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Abstract. This study aims to describe the level of scientific literacy of high school students in East Java. The method used in this research is quantitative descriptive. The variable of this research is the ability of high school students' scientific literacy in physics content. Samples were taken using purposive sampling including students of class XII IPA at MAN 2 Jember, SMAN 1 Lumajang, SMAN 1 Pandaan, SMAN 1 Prambon Nganjuk, MAN 2 Madiun City and SMAN 1 Kediri in the even semester of the 2019/2020 school year. The research results obtained the highest percentage of students achieving scientific literacy per school at 60.93% at SMAN 1 Kediri and the lowest at 57.71% at MAN 2 Jember from a maximum scale of 100%. Overall the average percentage of the results of the ability of scientific literacy (physics) high school students in East Java based on aspects of science content included in the low category, amounting to 43.71%.

Keywords: science literacy, high school students, East Java

1. Introduction

The prerequisite of life skills that students must have in the 21st century and the industrial era 4.0 is implementing integrated education that starts from the family, school and community environment through habituation to literacy culture. The six basic literacies (literacy literacy, numeracy literacy, scientific literacy, digital literacy, financial literacy and cultural and citizenship literacy) agreed by the World Economic Forum are important abilities for students, parents and guardians of students and citizens to be able to improve and develop their skills [1].

As part of the implementation of Permendikbud 2015 No. 23 since 2016 in Indonesia, the National Literacy Movement (NLM) has been launched by the Ministry of Education and Culture in the hope of supporting the environment of families, schools and communities in urban areas to rural areas to actively participate in fostering literacy culture [2]. The application of science and technology to 21st century learning is not only to understand the universe but requires students to have literacy skills. According to the Ministry of Education and Culture in 2017, there are several levels of scientific literacy, namely the lowest scientific literacy (practical or functional) that refers to a person's skills to carry out activities in

daily life as users of products and technology [3]. The lowest level is the basic needs, for example the needs about food, housing and health. The second level is high level literacy which includes literacy of citizenship which refers to the skills and abilities to take an active role in making decisions and using it wisely related to political, social, cultural, economic and state issues that are developing in the community. This is in accordance with the Law on Bookkeeping System Number 3 of 2017 article 4 which states the purpose of the implementation of the bookkeeping system in the country of Indonesia is to foster literacy culture in Indonesia.

The realization of Surabaya into a literacy city is a commitment of the Mayor of Surabaya who focuses on HDI (Human Development Index) throughout East Java Province [4]. This statement was conveyed by the Mayor of Surabaya with the hope that in the next five years it will be able to proceed according to plan. A number of educational figures and members of ICMA (Indonesian Cyber Media Association) conducted a Focus Group Discussion that discussed how to maximize the literacy movement in Indonesia, particularly in East Java Province. The results of the FGD (Focus Group Discussion) activities formed the Literacy Forum with the hope that this network could later be developed throughout Indonesia. The literacy movement of East Java Province and several other Provinces has developed widely, even hundreds of thousands of teachers and students have been born who are fond of writing [5]. The forum calls on campuses, schools, organizations and other communities to be able to disseminate literacy culture, by uniting vision and enthusiasm and maximum energy. Education quality assurance is part of the school literacy movement which should be able to carry out activities optimally so that literacy culture in the internal school increases [6]. Formal education in schools, school libraries, and communities within the school can realize the concept of going global and the spirit of writerpreneur. They can make a breakthrough to boost the culture of community literacy across borders so that they become more confident in building national and international literacy networks.

Schools that have implemented the school literacy movement are in Bojonegoro (Integrated Model High School). This program is a school effort with the aim of making schools lifelong literacy. The purpose of the school literacy movement program is to build ecosystems and foster literacy culture, practice science management activities and preserve the sustainability of literacy culture. The OECD (Organisation for Economic Co-operation and Development) published the results of Indonesia's PISA rating ranking survey in 2018 with details, reading ranked 72 out of 77 countries, mathematics ranking 72 out of 78 countries and science ranking 70 out of 78 countries [7].

Based on the results of the 2019 reading literacy activity index results and the results of the 2018 Indonesia PISA rating survey which is classified as low, it is necessary to have maximum efforts in the field of learning in schools through: (1) the application of an appropriate learning model based on the scientific discovery approach; (2) teachers must be able to make evaluation tools based on scientific literacy; (3) provide an opportunity to be independent in exploring scientific problems in the surrounding environment; (4) train students to think rationally in solving problems.

2. Literature Review

2.1. 21st Century Learning

The development of the world today is marked by advancements in science and technology. Human resources in the 21st century and the industrial era 4.0 began to be replaced with technology, for that skills must be possessed by humans must follow existing developments that refer to the use of science and technology, especially the application of sophisticated technology in the form of applications that provide the need to facilitate human survival.

The skills needed by school graduates in order to excel and compete in the community are increasing their selling power, working ability, and being ready to become good citizens. 21st century learning demands the readiness of students who are able to face global economic competition, so they must have 4 core skills, namely knowledge work, thinking tools, digital lifestyles and learning research [8]. Everyone must have critical thinking skills, digital literacy knowledge and skills, information literacy,

media literacy and master information and communication technology [9]. Some of these opinions implement that 21st century learning, teachers and students in schools, lecturers and students in higher education are required to have the abilities and skills according to the demands of the curriculum.

The delivery of 21st century education must always be adaptive to changing times. SISDIKNAS Law 2003 Number 20 in article 3 states, the purpose of national education is the development of the potential of students to become people of faith and devotion to God Almighty, to have noble, healthy, knowledgeable, capable, creative, independent, and become democratic citizens and responsible [10]. Indonesian National Education must be directed to form people who have the abilities, skills and abilities needed to maintain their identity.

The 21st century national education paradigm consists of: (1) science-oriented education; (2) education is accompanied by the cultivation of noble attitudes; (3) education must meet frontliners (prioritizing) knowledge at every level; (4) instilled a spirit of independence; (5) convergence of knowledge; (6) pay attention to aspects of diversity; (7) education for all; and (8) monitoring and evaluation [11]. In order for education to be achieved it is necessary to change the model of education in the future, namely the student-centered learning process, the teacher is only a facilitator, team-based learning, actively investigating, towards the real world context, typical behaviors empowering the rules of engagement, towards a networked environment, stimulation in all directions, multimedia and cooperative tools.

2.2. Science Literacy in Science Learning

At the end of the 1950s, scientific literacy began to be known in various circles. According to the Ministry of Education and Culture, scientific literacy is the ability to shape human behavior and character to care for and be responsible for themselves, society, and the universe [3]. Meanwhile, DeBoer states that scientific literacy is needed by students in learning, regardless of whether they will become scientists or not [12]. Emphasis on scientific literacy in this opinion means not only understanding or knowledge of scientific concepts and processes, but also being directed so that someone can participate and make decisions in social and cultural life.

Students' literacy abilities are grouped into two, namely less developed literacy and more developed literacy [13]. Meanwhile, according to Holbrook & Rannikmae, independence in science learning is a component of scientific literacy attitudes, scientific thinking skills, curiosity, and critical thinking skills [14]. Graber (in Holbrook & Rannikmae) describes a competency-based model of scientific literacy (Figure 1) which is the result of the intersection between what is known (consisting of scientific competence and epistemological competence), what is assessed (including ethical competence), and what can be done (including learning competence, social, procedural, and communication competence) [14].

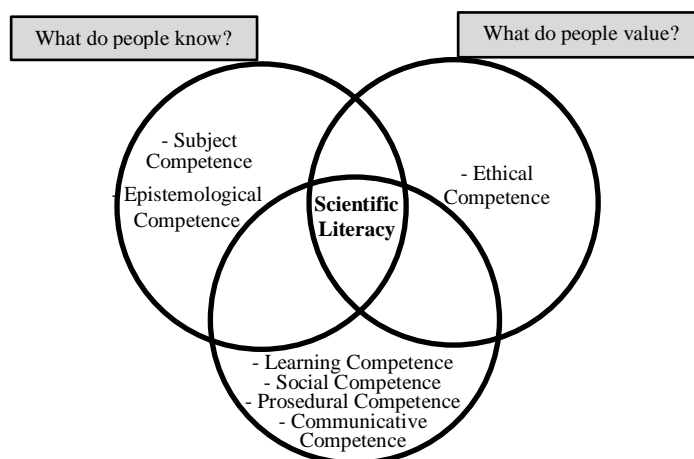


Figure 1. The Graber model for scientific literacy

Natural Sciences began to be known and applied in learning from the 1800s. According to McCormack, the broad science curriculum issues are divided into 4 periods, namely (1) in 1860-1920 called the beginnings period; (2) 1920-1957 was called the utilitarian / textbook period; (3) 1857-1978 was called the first revolution in science education; and (4) 1980 until now is called the second revolution in science education [15]. Students in learning Natural Sciences in 1920-1957 are done by reading about science, with the hope that through this method Natural Sciences can be learned quickly called the utilitarian / textbook year. This method has now begun to be abandoned. The science education revolution was first initiated by Russia with the creation of the first satellite. America reviews science learning programs including content and human resources. Pergerakan IPA education first revolution outlined in Table 1.

Table 1. The shift in science education in the first revolution

From	To
Textbooks are the main source of information	The main source of knowledge is laboratory data
Technology is included in the natural science category	Emphasis on pure science
Presented briefly several topics of natural science	Fewer topics are presented in more depth
Laboratory activities are used to verify concepts in textbooks	Laboratory activities are used to collect data and find concepts
Deductive thinking is used to get the right answer	Inductive thinking is used to get temporary answers that make sense
Memorize and learn from discourse	Investigation and inquiry

Source: McCormack (1992:21) [15]

Science education in the second revolution arises due to several inhibiting factors in the first revolution. One consequence is the emphasis of content on pure science which causes the application of natural sciences in real life to be less noticed. This revolution gave rise to a new taxonomy in science education. Given the issue and shift in science education, the term scientific literacy was already in the first revolution, but its development began in the second revolution by developing a scientific literacy-based curriculum sponsored by the American Association for the Advancement of Science (AAAS).

The science curriculum is only applied to provide facilities for continuing study in tertiary institutions or having a career in science in the past, so that it is less relevant to the social and community fields. The descriptive of scientific literacy is a shift that is only designed for learning science understanding specifically for future scientists and is turned into for the whole society. One reason is that only a few students will be producers or producers of new scientific knowledge, and all students are consumers or users of scientific knowledge and information.

For this reason, some countries choose the content and depth of science in the curriculum by adjusting the needs of students who will help develop scientific literacy and provide a strong understanding to continue a career in the field of science. This problem eventually led to the development of curriculum in the United Kingdom which resulted in the Twenty First Century Science Curriculum Model with an emphasis on scientific literacy. Students who have a career will or experts in the field of science can choose additional science or additional applied science [16]. The enactment of the curriculum is designed to improve the quality of science learning activities leading to scientific literacy. Monkman presents an overview of key components of the science curriculum by developing scientific literacy as a consideration of other countries developing curriculum [17].

The application of scientific literacy in Indonesia has started in the 2006 curriculum and was refined in the 2013 curriculum which is conceptually based on competency. Graduates Competency Standards (GCS) of the Natural Sciences group in the 2003 curriculum have a relationship with how to find out about nature systematically, meaning that Science does not teach mastery of a collection of knowledge

in the form of facts, concepts or principles but is a process of discovery. So, learning is directed through scientific discovery or inquiry activities. SKL in the 2006 curriculum is translated into Core Competencies (KI) in the 2013 curriculum, which is divided into 3 aspects, namely KI-1 and KI-2 (attitude aspects), KI-3 (aspects of knowledge), and KI-4 (aspects of skills). The 2013 curriculum uses a scientific approach consisting of 5 activities (5M), namely observing, asking, exploring, associating, and communicating. Some literatures call the scientific approach the same as the inquiry approach. So, the 2013 curriculum has accommodated the development of science literacy for students.

Referring to the components of scientific literacy delivered by Graber *et al.*, core competencies in the 2013 curriculum have led to the achievement of students' scientific literacy [18]. If the 2013 curriculum is mapped in the scientific literacy model, then KI-1 and KI-2 are what components are assessed, KI-3 includes what components are known, and KI-4 is a component of what is done. This indicates that all core competencies are in the category of scientific literacy models in the 2013 curriculum.

2.3. Science Literacy Evaluation Instruments

Several factors cause the low scientific literacy of students according to Angraini [19] and Sukowati *et al.*, [20] namely the tendency that the learning process does not support students in developing scientific literacy abilities. The assessment process that is commonly done in schools also causes the low position of Indonesia in the PISA study because students are not accustomed to working on questions using discourse. According to students, literacy tests are more difficult than the usual exam questions given by the teacher. Sukowati *et al.*, obtained an average level of student scientific literacy in each school less than 50 (low category) [20].

The PISA publication illustrates that the overall literacy rate of Indonesian students is low. Scientific literacy skills differ if the test is carried out in a smaller scope. Especially considering that the prevailing curriculum in Indonesia was developed referring to the conditions in the education unit, the potential and regional characteristics, the social and cultural conditions of the community and the conditions of students, so that it affects the learning aspect, namely scientific literacy. The development of a scientific literacy measurement tool can be adjusted to the subjects to be seen as scientific literacy, so that the terms physics literacy, biological literacy and chemical literacy emerge. Literacy learning practice is certainly integrated with proper assessment to see the quality of the learning being carried out. Given the large number of resources used with the concept of literacy and the resulting products, authentic assessment can be an alternative in literacy learning [21].

Understanding literacy as expressed by experts, it can be believed that literacy has a direct relationship with learning. The development of students in the world of education that to become a literate is absolute, both in cognitive, affective, and psychomotor mastery. Mastery of the three domains of educational goals is the ideal achievement of someone who follows an educational program to have the ability and apply it to the community environment. The basic concept of literacy in an educational perspective is the mastery of abilities in the form of literacy discourse, education, or educated individuals who can lead a social life.

The introduction of literacy does not only emphasize grades, but also as an effort to foster students' love of text, so that children learn the nature of written language. The introduction of literacy from an early age is very beneficial for children, as a provision for future life. In accordance with the opinion of Heckman (in Musfiroh) that learning about reading is a basic right owned by children because to achieve success in school formally and in non-formal education is required to master literacy [22]. Lots of evidence shows significant implications of achieving literacy, not only for individuals in personal life but also for social life.

Scientific literacy in the world of Indonesian education has not been optimally implemented, even the educational policies implemented tend to perpetuate the tradition of saying. Libraries in several schools have not created a literacy condition for students because the shape, type, and number of books contained therein are still very limited. Media for pouring written ideas by students is also not sufficient for literacy creation efforts in the educational environment.

The practice of literacy learning always integrates with evaluation to see the quality of the learning activities carried out. The number of resources used with the concept of literacy and products, then authentic assessment can be an alternative in learning literacy. Authentic assessment is closely related to many things done or known by students [23]. The purpose of authentic research is to measure the skills and abilities of various contexts that reflect situations and conditions in the real world when those skills are used. Authentic assessment emphasizes performance measurement to do something and is the application of science that students have mastered theoretically.

The success of students studying science literacy can be seen from the value obtained in the implementation of the test which results are used as evaluation material for teachers. This statement is in accordance with Education Assessment Standards through Permendikbud 2016 Number 23 which states, assessment is the process of gathering and managing information to measure the achievement of learning outcomes with the aim of monitoring and assessing the process, monitoring learning progress, remedial or continuous improvement [2]. Each assessment requires instruments to be measured achievement, one of which is a test.

Assessments made by teachers in schools are limited to those determined by the government in the implementation of the curriculum, namely cognitive, affective, and psychomotor assessments. Whereas scientific literacy skills are included in the affective assessment or attitude category. Therefore, scientific literacy skills and tests as measuring instruments are objects, namely students, so we need tests that have good quality. PISA (2012) states, the development of scientific literacy measurement tools involves three aspects, namely the content aspect (science knowledge), the process aspect (science competence), and the context aspect (science application). The content aspect of science refers to the key concepts of science to understand natural phenomena and their changes through human activities. Science process refers to mental processes when answering questions or solving problems. While aspects of the context of science refer to situations of daily life as land for the application of processes and understanding of scientific concepts [24].

Measurement of scientific literacy is needed to determine student understanding of science concepts that have been learned, so we need an instrument of scientific literacy. Although scientific literacy instruments already exist that can be adopted from international research such as PISA, they are generally accepted. Given the diversity of deficiencies in achieving scientific literacy skills, it needs to be developed in a small scope. Table 2 follows the science literacy test grid.

Table 2. The grid of scientific literacy tests for high school students in East Java, the subject of energy

No.	Indicator Derivation Science Literacy	Problem Indicator	Question Number
1.	Recall and apply appropriate scientific knowledge	Students can nominate a water uptake process at a micro hydro power plant	1
		Students can emphasize the function of the water wheel	2
		Students can emphasize the function of a belt or pulley	4
		Students can emphasize the transmission function	5
		Students can mention the tools used to produce electrical energy from motion energy	3
		Students can name a tool that can be used to convert AC voltage into DC	6
		Students can affirm the definition of the photoelectric effect on solar cells	7
2.	Identify, use and produce clear models and representations	Students can identify devices that function to store electrical energy in solar cells	8
3.	Make and justify correct predictions	Students can identify the components of solar power plants	9
		Students can identify renewable natural resources	15
		Students can identify environmentally friendly renewable energy sources that are widely available in Indonesia	16

No.	Indicator Derivation Science Literacy	Problem Indicator	Question Number
4.	Make a correct hypothesis	Students can predict the electricity needs of a household	10
		Students can predict the area of solar panels needed by a household	11
		Students can predict the electrical power needed by a household	12
		Students can predict the level of reliability of a Solar Power Plant	14
		Students can predict renewable energy categories	17
		Students can justify the characteristics of natural resources that can not be renewed	19
		Students can justify several sources of energy can be extracted from various minerals	20
5.	Explain the potential implications of scientific knowledge for the community	Students can consider efforts which can be done to increase the voltage and increase the ability of the current generated by a number of solar cells	13
		Students can consider environmentally friendly biogas energy sources in rural areas	18

3. Research Methods

The research method used is descriptive quantitative without giving treatment and using written tests for data collection. The test question used is a science content test on the physical aspects of scientific phenomena of energy teaching material. The object of research is achievement of scientific literacy in senior high school.

The study was conducted in several senior high schools in East Java province with a population of class XII science students using a purposive sampling method for sampling including selected schools, namely MAN 2 Jember, SMAN 1 Lumajang, SMAN 1 Pandaan, SMAN 1 Prambon Nganjuk, MAN 2 Madiun City and SMAN 1 Kediri in the even semester of the 2019/2020 school year. The stages of data analysis are as follows:

- Calculating the score of each student with the provisions of the correct answer score of 5 and the answer score of 0.
- Calculate the percentage of grades per student by the formula:

$$P = \frac{N}{M} \times 100\% \quad (1)$$

P = percentage of value obtained

N = score obtained

M = maximum score

- Calculate the average percentage of each school using the formula:

$$\text{Average value} = \frac{\text{Score total}}{\text{Total students}} \times 100\% \quad (2)$$

- The percentage results are converted using a scale of 5.

Table 3. Categories of percentage of student achievement in science literacy

Interval	Kategori
86% – 100%	Very high
76% – 85%	High
60% – 75%	Medium
55% – 59%	Low
< 54	Very low

(Sources: Modifikasi Purwanto, 2013) [25]

4. Results and Discussion

Based on the average value of the whole school obtained vary. The average value of the whole item items from the six sample schools was 58.80% on a 100% scale. Each school successively scored 57.71% (low) MAN 2 Jember; 58.68% (low) SMAN 1 Lumajang; 59.29% (low) MAN 2 Kota Madiun; 58.43% (low) SMAN 1 Pandaan; 57.78% (low) SMAN 1 Prambon Nganjuk; and 60.93% (low) of SMAN 1 Kediri. The results obtained indicate the scientific literacy ability of high school students in East Java on the aspect of content is still low as shown in Table 4.

Table 4. Results of senior high school students' scientific literacy skills in East Java

Research Samples	Many Respondents	Percentage of Average Value	Category
MAN 2 Jember	70	57,71%	Low
SMAN 1 Lumajang	68	58,68%	Low
MAN 2 Madiun City	78	59,29%	Low
SMAN 1 Pandaan	67	58,43%	Low
SMAN 1 Prambon Nganjuk	72	57,78%	Low
SMAN 1 Kediri	75	60,93%	Low
Overall Average		58,80%	Low

Student answers indicate that the level of student understanding of basic concepts of science is still low or weak, so students are less able to apply and interpret data, even though the form of the problem is simple. The cause of the low ability of students to express the content of the given discourse and interpret data in the form of images, tables, diagrams and other forms of presentation. In addition, there are limitations in the ability of students to express their thoughts in written form, reasoning ability, accuracy in reading is still low, and students are not accustomed to connecting information in the form of text and then express it in the form of new expressions to answer the test questions given.

Science literacy in learning is new to students so it requires a long process to get students accustomed to be able to titrate. Supporting the availability of adequate teaching materials and school facilities such as laboratories, the availability of a collection of books in the library, adequate internet networks and the skills of teachers managing learners are basic needs to improve the ability of scientific literacy [26].

PISA survey results in 2018 showed that the value of Indonesian students' scientific literacy is in the low category. Factors that influence the low ability of scientific literacy in Indonesia according to Huryah *et al.*, due to the average ability of students to be limited to the ability to remember and recognize scientific knowledge, have not been able to link sharing scientific topics, and are not accustomed to applying complex concepts and abstract [27]. Meanwhile, according to Ekohariadi, factors that influence the low scientific literacy because students have not been able to answer difficult questions, teachers have not made learning tools based on scientific literacy learning as well as student background factors (interests, intensity of learning and attitudes) towards low science [28]. This study identified the factors that influence scientific literacy of 15-year-old students with 5330 junior high school students, 926 MTs students, 2638 senior high school students, 240 MA students, and 1513 students in vocational schools in Surabaya, East Java Province.

Research on the profile analysis of the need to develop cognitive literacy instruments for high school students conducted in Madiun, East Java Province by Novitasari & Handhika, states that the development of existing instruments in general is still focused on targeting junior high school students with a general scientific context, whereas measurement of scientific literacy, especially in the field of physics is still not optimal so it is necessary to further develop cognitive instruments of scientific literacy of high school students especially physics that meet standards and quality [29]. The results of research conducted by Aryani *et al.*, in Batu City, East Java Province also resulted in low scientific literacy skills [30]. The ability of scientific literacy studied is the domain of knowledge and domain of competence that in both domains shows a percentage of less than 50% so that it can be stated that the scientific literacy ability of students is relatively low.

Other supporting research which also concluded the literacy ability of students in East Java in the low category was conducted by Rizkita *et al.*, with a sample of students of SMAN 4 Malang East Java Province class X in the 2015-2016 academic year with 68 student respondents [31]. The results of data analysis showed that the students' initial literacy abilities were relatively low. Based on the results of tests conducted obtained an average low percentage of 52%. This study is a preliminary study of quasi-experimental research to find out the strategies that are thought to affect the ability of students' scientific literacy. Faizah & Shofiyah conducted a study in urban and rural schools in Sidoarjo Regency, East Java Province which concluded that overall scientific literacy of students in urban and rural schools was relatively low [32]. Some contributing factors are: (1) the test material has never been studied so that students have difficulty in answering the questions given; (2) students are not accustomed to working on questions that use discourse, (3) teachers are less accustomed to implementing learning processes that support students in developing scientific literacy.

The ability of scientific literacy is still low according to Sari *et al.*, can be improved by the use of appropriate learning models [33]. This statement is supported by Yuliati which states, the ability of scientific literacy can be improved by applying learning models that prioritize the development of attitudes, ideas and process skills that emphasize the scientific discovery approach so as to increase enthusiasm, interest, motivation and curiosity about science [34]. Applying appropriate and effective learning models can be used to improve scientific literacy. Rakhmawan *et al.*, used inquiry-based scientific literacy learning, using a quasi-experimental method with counterbalanced design to see the effect of increasing students' scientific literacy abilities [35]. The instruments used in this study were multiple choice test observation sheets, questionnaires and interview sheets. The measured aspects of scientific literacy include aspects of science content, context, processes and attitudes. The results obtained that the design of learning that has been designed turned out to be suitable for the development and improvement of students' scientific literacy, in addition to their motivation to learn, understanding and curiosity about science also increases.

Asyhari & Clara's research involving X MIA students in SMA Negeri 1 Baradatu aims to see the effect of learning levels of inquiry (LOI) on increasing scientific literacy [36]. The method used is a quasi-experimental design with the type of matching only pretest-posttest control group design. Sampling uses purposive sampling where the experimental class uses LOI learning and the control class uses conventional learning. The instruments used were tests and observation sheets. The test instrument consisted of 8 items, while the observation sheet was used to determine the feasibility of the student and teacher learning model. The results showed that there was a significant influence on the application of LOI learning to scientific literacy compared to conventional learning. This research is supported by Arief & Utari, which shows the results that the application of science learning with the LOI model has a significant improvement in the three aspects of scientific literacy, namely aspects of content, procedural, and epistemic knowledge [37].

Research Rusilowati *et al.*, was conducted by developing science textbooks based on scientific literacy. This research development was carried out by analyzing the needs, developing the theme of textbook development, testing the validity and readability of the books that had been developed. The subjects in this study were students in grades VII, VIII and IX, using descriptive analysis techniques to test the validity and readability with the t test to see the effectiveness of the use of textbooks. The results showed that the textbooks developed were effective in improving students' scientific literacy abilities [38]. Supported by research Haristy *et al.*, which concluded that learning based on scientific literacy provides an increase in learning outcomes, student activities and scientific literacy abilities [39].

Research Afriana *et al.*, uses integrated project-based learning Science, Technology, Engineering, and Mathematics (STEM) which aims to investigate the effect of gender on science literacy through Project Based Learning (PjBL) learning. The results obtained from this study are that groups of men and women both experience an increase in the ability of scientific literacy [40]. Whereas research by Ismail *et al.*, looked at the effectiveness of using STEM-based virtual laboratories in increasing scientific literacy with gender differences using independent-samples t-test analysis and calculated the size of the

effect size found that there was an increase in science literacy in female and male classes, meaning that the use of STEM-based virtual laboratories can improve students' scientific literacy [41].

Efforts made by Safitri *et al.*, in research aimed at looking at the implementation of students' scientific literacy learning and students' responses to the scientific approach resulted in very good learning with a scientific approach, with N-gain scores of the results of the pretest and posttest increase. Students respond well to the approach used. The results show that a scientific approach can improve scientific literacy skills [42]. Hasanah *et al.*, used a writing to learn approach in her research to improve scientific literacy in Bandung district SMPN in class VIII using a quasi-experimental method (Nonequivalent control group design). Based on the analysis it was found that there was an influence of the use of the writing to learn approach in increasing scientific literacy in optical material with N-Gain of 0.32 which showed the use of the writing to learn approach in science learning was effective in increasing students' scientific literacy [43].

In addition to the effective use of diverse learning approaches and models, in terms of the right evaluation instruments can also be influential for efforts to increase scientific literacy. As research Hasana *et al.*, which aims to produce valid and reliable scientific literacy assessment instruments. This instrument was developed using the ADDIE model which consists of five stages. Subjects treated were 33 students of Class XI MIPA B at SMAN 9 Malang. The results found that the assessment instrument using the ADDIE model can improve students' scientific literacy skills [44].

5. Conclusions and Suggestions

Overall the results of the study indicate the ability of scientific literacy of high school students in East Java is still low. This gives information for science teachers to be able to improve students' ability to apply their knowledge by inviting students to try to make scientific problems through daily activities or events and to provide solutions to these problems by explaining scientifically what has been previously learned. This effort is carried out so that students increasingly understand that events around them can be predicted logically using science knowledge (physics).

Suggestions that can be given to science teachers in high schools are: 1) teachers must always provide motivation about literacy culture during learning; 2) science teachers must give lots of examples of problems based on scientific literacy; and 3) evaluation tools made by science teachers must also be based on scientific literacy.

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