies symptoms and phenomena specifically global warming through established scientific processes on base attitude science and the results achieved from output applicable theories, laws, and principles in a way comprehensive. Learning physics' own objective in a way general forms the ability of students to implement reasoning through methods to think critically, systematically, and logically to problem-solving in the field of physics or life (Putri, et al., 2018; Irwan et al., 2019; Oktavera & Izzati, 2023). Evaluation many people think physics is a lesson formula influential with learning in the classroom. The final student must complete a large amount of material, regardless of the student's ability. This difficulty hinders the ability to apply science to real-life problems and solutions. (Ahmad, et al., 2018).

Based on the results of observations and interviews with Physics teachers at SMAN 1 Surabaya, it was found that students are not very enthusiastic about the physics learning process at school. This is because the learning methods are considered to be too monotonous and conventional. Additionally, there is a lack of science learning activities that focus on environmental care. This is particularly important due to the climate change problems in Surabaya, such as increasing air temperatures in urban areas, excessive waste in landfills, and various disasters leading to climate change in the region (Surabaya.go.id, 2023). Research by Armas et al. (2019) indicates that scientific literacy has a positive relationship with increasing student's knowledge.

Furthermore, according to Carman et al. (2021), teachers can improve student's science knowledge skills by connecting these topics to real-life situations, contributing to efforts to address climate change. The lack of physics learning related to the environment and climate change is the focus of this research, as it aims to improve scientific literacy skills and motivate students to contribute to addressing climate change in line with the SDGs'13 concept. This research also aims to analyze the scientific literacy abilities of students based on the achievement of scientific literacy indicators at SMAN 1 Surabaya. Based on these identified problems, there is a need for new ideas to improve learning at school.

Research Method

This study uses a Mix method approach. The mixed method is a procedure with method collection, analysis, and combine of method quantitative and qualitative in a way sequence in research. The study begins with the collection and analysis of quantitative data, followed by the collection and analysis of qualitative data to help explain or elaborate on the quantitative findings (Sugiyono, 2018; Creswell, 2018; Fraenkel et al., 2012). The research design uses a sequential explanatory design by Figure 1. In the first stage, data is collected regularly in quantitative form using a method that tests the science literacy of the participants. The data is then analyzed to assess the students' scientific literacy. Following this, qualitative data is collected through interviews with teachers regarding scientific literacy. So the interpretation of the quantitative data is supported by the qualitative data (Creswell, 2018).

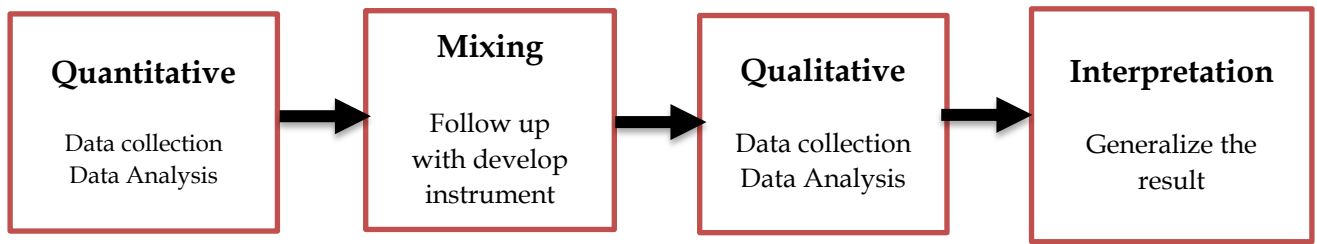


Figure 1. Explanatory Sequential Design (Creswell, 2018)

The research used test questions with scientific literacy indicators, response questionnaires, and interview question sheets with teachers. These instruments were validated by expert Physics Education lecturers at UNESA. The validity and reliability tests showed high scores, with a validity score of 100% and a reliability score of 0.705, indicating that the learning instrument can be used for further research. The primary quantitative data was collected in the form of a science literacy test, while the secondary qualitative data was gathered through interview test results with teachers and student response questionnaires. Data collection techniques included administering scientific literacy test questions and interviewing physics teachers at schools (Sutrisna, 2021). The sample for this research consisted of students in classes X5 and X6 at SMAN 1 Surabaya.

Data analysis techniques used are linked with indicator literacy in science. The indicators are shown in Table 1.

Table 1. Competence Scientific Literacy and The Indicators

No	Competence Aspect	Indicator
1.	Explain Scientific Phenomenon.	Identify phenomenon nature and phenomena technology.
		Putting it forward explanation about phenomenon nature and technology.
		Apply explanation phenomenon nature and phenomena to technology.
2.	Build and evaluate design for investigation scientific and interpreting data and evidence scientific in critical.	Build method investigate question in a way scientific.
		Analyze as well as evaluate scientific data in a way critical.
3.	Research, evaluate and use information scientific for taking decisions and actions.	Find information scientific about issue related global, local, or science personal.
		Compare from information scientific about issue related global, local, or science personal certain.
		Evaluate weaknesses, potential, and applications information in taking decision.

(PISA 2025 Science Framework, OECD 2023)

Before doing test questions, the student is requested to fill in a questionnaire response related to knowledge physics learning for measure capability scientific literacy to support SDGs'13 in the material global warming. Criteria measurement uses a Likert scale on the response students were shown in Table 2:

Table 2. Criteria Measurement Response Learners on a Likert Scale

Criteria	Score
Strongly Agree (SA)	4
Agree (A)	3
Disagree (D)	2
Strongly Disagree (SD)	1

Score results of scale likert already calculated and totaled. Then made the score percentage using the formula as follows:

$$Percentage (\%) = \frac{total\ score\ obtained}{maximal\ score} \times 100\ \% \quad (1)$$

Percentage earned then be measured in the criteria scale likert as in Table 3:

Table 3. Criteria Percentage Response Learners

Percentage (%)	Criteria
0 - 20	Very less
21 - 40	Not enough
41 - 60	Enough
61 - 80	Good
81 - 100	Very good

(Arikunto, 2013)

The data obtained from the results instrument question test the student. Then be measured with method change score raw test results literacy science form value on each using domain formula as follows: (Arikunto, 2013)

$$Score = \frac{total\ score\ obtained}{maximal\ score} \times 100 \quad (2)$$

Next, assess achievements literacy resulting science. Then, collected based on capability literacy participant educate use scale category ability literacy science in each indicator were shown in Table 4:

Table 4. Category Capability Scientific Literacy

Score Range	Category
86 - 100	Very good
72 - 85	Good
58 - 71	Enough
43 - 57	Not enough
0 - 43	Very less

(Djaali & Mulyono, 2008)

Results and Discussion

To assess student's scientific literacy, the researcher administered a questionnaire with 8 knowledge-based questions related to global warming and the Sustainable Development Goals (SDGs 13). The questionnaire aimed to evaluate the participant's scientific literacy abilities in the context of global warming. Additionally, the test questions were designed to gauge the students' scientific literacy in global warming, aligning with the literacy science standards outlined in PISA 2025. The questionnaire responses from the students are summarized in Table 5, using an instrument validated by an expert lecturer in UNESA.

Table 5. Questionnaire Data Response Learners

Interval	Category	Frequency (f)	Percentage (%)	Average
64-75	Very satisfactory	0	0	
52-63	Satisfying	3	5	
40-51	Enough Satisfying	42	70	42.16667 (Enough)
28-39	Not satisfactory	14	23.3	
15-27	Very Dissatisfying	1	1.67	
TOTAL		60	99,97	

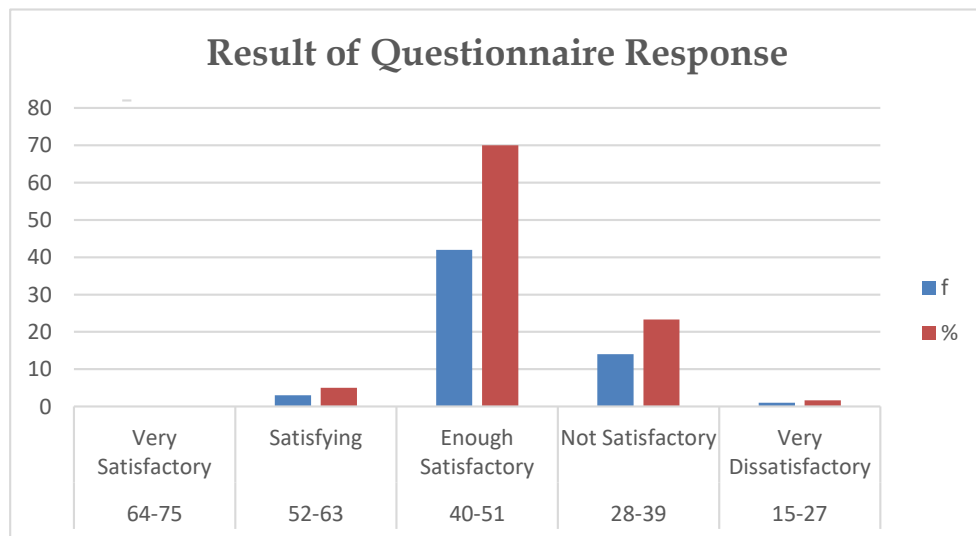


Figure 2. The Results of Questionnaire Response

Based on the results of the questionnaire response students from a total of 60 respondents of the two selected classes. The survey results showed that 3 responses were satisfactory, 42 responses were enough satisfactory, 14 responses were not satisfactory, and 1 response was very negative. However, there were still some very satisfactory responses to the questionnaire from students. On average, 42% of students found the material on learning physics to be enough satisfying in supporting SDGs (Sustainable Development Goals) in scientific literacy. This suggests that students responded positively to the effectiveness of the learning materials (Lestari & Setyarsih, 2020). It can be concluded that students are enthusiastic and have some understanding

of scientific literacy related to global warming. The concepts of SDGs, particularly climate action, need to be integrated into the learning process so that students can take action and care for the environment in response to climate change and its impact on sustainability (Perbina et al., 2021; Hartati & Haryono, 2020). The next test is for students to answer eight questions that assess their scientific literacy, with customized indicators based on the PISA 2025 framework. The results will be presented in Table 6, showing the percentage of students' scientific literacy scores.

Table 6. Category Data Scientific Literacy Ability Students

Score Range	Category	Frequency (f)	Percentage (%)	Grade Average
86-100	Very good	3	4.76	65.15556 (Enough)
72-85	Good	15	23.8	
58-71	Enough	32	50.8	
43-57	Not enough	6	9.52	
0-43	Very less	7	11.1	
Total		63	99,98	

The results from Table 6 show that 5% of students have a "Very good" scientific literacy ability, 24% have a "Good" ability, 51% have an "Enough" ability, 9.5% have a "Not enough" ability, and 11% have a "Very less" ability. The average value of students' abilities is 65.2, falling into the category of "sufficient" value. Overall, based on the researcher's findings, the students' scientific literacy abilities are not yet at their maximum and are only categorized as "enough." The scientific literacy abilities were tested using three aspects of competencies: explaining phenomena scientifically, building and evaluating designs for scientific investigation, and interpreting data and evidence critically. Each aspect was broken down into 8 indicators, with one question tested for each indicator.

1. Explain scientific phenomenon.

Questions in Competence 1 is :

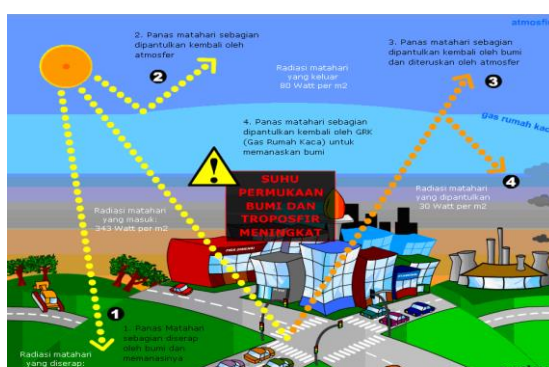


Figure 3 a. Questions in Competence 1

"Based on the picture, what natural phenomena do you think are occurring? Provide an explanation based on the picture regarding the mechanisms of natural phenomena that occur on this earth according to your personal language and views."

Student answer in Competence 1 :

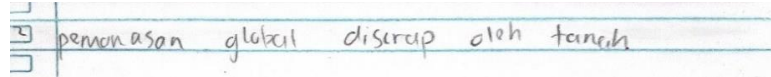


Figure 3 b. Student answer not perfect in Competence 1

Mekanisme Efek Rumah Kaca pada pemanasan global yaitu Bumi menerima energi panas dari radiasi sinar matahari. Sebagian dari panas tersebut akan diserap oleh bumi dan sisanya akan dipantulkan kembali. Namun, dari sebagian panas tersebut akan terperangkap di atmosfer bumi akibat menumpuknya gas rumah kaca. Panas yang diserap oleh bumi akan diserap oleh gas-gas rumah kaca dan dipantulkan kembali ke permukaan bumi. Akibatnya, energi panas tersebut terperangkap di atmosfer bumi sehingga suhu di permukaan bumi semakin meningkat. Gas rumah kaca yang dihasilkan seperti polusi asap pabrik, polusi kendaraan bermotor, pembakaran hutan dan segala aktivitas manusia.

Figure 3 c. Student answer perfect in Competence 1

In terms of competency indicators, this student was asked to provide an explanation related to a natural phenomenon associated with global issues presented in the question. Figure 3.b illustrates that students only explain phenomena based on pictures without providing any analysis or scientific reasoning, as requested in the global warming scheme. On the other hand, in Figure 3.c, students are able to effectively explain the global warming phenomenon in a coherent and detailed manner, based on the picture provided in the question.

The correct answer is: This phenomenon is related to global warming. It occurs when the Earth receives heat energy from the sun. The thermal energy that reaches the Earth creates a warm feeling that can heat up the planet. Some of this heat is absorbed by the Earth, and the rest is reflected back. However, most of this heat gets trapped in the Earth's atmosphere due to the accumulation of greenhouse gases. The heat reflected by the Earth is absorbed by greenhouse gases and then reflected back to the Earth's surface. As a result, this heat energy becomes trapped in the Earth's atmosphere, leading to an increase in the Earth's surface temperature. The greenhouse gases are produced by motor vehicle emissions, factory smoke, forest burning, and other activities that cause high levels of air pollution. To address this issue, we can take the following steps: reduce the use of motor vehicles, minimize waste and recycle materials, and plant trees to absorb carbon dioxide, which contributes to air pollution.

2. Build and evaluate design for investigation scientific and interpreting data to evidence critical scientific

Questions in Competence 2 is :

Tanpa Tanaman		menggunakan tanaman	
Waktu (s)	suhu (°C)	Waktu (s)	suhu (°C)
0	30	0	28
5	30	5	28
10	32	10	27,8
15	33,5	15	27,4
20	34	20	27,4

Figure 4 a. Question in Competence 2

“Based on the results of the student's experimental data table regarding increasing temperature, create a graph showing the relationship between time and temperature! And then, Based on the data results, explain and evaluate the impact of temperature and time from the two experiments, and how they relate to our natural environment!”.

Student answer in Competence 2 :

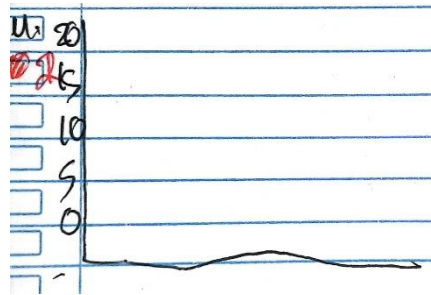


Figure 4 b. Student answer not perfect in Competence 2

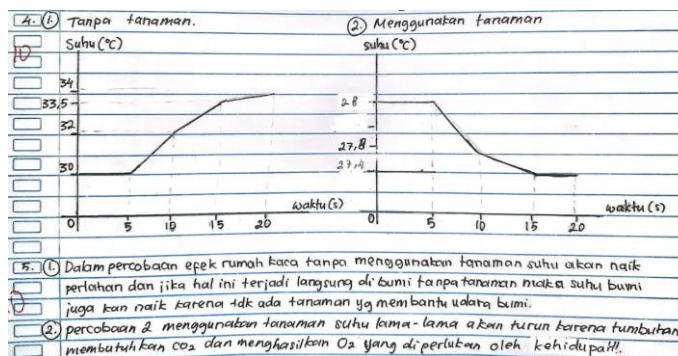


Figure 4 c. Student answer perfect in Competence 2

When assessing competence, this student was asked to analyze and evaluate data critically. In Figure 4.b, it is evident that the student is not yet proficient in creating charts that align with the coordinate lines of the x and y axes, as the number 0 should be parallel with these lines. Additionally, the student did not include information for each part of the graph. Moreover, the student is not yet able to effectively analyze and evaluate scientific data to address existing problems, as it seems that the student only read the data without analyzing it. On the other hand, in Figure 4.c, the student excels at creating graphs related to experimental data. The graphs are comprehensive, with information provided for each variable, and the student is able to explain the two graphs and analyze the associated problems.

The correct answer is: Based on the existing graphs and data, we can conclude that when the experiment is carried out without plants, the longer the time is applied, the higher the temperature obtained will be. In contrast, in experiments using plants, the longer the time applied, the lower the temperature. This is related to the application of plants, which are very useful for reducing high temperature levels due to the impact of global warming. Plants can neutralize the air around them by trapping some of the carbon dioxide-producing air, which will then be converted into oxygen

again. Therefore, experiments using plants will experience a decrease in temperature over time.

3. Research , evaluate and use information scientific for taking decisions and actions.

Questions in Competence 3 is :

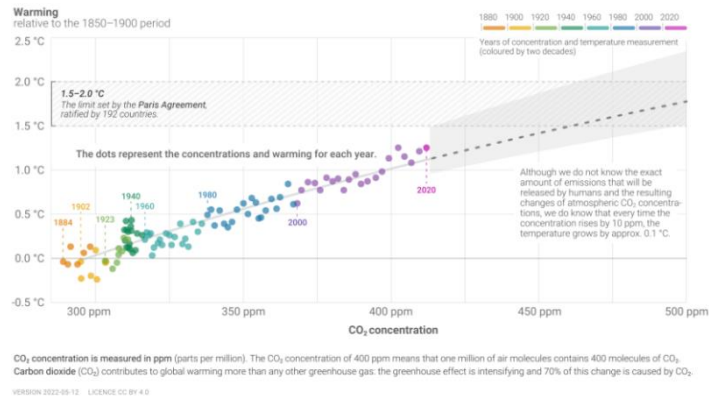


Figure 5 a Questions in Competence 3

“What conclusions can be drawn from the graph above? How is Carbon dioxide concentration linked to global warming? What simple steps can we take to reduce Carbon dioxide levels in future graphs, starting from 2021?”

Student answer in Competence 3 :

*CO₂ semakin monaik .
Data konsenstrasi gas CO₂ yg diukur dan dikumpulkan terus naik.*

Figure 5 b. Student answer not perfect in Competence 3

*Efek rumah kaca yang disebabkan gas rumah kaca seperti gas karbondioksida dari tahun ke tahun terus meningkat .
Berdasarkan data yang berasal dari NASA tahun 1880 - 2020 titik yang diberi kode warna menunjukkan bahwa peningkatan konsentrasi gas CO₂ meningkat pesat tiap tahunnya. Peningkatan konsentrasi CO₂ di atmosfer berbanding lurus dengan terjadinya pemanasan global di bumi hingga kenaikan suhu 1,5 - 2,0 °C pertahun. Solusi sederhana yang dapat kita lakukan seperti mengurangi polusi dari asap pabrik hingga kendaraan , memperbanyak menanam pohon sebagai penyumbang O₂ bagi bumi .*

Figure 5 b. Student answer perfect in Competence 3

On the topic of competence indicators, this student was asked to compare scientific information related to global issues and to evaluate and apply methods to overcome some problems. Figure 5.a indicates that students are not yet fully capable of effectively comparing news sources to observable phenomena. Additionally, when evaluating problems, they only mention them without providing scientific explanations. On the other hand, in Figure 5.b, students are able to analyze scientific

information based on global warming data from around the world. Furthermore, they also offer evaluations and solutions that can be implemented in their daily lives.

The correct answer is: The data shows that carbon dioxide levels on Earth are increasing every year. The graph uses color codes to group the points by year (each group represents 20 years). The points illustrate that the rise in carbon dioxide concentrations has been accelerating in recent years, aligning with the increase in annual carbon dioxide emissions. This suggests that global warming is directly linked to the increase in carbon dioxide concentration in the atmosphere. Specifically, every time carbon dioxide concentrations increase by 10 parts per million (ppm), global temperatures rise by 0.1 °C. However, global warming is influenced by various other factors such as other greenhouse gases, atmospheric and ocean currents that distribute heat across the planet, as well as aerosols and cloud formation (shadow effect). To reduce carbon dioxide concentration levels on Earth, we can take several actions such as planting trees to absorb and store carbon naturally, improving energy efficiency at home, opting for environmentally friendly home equipment like LED lights, and reducing driving by switching to public transportation, cycling, or walking to minimize carbon emissions.

The student has not yet fully demonstrated competence in identifying and analyzing phenomena in a scientifically proven manner. The answers provided only offer a limited interpretation of the visuals without a complete explanation related to the scientific display. When asked to present solutions or potential evaluations for addressing climate change and global warming, the student does not explain or analyze the scientific aspects, only mentioning key points. This observation aligns with [Rohmah's study \(2021\)](#), which emphasizes that the learning process should prioritize critical and analytical thinking, enabling students to provide solutions to the problem at hand. Furthermore, the students still lack the ability to apply physics concepts by formulating questions based on existing scientific knowledge and conducting experiments. They are also unable to effectively present their findings in a scientific format, such as through data charts.

The students lack the ability to analyze data because they are only used to filling in tables based on the educator's instructions. As a result, their skills in interpreting data presented in charts are limited ([Hidayah et al., 2019](#)). The students do not have a clear method for reading data and graphs, and their scientific literacy skills need to be tested and improved by the educator ([Maulida & Sunarti, 2022](#)). This lack of competence in designing and evaluating scientific investigations and interpreting scientific data critically is due to the students rarely being involved in designing and conducting scientific tests at school. To address this issue, interviews with physics teachers were conducted to assess and compare students' test results in scientific literacy, which can be seen in Table 7.

Table 7. Results of the Question and Answer Session with the Physics Teacher During the School Interview.

Question	Answer
What learning models are often used in the classroom?	Still using the conventional model, which includes teacher, discussions, demonstrations, practicals, and sometimes PBL, is appropriate with existing material, but not often.
What kind of learning do students prefer? Is it practicum, learning outside of class, etc?	The student is enthusiastic about practicing, especially outside the classroom. They adapt suitable and related materials from the book.
Do you think physics learning needs to be linked to phenomena that occur in life? Why?	It is very important for students to possess knowledge early on. When the teacher asks questions, students should be able to respond directly and feel enthusiastic about the lessons.
Does physics learning in class apply that begins with problems in everyday life and then links it to existing physics concepts?	Yes, learning physics in class sometimes starts with everyday events. However, it is rarely adjusted with the material in the physics book.
What kind of learning method do you use for this global warming material for students?	Planned to address the issue of global warming and its impact on the environment. Also, actively seeking relevant news to share with students.
What learning media are used for global warming material in class?	No media have been used yet and we are still looking for the most suitable material to experiment with for global warming.
Have you ever given tests to students to determine scientific literacy skills?	For 10 th grade, material is seldom given because the learning theory is limited. Concepts like reading graphs, data, and tables are not taught in grade 10.
Have students ever been given SDGs-based learning?	Learning physics has not yet been applied in accordance with the Sustainable Development Goals (SDGs). However, it is already linked with P5 learning (life sustainability) related events and problems occurring in the surrounding environment. The students are requested to look for solutions to existing problems.
What does teachers do in class to understand students regarding climate change management?	There hasn't been much action related to learning about climate change yet.
Is there any learning media used regarding climate change/global warming?	No media have yet effectively utilized related learning to address climate change and global warming.
Are there any school programs carried out with students related to nature conservation, such as school community service, planting trees, etc.?	Not implemented. We've only implemented the big day moment because it requires long hours and cutting class hours, so it's rarely done. It's usually done on Fridays (clean Friday) when we exercise together, then there is work devotion. Once, a child requested to bring a tree or plant home to plant together at school.

The study results indicate that the level of scientific literacy among students is not yet maximum potential, and this is influenced by the teaching methods employed by their teachers. Observations and interviews with the teachers revealed that they do not adequately teach students how to apply scientific methods or critical thinking, such as data analysis and the interpretation of tables and graphs. As a result, students have a limited theoretical understanding of physics and very few opportunities for hands-on experiments. Scientific literacy goes beyond studying and reading course materials; it requires a deep understanding and practical application of scientific knowledge to solve various problems (Ekaputra & Widarwati, 2023). According to Shihab (2019), scientific literacy should include the practical implementation of scientific concepts. Sutrisna (2021) also emphasizes that the lack of focus on the practical application of science learning by teachers has a significant impact on students' scientific literacy.

Relevant Research

Based on the previous explanation, the goal of the study is to analyze the scientific literacy of high school students in supporting SDGs'13, focusing on the phenomenon of global warming. The following are the results of the analytical study taken from various relevant articles, which are used as the basis for the issues raised in this research. These results can be seen in Table 8.

Table 8. Study Relevant range 2020-2023

Author (Year)	Sample Characteristics	Research result
Hartati & Haryono (2020)	Subject study is class XI at SMAN 4 Probolinggo.	Learning about climate action based on SDGs principles can increase student awareness to conserve the environment and improve student character, as well as encourage active participation in handling climate change.
Mursalin & Setiaji (2021)	Use literature review of source of data studied.	Scientific literacy enables students to enhance their understanding of the environment through contextual learning approaches.
Setiawani et al., (2021)	Research sample is Classes XI MIPA and XI IIS totaled 60 participants educate.	Competence in scientific literacy has an effect on improving students' scientific literacy abilities regarding the topic of global warming.
Kiswanda Vira et al., (2022)	Samples on students class XI.	Learning the principles of physics for sustainable development is effective in increasing students' scientific literacy.
Krisdiana et al., (2023)	Research Sample is student class X at SMAN 1 Sooko.	The application of the Problem Based Learning (PBL) model enhances students' learning outcomes and scientific literacy regarding global warming.

Author (Year)	Sample Characteristics	Research result
Lestari et al., (2022)	Gather information and data from various literature like books, articles, research previously as well as related journals with application literacy science on learning physics in the era of society 5.0	Literacy in science is closely related to learning physics, as it involves finding problems and analyzing sources to solve problems in accordance with the era of society 5.0.
Millenia & Sunarti (2022)	Secondary data collection study use <i>Publish or Perish</i> (PoP) in the form of five year article latest (2016-2020) on Google Scholar and Scopus.	Scientific literacy plays a crucial role in understanding physics and its impact on technological advancements and the progress of science.
Nurhayati et al., (2022)	Sample use control and experimental classes at SMPN 1 Purwoharjo.	Understanding the impact of climate change is crucial for students' scientific literacy and academic performance

Each researcher has a different focus on research but within the same scope. According to the research by Millenia & Sunarti (2022), Lestari et al. (2022), and Kiswanda Vira et al. (2022), scientific literacy skills in physics learning have a significant influence on life technology and the era of science in addressing issues in the era of society 5.0. Additionally, according to Krisdiana et al. (2023) and Nurhayati et al. (2022), learning physics related to climate change and global warming leads to increased scientific literacy abilities in students. However, there are still many students who do not prioritize preserving the environment and mitigating climate change in response to the impact of global warming on Earth for the sake of life's survival.

In line with the research by Mursalin & Setiaji (2021), and Setiawani et al. (2021), education conducted through an active learning approach regarding climate change encourages students to address existing environmental problems, serving as an application of contextual learning to enhance scientific literacy skills. Furthermore, research by Hartati & Haryono (2020) demonstrates that learning about climate action using Sustainable Development Goals (SDGs) principles as an innovative method increases students' social awareness of global issues, leading to improved environmental preservation and enhanced student character and participation in addressing climate change sustainably. Therefore, the concept of learning physics related to the phenomenon of global warming is deemed effective in enhancing scientific literacy skills for sustainable living, especially in addressing Earth's climate change in the coming years.

Conclusion

Based on the results study analysis capability of scientific literacy students at SMAN 1 Surabaya can shows that the average score for class X students is 65.2, indicating that students' scientific literacy is still in the Sufficient category. The lack of maximum scientific literacy among students can be attributed to several factors, including a lack of competence in applying scientific literacy to learning, teachers' unfamiliarity with analyzing phenomena scientifically, and the continued use of conventional learning methods that focus on theory rather than practical experimentation and data analysis. The limitation of the research has not yet been

implemented directly in the school environment. Therefore, further research should focus on the implementation stage, including experiments and school activities related to the topic of global warming, particularly in physics lessons. So it's essential to introduce innovative physics learning methods and instruments, such as incorporating the topic of global warming with the concept of climate action and problem-based learning models. This approach aims to make students more critical and environmentally conscious, enabling them to address global issues and contribute to preserving the environment in the face of climate change. Ultimately, these skills should be applicable to students' daily lives in the long term.

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