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Profile and Factors Influencing Students' Scientific Literacy

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ABSTRACT

The study aims to determine students' scientific literacy skills in biological teaching and to describe the factors that influence scientific literacy. The research subjects were high school students of class XI with a sample of 40 students. Students are given a test containing 10 scientific literacy questions in biology material based on indicators developed by Gormally. The results show there are skill categories denoting and analyzing the use of inquiring methods for which scientific knowledge is obtained results of 55.5% and skill categories related to organization, analytical, and interpretation of quantitative and information data of 50%. The average mastery of biological scientific literacy is 52.75% and is in the very low criteria. The factors that influence students' scientific literacy are learning prosses, the enjoyment of science and students' interest in science. The implication of the findings obtained that in order to improve scientific literacy skill, it is necessary to prioritize constructivism learning activities.

Keywords: biological teaching, constructivism paradigm, enjoyment of science, interest in science, science learning, scientific literacy.

INTRODUCTION

Education is defined as a process that helps every human being in developing skills to meet future needs. The skills referred to generally refer to the skills needed by students to prepare for the challenges of the future (Anagün, 2018). The World Economic Forum (2015) formulated the 21st-Century Skills framework which displays 16 student skills needed in primary and secondary education divided into three categories, namely basic literacy, competence, and the character quality of students. One of the skills included in the category of basic literacy is scientific literacy. Scientific literacy is knowledge that takes into account scientific views and procedures that are important in making their own decisions to contribute to public and ethnic issues (Shahzadi & Nasreen, 2020). Students with sufficient scientific literacy skills can apply his knowledge to living conditions (Altun & Kalkan, 2021).

Data regarding students' mastery of scientific literacy of in Indonesia were obtained from the PISA test results. The results of the PISA analysis in Indonesia in 2018 for the reading, math and science categories showed that Indonesia was in position 70 out of 78 countries with a science category (OECD, 2019). The results show that scientific literacy in Indonesia is still low.

The low scientific literacy ability of Indonesian students including in biology classes, needs to be a concern. Biology learning seeks to form students as humans who have scientific literacy capital, namely humans who are open, explore, and contribute to developing knowledge and technology for the common good (Adnan et al., 2021). This still low result became an important reason in identifying the factors that influence students' science literacy. Previous research has not discussed much about the scientific literacy of high school students, especially class XI in learning biology. Based on this, the study aims to determine and describe the factors influence students' scientific literacy skills in biological teaching.

LITERATURE REVIEW

21st Century Education

The 21st century is synonymous with globalization which is marked by no demographic boundaries between one country and another. Students of all levels in this century are facing the explosion of digital technology and information that has an impact on the growth of the millennial generation (Afandi et al., 2019). This 21st century education aims to encourage students to master skills that support them to be more responsive in dealing with the times and mastery of 21st century educational competencies which are defined as a combination of knowledge, skills, attitudes and values competencies that students must possess (Sutrisna, 2021). Wang, Lavonen, and Tirri (2018) also stated that the need for 21st century education does not only mean education on cognitive competence, but also defines values and ways of thinking that develop for student learning and skills. Thus, in supporting the mastery of 21st century educational competencies, effective learning is needed. Smaldino et al., (2011) mentions several principles of effective learning for 21st century education, namely: 1) reviewing prior knowledge, 2) considering individual differences, 3) developing metacognitive skills, 4) combining realistic contexts, and 5) involving learners in the relevant context.

21st century education learners need skills that will help them meet future market needs. The World Economic Forum (2015) formulates the 21st-Century Skills framework which displays 16 student skills needed in primary and secondary education which are divided

into three categories, the first is basic literacy, the second is competence, and the last is the category of student character quality. The basic literacy category represents the way students implement their core skills in daily activities. One of the skills included in the category of basic literacy is scientific literacy. It is known that mastering good scientific literacy skills in the 21st century will significantly increase career opportunities when students graduate from high school (Ainley & Ainley, 2011).

Scientific Literacy

Wahyu et al. (2020) defines scientific literacy is a way to motivate and guide students to play an active role in activities so that the science learning process is more effective. Ismail et al. (2016) define scientific literacy as the knowledge and skills needed to identify problems, gain new insights, explain a natural phenomenon, and draw conclusions in accordance with existing evidence, so that they can be applied in solving problems.

Broadly speaking, scientific literacy is the ability to understand reading, especially about scientific articles well (information literacy). Students who have scientific literacy skills are productive individuals in an educational environment and are able to learn as lifelong learners (Solmaz, 2017). Pratiwi et al. (2019) states that students who are scientifically literate understand scientific facts related to science, technology and society, and can implement their knowledge in solving problems in everyday life. Naganuma (2017) states that in the 21st century, people with mastery of scientific literacy must, appreciate the influence of science and technology, make personal decisions with things related to science, understand important things that involve science, and participate in discussions involving science. OECD (2013) defines students to master scientific literacy if they already have scientific knowledge and are able to apply it, understand all the nature of science, the role of science and technology in the environment and culture, and are willing to be involved in all things related to science.

The result of scientific literacy is known from the result of analysis PISA. PISA assesses the ability of students aged 15 years to apply scientific knowledge and skills (Naganuma, 2017). The PISA evaluation focuses on reading, mathematics, and scientific literacy skills, where the PISA test is an instrument to assess students' abilities in dealing with real life (Supahar & Widodo, 2021). Forbes et al. (2020) also explained that the PISA analysis provides an overview and opportunities to make improvements in educational activities and outcomes comparatively based on data collected from samples of school students from various countries.

Biology Learning

Science education aims to develop scientific literacy, including the development of basic knowledge, competence, and creativity in accordance with scientific knowledge and appropriate problem solving (Jufrida et al., 2019; Sutrisna, 2021). Biology is a part of science related to the life of the universe. Osuafor & Amaefuna (2016) stated that biology leads to a practice that focuses more on the application of knowledge than just acquiring knowledge. Biology learning examines natural sciences including living things and other aspects in a systematic and complex manner (Saputra, 2016). Maruf et al. (2017) supports this statement and state that biology is a science whose validity can be proven by regularly analyzing nature and involving the five senses.

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RESEARCH METHOD

This study uses two approaches in data collection. The data regarding the scientific literacy profile of students uses a quantitative approach derived from the results of tests based on scientific literacy, so that quantitative data is obtained to be analyzed and interpreted the meaning of the data. Meanwhile, to find out the factors that affect scientific literacy using a literature review approach. The type of data collected is secondary data from the results of previous studies that are in accordance with the topic of factors that affect students' scientific literacy skills. The data obtained are then analyzed and concluded, so that answers are obtained that are in accordance with the research objectives.

This study involved students of class XI in one of the high schools in Surakarta. A sample of 40 students was selected using a random sampling technique. The instrument used in this study was a scientific literacy test consisting of 10 biology questions presented in multiple choice questions and adjusted to scientific literacy indicators. The scientific literacy indicators used are based on the indicators mentioned by Gormally et al. (2012) in terms of two categories, namely understanding the methods of inquiry that lead to scientific knowledge with 4 indicators and organize, analyze, and interpret quantitative data and scientific information with 5 indicators.

Data on biological science literacy skills were analyzed using the formula from (Arikunto, 2013):

Scientific literacy skills: $\frac{number\ of\ correct\ scores}{number\ of\ maximum\ scores}\ X\ 100\%$

Biological science literacy skill scores were then interpreted into several categories, according to Table 1.

Table 1. Category of Scientific Literacy

Category	Criteria Score
Very good	86-100
Good	76-85
Quite good	60-75
Low	55-59
Very low	<54

(Purwanto, 2009)

RESULTS

Science Literacy Skills Profile

The calculation results from the given tests, are presented in Table 2.

Table 2. Students' Science Literacy Results for each Indicator

Categories	Indicator	Question Number	Results of Each Sub Indicator (%)	Results of Each Categories (%)
Understanding the method	(1) Identify valid scientific arguments	1	52.5 (very low)	55.5 (low)

research that leads to scientific knowledge	(2) Evaluating source validity	2	62.5 (quite good)	
	(3) Evaluating of scientific information	3	72.5 (quite good)	
	(4) Understand the elements of research design and how they affect scientific findings or conclusions	4	40 (very low)	
		5	50 (very low)	
Organize, analyze and interpret quantitative data and scientific information	(5) Create graphics from data	6	45 (very low)	50 (very low)
	(6) Read and interpret graphic	7	65 (quite good)	
	(7) Use quantitative skills in solving problems	8	42.5 (very low)	
	(8) Understand and interpret basic statistics	9	57.5 (low)	
	(9) Assess conclusions based on quantitative data	10	40 (very low)	
			Average	52.75 (very low)

In general, the scientific literacy ability in the first category is still low. Indicators 1 and 2 need attention because they are included in the very low category, namely each question with 52.5%; 40% and 50%. The second category is still in the low category. Indicators 5, 7 and 9 earning a percentage of 45% respectively; 42.5%; and 40% which are included in the very low category, so they need more attention. Indicators of identifying valid scientific arguments and understanding and interpreting basic statistics fall into the low category. The rest fall into the pretty good category.

Factors Influencing Scientific Literacy

Before studying further about the factors that influence scientific literacy, it can be known in advance about analysis results of students in Indonesia in the last 5 periods of the PISA test in Table 2 below.

Table 3. Science Literacy Data for Indonesian Students in 2006 – 2018

Year	2006	2009	2012	2015	2018
Score	393	385	375	403	396
Rating	50	60	64	62	70
Number of Participating Countries	57	65	65	70	78

(Sutrisna, 2021)

Based on the data in Table 3 that has been released by PISA, it can be seen that the ability of Indonesian students still needs to be improved when compared to other countries. In the last few periods, Indonesia has been in a position below other countries

which shows that the scientific literacy ability of students in Indonesia is still very low when compared to other countries, so it is important to know what factors influence scientific literacy.

DISCUSSION

Science Literacy Skills Profile

The ability of scientific literacy in learning biology in class XI is still very low. The average obtained for this student's science literacy score is 52.75% from a range of 0 to 100. The questions given contain 10 questions related to biology subjects and are based on the indicators by Gormally et al. (2012) which refers to in 2 categories, where the first category contains 4 indicators and the second category contains 5 indicators. The results of scientific literacy skills in this study, both in the first and second categories, were still low. Category of understanding the method research that leads to scientific knowledge with a percentage 55.5% and category of understanting of quantitative data and scientific information with a percentage 50%.

Low scientific literacy results in each category become an important thing to study. If the indicators in each category are examined, it can be seen that the understanding of the methods of investigation and data processing on the scientific information obtained is closely related to inquiry learning activities where students are directed to conduct investigations and find their own knowledge. Based on this, it is important to apply appropriate learning to improve students' scientific literacy. Adnan et al. (2021) states that to improve students' biological literacy skills, the right learning paradigm to use must lead to a constructivist paradigm.

The constructivism paradigm states that students build knowledge by constructing their own knowledge from the information they have just received. The constructivist learning paradigm refers to the active role of students to find solutions in problem solving, creative and critical thinking Bas (2012). Thus, a constructivist learning environment can be used in improving students' scientific literacy, because it is inquiry-based and encourages students to actively participate in building their own knowledge. This constructivist learning environment encourages students to reflect on experiences, learn to analyze real world problems, improve social negotiation, learn how to communicate well, implement and integrate what is in learning (Cetin-Dindar, 2016). In addition, studying science in a constructivist learning environment teaches students to take responsibility for their own learning, motivates and encourages their participation in learning.

Factors Affecting Scientific Literacy

Learning process

Pratiwi et al. (2019) state that low scientific literacy is caused by the absence of support for students during the learning process to explore and develop all reading, math, and science skills. The learning process has a strong positive relationship with the student's scientific literacy (Jannah et al., 2020). A good learning process in improving scientific literacy needs to provide learning that supports students to explore and develop their own abilities optimally by integrating contextual life into the learning process. One of the learning processes that can be applied is by conducting practical activities to support scientific literacy with inquiry activities to encourage students to be more creative and take the initiative in using their abilities through profile experiments. Alneyadi (2019) states that direct practical activities are an important part of scientific literacy with the aim of developing students' scientific thinking skills.

Lack of use of media and learning materials is another factor causing low scientific literacy (Ismail et al., 2016). OECD (2019) also explains that the low results of PISA Indonesia are due to the fact that schools in Indonesia still have many shortcomings in terms of learning related to the availability of teaching materials for students during the learning process. Which is one of the factors causing scientific literacy is the selection of learning resources. In Indonesia, scientific literacy in science learning is still largely limited to textbooks or texts rather than direct learning.

Attitude to Science

The structure of scientific literacy within the framework of the PISA, suggests that scientific competence is influenced by knowledge of science and attitudes towards science (Lu et al., 2022). Attitudes towards science are an important aspect that affects scientific literacy and can also affect the way individuals interact with science in their lives (Lu et al., 2022). Some of the attitudes towards science include.

Enjoyment of Science

Enjoyment of science has a positive effect on scientific literacy (Altun & Kalkan, 2021). Enjoyment of science is a factor that affects scientific literacy, because feeling happy and enjoying learning will make students feel comfortable in participating in science learning. Enjoyment is shown as a focused, positive activity, activates emotions and involves feelings of pleasure in doing an activity (Mercan, 2020). Enjoyment of learning science is defined as positive emotions that people get from activities related to scienceand this emotional response can provide a stimulus to engage further (Harlen, 2010). Further involvement relates to the individual's desire to participate actively in scientific activities, so that it will affect scientific literacy.

Enjoyment of learning science as a positive emotion has an important role in assessing and mediating different structures that are relevant to the learning process, so it can be understood how enjoyment of learning science as a positive emotion can help deepen understanding of students' experiences and learning processes (Mercan, 2020). In the PISA questionnaire, students indicated their self-reported enjoyment of science with statements such as 'I usually have fun when I study science topics' and 'I like reading about science' (Hampden-Thompson & Bennett, 2013). Thus, if students are able to enjoy learning science, they will feel happy to be involved in learning, thus affecting their scientific literacy skills.

Student Interests in Science

Students' interest in science includes attitudes towards science that affect scientific literacy. Students' interest in science at school can be interpreted as a relatively stable and long-lasting personal emotion in the form of an affective reaction to events in science learning. Wan and Lee (2017) in Cheung (2018), explore how factors of different attitudes can relate to each other, and the result is that students who have a higher interest in science knowledge and problems, they have more tendency to participate in science programs which can increase their interest in engagement and enjoyment. Thus, this attitude leads them to improve scientific literacy because they follow science learning based on their interests and with feelings of pleasure. Students who have an interest in science tend to show curiosity in all things related to science, are willing to gain additional scientific knowledge, are interested in scientific problems, and have more interest in science (OECD, 2007).

CONCLUSION

The scientific literacy skills of class XI high school in learning biology are still very low. The average score of students is 52.75%, where in the first namely understanding the method research that leads to scientific knowledge with a percentage 55.5% and second category namely understanting of quantitative data and scientific information with a percentage 50%. The factors that influence students' scientific literacy are the learning process and students' science attitudes, including the enjoyment of learning science and students' interest in science.

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DECLARATION OF CONFLICTING INTERESTS

No potential conflict of interest.

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