Analysis of Students’ Scientific Literacy Skills and The Relationship with Critical Thinking Skills on Global Warming Materials

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Abstract. This study aims to analyze the scientific literacy skills and critical thinking skills profile of high school students and their relation based on the gender on global warming materials. The research used a qualitative descriptive with the subject of research is 100 senior high school students, consisting of 48 male students and 52 female students. Student’s literacy scientific and critical thinking skills are measured by 16 of the descriptions questions about global warming issues which are valid and reliable with online data collection techniques. The results show that: a) male student's scientific literacy skills profile are 4% higher than female students, b) there is no significant difference between the profiles of male and female student's critical thinking skills, c) the lowest percentage indicator of scientific literacy skills of male and female students is interpreting evidence and data scientifically by 75% and 71%, while the highest indicator is explained phenomena scientifically at 83% and 78%, d) the lowest percentage indicators of critical thinking skills of male and female students is evaluated and assess by 36% and 38%, while the highest indicator is to make conclusions by 42% and 45% and e) based on correlation analysis, there is a significant positive relationship between scientific literacy skills and critical thinking skills with perfect criteria ranged from 0.81 - 1.00.

1. Introduction
The 21st century is a knowledge century marked by the rapid development of science and technology. The rapid development of science and technology has an impact on all aspects of life such as the economy, socio-culture, politics, and education. From various aspects of life, education is very important for understanding the process of developing science and technology, especially through physics. Physics is the most basic knowledge of education. Physics is a very important aspect because it is considered capable of developing thinking skills, increase motivation, and directing the interest of students [1]. Physics also provides students with an understanding of the form of facts, concepts, principles, procedures, and theories that are applied in daily life. In the process, Physics is closely related to science, which is the systematic search for information, knowledge collection in the form of facts, process of discovery related to a natural phenomenon [2]. In the discovery process, students are expected to be literate in science and technology and able to think in a more complex, rational, and creative manner [3]. This statement means that students are required to be able to understand, oral communicate, and writing, apply science, and make decisions on a problem based on science [4]. In science, scientific literacy and critical thinking skills are key components that need to be considered so that students can be better prepared to solve the increasing development of science and technology.
Therefore, scientific literacy and critical thinking are the main intellectual assets that students must have in the 21st century.

Scientific literacy is the process of understanding all scientific information and its application in daily life [5]. Scientific literacy is an important aspect to solve various problems of the development of science and technology. Based on research [6], a person with high scientific literacy tends to support all aspects of scientific development and is able to solve various scientific issues. For all components of education, scientific literacy is an interesting discussion topic that really needs to be discussed [7]. Scientific literacy is also a component that needs to be continuously developed because it is very important for the thinking and communicating processes of students. Scientific literacy is one of the benchmarks for the quality of education in several countries including Indonesia through the PISA program (Program for International Student Assessment) [7]. The PISA result test for high school students in Indonesia shows that the scientific literacy skills have a low average score of 396, the average cognitive understanding of C5 and C6 is 0.08%, and the ranking is 75 out of 80 [5]. The science literacy of high school students is classified as very low and also found for junior and senior high school students [1,8]. One of the key factors that make students' scientific literacy skills low is the lack of depth in the thinking process solving a problem [9]. The problems that are present require every student to think critically in all components of life [10]. That way, scientific literacy skills can be relied on by critical thinking skills to solve daily life problems.

Critical thinking is a process of deep thinking and can make a conclusion based on evidence about daily life problems. Research [11] shows that critical thinking is thinking and productive. The critical thinking skills are activity to analyze ideas, differentiate, choose, study, and develop [12]. Critical thinking will increase students to show a very large curiosity in daily life to solve any problem. The fact shows if research about scientific literacy and critical thinking skills is difficult to found [1]. These two aspects of skills are only measured by presenting tests that do not measure the desired skills. Every student has different skills between males and females. Female students tend to have lower skills than male students [13]. This is because female students are more focused on health and environmental problems, while male students are superior in the calculation, measurement, and science problems [14]. Therefore, one alternative that can be used is a test in the form of a description which can affect the two aspects. The test in the form of a description expects students to solve any problems with their own sentences. Global Warming is one of the physics materials that involves scientific literacy and critical thinking skills to find more information and solve any problems.

The problems are present show that the students' development of scientific literacy skills and critical thinking skills is very important. The development of skills purposes to grow and prepare human resources to be able for the future in several life aspects. This problem gives researchers inspiration to describe the scientific literacy skills profile and the relationship with the critical thinking skills of high school students based on gender. The indicators of scientific literacy and critical thinking used in this study are presented in Table 1.

| Table 1. Scientific Literacy and Critical Thinking Indicators [5] |
|---------------------------------------------------------------|
| Scientific Literacy Indicator | Critical Thinking Indicator |
| Explain phenomena scientifically | Be able to answer questions |
| Evaluate and design scientific enquiry | Able to analyze arguments |
| Interpret data and evidence scientifically | Be able to solve problems |
| | Be able to make conclusions |
| | Able to evaluate and assess |

2. Method

To determine the scientific literacy and critical thinking skills profile measured by the average percentage score on each indicator according to the criteria of 86% - 100% very good, 76% - 85% good, 60% - 75% sufficient, 55% - 59% less and ≤ 54% very less [15]. To determine the relationship
between scientific literacy and critical thinking skills measured by the Pearson Product-Moment Correlation test according to the criteria $r < 0.2$ is very weak, $0.2 < r < 0.4$ is weak, $0.4 < r < 0.7$ is sufficient, $0.7 < r < 0.9$ is strong and $0.9 < r \leq 1$ is very strong [16] with the following hypothesis:

- $H_0$: there is no relation between scientific literacy and critical thinking
- $H_1$: there is a relation between scientific literacy and critical thinking

Based on decision making, namely:

- $H_0$ is accepted if the significant p-value $> 0.05$
- $H_0$ is rejected if the significant p-value $< 0.05$

3. Results and Discussion

3.1. Scientific Literacy Skills profile of High School Students by Gender (Male and Female)

Based on the analysis that has been carried out on 100 students consisting of 48 male students and 52 female students, the results of scientific literacy skills for each indicator are presented in Figure 1.

From Figure 1 it can be seen that the percentage of male students' scientific literacy skills from the highest to the lowest is (1) indicator 1 of 83% in the good category, (2) indicator 2 of 80% in the good category, and (3) indicator 3 of 73% in the sufficient category. As for female students, the percentage of scientific literacy skills from the highest to the lowest is (1) indicator 1 of 78% in the good category, (2) indicator 2 of 75% in the sufficient category, and (3) indicator 3 of 71% in the sufficient category. In general, Figure 1 shows that the scientific literacy skills of high school students in each indicator are a sufficient category with an average percentage of 78% for male students and 74% for female students. If viewed from each indicator of scientific literacy, the lowest percentage is shown in indicator 3, which is interpret data and evidence scientifically. The inability of students to solve problems on these indicators is because students are not used to connecting the data and evidence presented on the problem with the answers they write down. So far, what often happens is that students only write answers by following per under opinions, without involving real data and evidence. The highest percentage of scientific literacy skills is shown in indicator 1, which is explain phenomena scientifically.

There are facts related to the low literacy skills of students, it must be used as a benchmark to analyze the factors that cause it. Of the several factors that trigger low scientific literacy skills such as environment, learning experience, the role of teachers, and educational background, students are not accustomed to solving problems related to the scientific process being the most common [17]. So far, students are only given problems that require understanding and application [18]. In addition to the factors already mentioned, scientific literacy is also influenced by the knowledge and skills of students...
in the scientific process. Based on research [19], the knowledge and science process skills are two important components that can determine the level of scientific literacy skills.

3.2. Critical Thinking Skills profile of High School Students by Gender (Male and Female)

Based on the analysis that has been carried out on 100 students consisting of 48 male students and 52 female students, the results of critical thinking skills for each indicator are presented in Figure 2.

![Figure 2](image)

**Figure 2.** Percentage of Critical Thinking Skills based on Gender.

From Figure 2, it can be seen that the percentage of male students' critical thinking from the highest to the lowest is (1) indicator 1 of 42%, (2) indicator 4 of 42%, (3) indicator 2 of 41%, (4) indicator 3 is 37%, and (5) indicator 5 is 36%. As for female students the percentage of critical thinking skills from the highest to the lowest is (1) indicator 4 of 45%, (2) indicator 1 of 43%, (3) indicator 2 of 40%, (4) indicator 3 of 38%, and (5) indicator 5 of 38%. In general, Figure 2 shows that the critical thinking skills of high school students in each indicator is in the very less category with an average percentage of male students of 40% and female students 41%. If viewed from each critical thinking indicator, can make conclusion is the highest percentage score. This means that students can conclude the problems presented based on the thoughts and data available in the problem text. In this case, students have been able to find main ideas, look for causes and effects, use opinions, and connect opinions in solving a problem.

Can evaluate and assess are the lowest percentage score indicator. This means that students are less able to complete the critical thinking process in evaluating and assessing the problem presented. In general, students only arrive at the stage without giving evaluation and value to a problem. The participants who are said to be capable of evaluating and assessing an existing problem if they have several criteria, namely (1) able to define problems, (2) able to choose problem solution criteria, (3) able to formulate alternative solutions, (4) able to decide the action to be taken, (5) able to review the relationship between solutions and problems, and (6) able to and implement solutions from the given solutions [21].
Based on the research results, it can be concluded that the critical thinking skills of high school students are low [22]. This means that students have not been able to use their thinking critically in solving a problem. Several factors can cause a low level of critical thinking skills of students is the lack of training of students in involving critical thinking processes in solving complex problems. Critical thinking skills can be developed by asking and questioning activities related to natural phenomena in daily life [23]. Apart from these factors, most students only memorize concepts and are less able to think more deeply related to what relationships they have learned with their application in new situations [24]. The two factors mentioned make the critical thinking skills students cannot be explored properly [25].

3.3. The Relationship between Scientific Literacy Skills and Critical Thinking Skills

The relationship between scientific literacy skills and critical thinking skills of male and female students as a whole can be measured using the Pearson Product-Moment Correlation Test which is presented in Table 2.

| Table 2. Pearson Product Moment Correlation Test Results |
|---------------------------------------------------------|
| **Variabel** | **N** | **Mean** | **S. Dev.** | **r** |
| Scientific Literacy | 100 | 74.00 | 7.40 | |
| Critical Thinking | 100 | 82.00 | 8.20 | |

Based on the results of the Pearson correlation analysis, it shows that there is a relationship between scientific literacy skills and students' critical thinking skills with a very strong category in the range 0.81 - 1.00. The results of the correlation test also showed a positive pattern of relationships, so it could be interpreted that students' scientific literacy skills would increase along with critical thinking skills [26]. Scientific literacy skills will be supported by critical thinking skills. Students who are scientific or literate will have the ability to think critically about a problem. Critical thinking is needed in scientific literacy because students not only process the knowledge obtained, but students are also required to be able to apply it in everyday life. Therefore, scientific literacy and critical thinking are two important skills that must be mastered by students to handle the increasing development of science and technology [27].

4. Conclusion

From the research, the results show that the students' scientific literacy skills profile is in a sufficient category. Meanwhile, students' critical thinking skills are in a low category. It caused students to still be unable to explore their thought processes. Therefore, it can be recommended that steps develop scientific literacy and critical thinking skills through the test instruments of descriptions by presenting concrete problems in daily life such as on global warming material.

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