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Students' Scientific Literacy in Chemistry Learning through Collaborative Techniques as a Pillar of 21st-Century Skills

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Abstract: This study aims to measure students' scientific literacy and collaboration skills. The method used was survey research on 267 high school students in Jakarta. The instrument in this study was a scientific literacy test of 40 multiple-choice PISA items developed by Moore and Foy (1997) and a non-test instrument in a rubric observation sheet to measure students' collaboration skills. The results show that students' scientific literacy is at a moderate level. Of 27 students, there are 3% of students with very high scientific literacy skills, 7% of students with high scientific literacy skills, 64% of students with moderate scientific literacy skills, 11% of students with low scientific literacy skills, and 15% of students with very low scientific literacy skills. The research concludes that scientific literacy is a skill that students must possess. Scientific literacy and collaboration skills are needed to face the demands of 21st-century learning with the rapid development of technology and knowledge.

Keywords: scientific literacy, collaboration skill

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INTRODUCTION

In 21st-century learning, which combines technology and is now proliferating, students must be equipped with good knowledge and critical and creative thinking. There needs to be attention related to scientific literacy, which includes understanding scientific concepts, skills, and problem-solving (Kurniawati et al., 2021). Students learning outcomes will be better and more meaningful if students have good scientific literacy in science learning (Febryana et al., 2020). Scientific literacy is essential for students because: (1) Science Literacy (IPA) brings personal growth and joy, the benefits of which are shared with everyone; (2) The state faces problems that require scientific information and scientific thinking to make decisions and benefit the people (Situmorang, 2016). Literacy is needed to support a successful understanding of scientific content. Countries whose population has low literacy will be weak in problem-solving skills and lack knowledge.

In 2015, the TIMSS results showed that of the 49 participating countries, Indonesia was ranked 44th with a score of 397 (Agustin et al., 2019). The program for International Student Assessment (PISA) was held in 2018. Based on PISA results, Indonesia is still ranked 74th out of 79 countries with an average score of 396. This ranking shows that students' literacy skills are still deficient (OECD, 2018). Indonesia is ranked 44th with a score of 397, describing the ability to understand science as still low, so various innovations are needed to overcome it.

Collaboration skills are a form of cooperation to achieve the goals desired by a group (Marlina & Jayanti, 2019). Collaboration is one of the 21st-century skills that help students work effectively and systematically, be responsible, appreciate, and help in groups to solve problems and achieve common goals (Raniah, 2018). Individuals with collaboration skills can work in groups, learn and teach, and interact well with others outside of the classroom (Ridwan, 2019). Students who lack cooperation will have difficulty solving problems and achieving common goals.

Collaboration skills are learning to work together, participate in discussions on a topic, contribute, listen, and support others. Collaboration is needed to help the team members who cannot do their work individually. Students should cooperate if there is difficulty understanding the content and if it is difficult to solve the problem (Saenab et al., 2017). Collaboration skills are important to be integrated into the teaching and learning process. Collaboration skills are also critical for students to compete in the globalization era of the 21st century (Muiz et al., 2016).

Duffy and Cunningham (1996) stated that collaboration is the ability to form partnerships to achieve good results. According to Pheeraphan (2013), collaboration is one of the abilities to work with other people, make someone care about team members, and hold someone accountable for their tasks. The collaboration

aims to build capacity and improve individual skills through collaboration between groups (Richards et al., 2016). Students have collaboration skills if they meet three requirements: 1) they work effectively and respect group differences; 2) they have the flexibility and willingness to accept the opinions of others; 3) they work collaboratively and value the contribution of each team member (Trilling & Fadel, 2009). Teachers act as learning managers. They plan collaborative skill development in schools so that they run well and achieve learning goals. Several research results state that learning in this pandemic era has changed concepts, methods, learning designs, and innovations in teaching materials, including books, modules, and e-modules**.** The objectives of this survey are as follows: (1) to analyze the profile of scientific literacy, and (2) to analyze students' collaboration skills in eleventh grade on chemistry learning materials. The analysis results are expected to be the following basis for developing teaching materials in the form of e-modules that are easy to use and can improve students' scientific literacy and collaboration skills.

METHODS

The method used in this research was the descriptive survey method proposed by Sugiyono (2018). It aims to analyze the profile of science in two aspects: scientific attitudes and scientific literacy. The research was conducted in one of the public high schools in Jakarta with a population of 267 eleventh-grade students. The study used a random sampling technique for up to 10% of the total number of students. The sample used for each class is three students from class XI IPA 1 – 9, so there are 27 students. The data collection technique in this study was a test. The instrument used is a scientific culture test in 40 multiple-choice questions from Dinata (2014). Question indicators include scientific literacy and scientific attitudes.

Table 1. Indicators of Scientific Literacy

Indicators	Number of questions
Identify problems	
Recognize scientifically investigated problems	1,2
Search for keywords to obtain information	3,7
Know the features of scientific investigations	4,10
Explain phenomena	
Apply scientific knowledge to situations	6,8
Describe and interpret scientific phenomena	14,18,20
Identify appropriate descriptions, explanations, and predictions	9,11,12
Use scientific evidence	
Interpret scientific evidence and communicate conclusions	13,16, 15
Identify assumptions, evidence, and reasons for conclusions	17,19
Reflect on the social implications and developments of science and technology	5

Indicators of scientific attitude in research are in Table 2.

Table 2. Indicators of Scientific Attitude

Indicators	Answer	
	+	-
Scientific Inquiry Support		
Appreciate differences in scientific views or opinions, be open-minded to conducting investigations	15	16
Support the use of factual and rational information	19	20
Demonstrate understanding, critical and careful in drawing conclusions	5	13
Belief as a science learner		
Confidence to handle difficulties and solve problems	9	10
Belief to demonstrate scientific skills	7	17
Curiosity about science and scientific issues	12	8
Responsibility to natural resources		
Demonstrate a sense of responsibility to care for the environment	1	2
Show concern for the consequences of human activities on the environment	-	6
Show a desire to take part in the preservation of natural resources	11	14
Demonstrate a desire to acquire additional scientific knowledge and expertise using a variety of sources and methods	3	-
Demonstrate a desire to seek sources of information and have an ongoing attachment to science and develop a career related to the field of science	18	4

Data analysis was based on students' answers to the test. The results of all test instruments are in the form of overall percentages on each indicator of scientific literacy and scientific attitudes. The criteria for assessing students' scientific literacy are in Table 3.

Table 3. Criteria for Assessment of Student Science Literacy According to Purwanto (2008)

Categories	Intervals
Very high	86 – 100
High	76 – 85
Moderate	60 – 75
Low	55 – 59
Very low	≤ 54

RESULT AND DISCUSSION

The data analysis of students' scientific literacy profiles in one of the public high schools in Jakarta is presented in Table 4. The percentage score per scientific literacy indicator is presented in Table 5, and the comparison of percentage scores per science attitude indicator is in Table 6. In one of the public high schools in Jakarta, 15% of students have very low scientific literacy, 11% of students have low scientific literacy, 64% of students are in the moderate category, 7% of students have high scientific literacy, and 3% of students have very high scientific literacy. The teacher's role is vital to help students have good scientific literacy. If students have good scientific literacy, students will find it easier to solve problems.

Table 4. Students' Scientific Literacy Profile at a Public High School in Jakarta

Categories of Scientific Literacy	Number of Students	Percentage
Very low	4	15%
Low	3	11%
Moderate	17	64%
High	2	7%
Very high	1	3%
Total	27	100%
Average		63%

The percentage of scores per student scientific literacy indicator is in Table 5. It includes indicators of identifying scientific problems, explaining phenomena scientifically, and using scientific evidence.

Table 5. Percentage of Scores Per Indicator of Students' Science Literacy at a Public High School in Jakarta.

Indicators of Scientific Literacy Skills	Question	Percentage	Category
Identify problems			
Recognize problems scientifically	1,2	29,2%	Very low
Identify keywords to obtain scientific information	3,7	64,5%	Low
Recognize the features of scientific inquiry	4,10	70,7%	Low
Explain phenomena			
Apply scientific knowledge to a given situation	6,8	53,7%	Very low
Describe scientific phenomena and predict their changes	14,18,20	63,7%	Low
Identify the right description, explanation, and prediction	9,11,12	66,9%	Low
Use scientific evidence			
Interpret and communicate conclusions	13,16, 15	61,3%	Moderate
Identify assumptions, evidence, and reasons behind conclusions	17,19	88,6%	Very high
Reflect on the social implications and developments of science and technology	5	26,8%	Very low

The results of each students' science attitude indicator are presented in Table 6. The science attitude indicators include support for scientific inquiry, self-confidence as a science learner, responsibility for resources and the environment.

Table 6. Percentage of Students' Science Attitude Indicator at a Public High School in Jakarta

Indicators	Answer		Percentage	Category
	+	-		
Scientific inquiry support				
Appreciate differences in scientific views or opinions, open-minded to conducting investigations	15	16	63,9%	Moderate
Support the use of factual and rational information	19	20	75,7%	Moderate
Demonstrate understanding and carefully draw conclusions	5	13	45,5%	Very low
Belief as a science learner				
Confidence to deal with difficulties and solve problems	9	10	82,9%	High
Confidence to demonstrate the scientific skills	7	17	95,1%	Very high
Indicate curiosity about science and science issues	12	8	85,3%	High
Show a desire to acquire knowledge	3	-	47,6%	Very low
Show a desire to seek information on science	18	4	42,5%	Very low
Responsibility to natural resources				
Show a sense of personal responsibility	1	2	95,9%	Low
Show concern for the consequences of human activities on the environment	-	6	85,4%	High
Show a desire to maintain natural resources	11	14	92,6%	Very high

Based on the research results, students' abilities to identify indicators of scientific problems are still very low because current learning is still limited to memorization without being followed by understanding. As a result, students' abilities are still included in the low category of science competence (Permanasari, 2010). So learning is needed that emphasizes students to be oriented to real contexts in everyday life so that students become independent learners (Arends, 2012). The ability to identify keywords to obtain information is quite good because students can think critically and do inductive/deductive reasoning. Students can compare existing information and determine the variables that should be used (Adisendjaja & Hilmi, 2007).

The average science inquiry index of students' ability to understand scientific content is quite good. Some students do not pay attention to reference sources and dates in science research features (Rahayuni, 2016). The analysis shows that students' ability to apply science, including the application of science, has not been well socialized because, in everyday life, students ignore observing phenomena, so there is a need for the learning process which requires students to learn in context to apply their scientific knowledge (Rizkita, et al., 2016). The ability to describe or explain scientific phenomena and predict changes is in the moderate category. Students' understanding of science and science content in everyday life is good. Students can describe scientific phenomena and analyze changes (Rahayuni, 2016).

The ability to recognize descriptions, explanations, and predictions is in the average category. Some students only understand concepts by memorization, so students are less able to recognize and predict problems. The teacher's learning process does not invite students to analyze the causes of a problem. The teacher must provide examples of problems that may arise around students so that students can analyze and find solutions to these problems (Nugraheni et al., 2017). The interpretation of scientific evidence and the formulation and communication of conclusions are moderate. Most students have difficulty concluding, which may be due to the lack of practical problems involved and the teacher's lack of presentation of scientific evidence so that students cannot develop their scientific understanding (Adisendjaja & Hilmi, 2007). The ability to identify hypotheses, evidence, and reasons is high. The percentage of students who answered this question was 88.6%, proving that the teacher's learning activities follow the scientific level indicators so that the students' ability to identify hypotheses and evidence is very good.

Problems are difficult to solve, students' reactions tend to choose a negative attitude or strongly disagree. Students are not used to directly defining scientific problems in the field (Arohman et al., 2016). According to Adisendjaja and Hilmi (2007), by conducting field activities, students will learn directly (direct experience), independently observe (train) existing phenomena so that students can gain confidence, face difficulties in solving problems independently. Students' scientific skills are high because students' reactions tend to choose negative or unpleasant attitudes, students are not used to identifying scientific problems (Arohman et al., 2016). According to Adisendjaja and Hilmi (2007), through field trips, students will learn directly (direct experience), observing phenomena themselves (practice) so that students can confidently demonstrate their scientific skills.

CONCLUSION

The results show that eleventh-grade students' scientific literacy profile in one of Jakarta's public high schools was 63% in the moderate category. The indicator of scientific problems is very low. The indicator for searching for keywords to obtain scientific information is moderate. The indicator of applying scientific knowledge is still very low, and the indicator of describing phenomena and identifying descriptions and expansions is in the moderate category. The indicator of interpreting and providing conclusions is in the moderate category. The indicator of identifying opinions and drawing conclusions is in the very high category. The indicator of reflecting on social implications and the development of scientific attitudes are still very low. This research implies that scientific literacy is a skill that every student must possess to face 21st-century learning and the rapid development of science and technology.

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