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Validity of Science Literacy on the Respiratory System in Indonesia's Merdeka Curriculum

Putri Apriliyani[1*], Endang Susantini[2], Yuliani[3]
[1,2,3] State University of Surabaya, Surabaya, Indonesia

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ABSTRACT

Objective: This study aims to produce a junior high school-level scientific literacy test on the topic of the human respiratory system in the Merdeka Indonesia curriculum. **Method:** The method used in this study is a modified research and development method. The data collection technique was carried out using the validation method of Aiken calculations. The scientific literacy test instrument was developed using scientific literacy indicators from the adaptation of Gormally et al. (2012) combined with learning objectives. Then it was validated by three validators who are experts in their fields. The validator provides a Likert scale score (1-4) and suggestions as material for consideration for improvement. The validator assesses the instrument based on material substance, construction, and language aspects. The research data were analyzed quantitatively and descriptively. **Results:** The results of the validation were then carried out by Aiken calculations, with very valid results, namely the value of V ≤ 0.80 on the substance aspect of 0.89, the construction aspect of 0.94, and the language aspect of 0.93. The scientific literacy instruments developed are valid and can be used to measure the scientific literacy of junior high school students in the Merdeka Indonesia Curriculum. **Novelty:** This research can provide an overview of scientific literacy instruments per the Merdeka curriculum, which can motivate teachers to train in scientific literacy.

INTRODUCTION

Education in the 21st century encourages students to be reliable and of good quality to face the challenges of globalization (Afandi et al., 2019). In this era, it is expected to have an increased ability and understanding of science and technology, which is crucial progress of a nation (Fahmiati et al., 2017). Education and curriculum are interconnected and curriculum can improve education (Campbell, 2020). Therefore the curriculum should be evaluated dynamically and periodically following the times, especially science and technology (science technology). The curriculum should also be prepared by taking into account the competencies needed by the community and future graduates Mukminin et al. (2019). Merdeka curriculum is a form of evaluation of the previous curriculum (Lestari et al., 2023). Based on Permendikbudristek No. 56 of 2022, the Merdeka curriculum has various intra-curricular learning, where the content is more optimal to deepen concepts and strengthen competence (Kemendikbud, 2022b). Merdeka's curriculum has the concept of independent learning (freedom in thinking) (Indarta et al., 2022). In addition, it seeks to develop skills and competencies according to students' achievements (Kemendikbud, 2022a). Merdeka Curriculum can accommodate students' potential and attitudes to achieve 21st-century skills (Purnomo et al., 2023). Incorporating competencies into the curriculum makes teaching and assessing students' abilities possible (Baderiah, 2018). One of the competencies is scientific literacy.

Literacy is a person's ability to read, understand, write, and solve problems based on scientific knowledge (Hidayati et al., 2023). Scientific literacy is an individual's ability to explain phenomena scientifically, interpret data and evidence scientifically, and evaluate and design scientific investigations (OECD, 2017). In general, scientific literacy is a combination of skills, values, attitudes, understanding, and knowledge of science needed for individuals to develop research, solve problems and make decisions (Ahmet et al., 2015). Students with scientific literacy skills will be ready to take on essential roles in science, technology, and social progress. Scientific literacy is one of the basic life skills (Rusmanyah et al., 2023).

Measuring scientific literacy is essential to determine the extent of students' literacy in learning science in junior high schools (Fuadi, 2020). In this century scientific literacy is an essential aspect of assessment for students to have in determining the quality of education in a country (Afnan et al., 2023). Unfortunately, scientific literacy results are still low with test results at the Program for International Student Assessment (PISA) held by the Organization for Economic Co-operation and Development (OECD), the average score of Indonesian students in science reaches 389 with an average OECD score of 489 which makes Indonesia ranked 74th out of 79 countries (OECD, 2018). In the national context, namely the Minimum Competency Assessment (MCA or *AKM*) measures students' reading literacy and numeracy literacy, with the results for the East Java province area of less than 50% of students achieving the minimum competency limits for reading literacy and numeracy (Kemendikbud, 2022c).

Low reading ability, non-contextual learning, learning environment, climate, and still teacher-centered learning (Fuadi, 2020). The low value of scientific literacy is due to several factors, including learning that focuses too much on mastering theory and memorization and no literacy experience, including literacy instruments (Saraswati et al., 2021). The habit of students filling in the tables presented by the teacher without interpreting graphs or tables and are not used to working on scientific literacy test questions (Fuadi, 2020). Students rarely face science questions in the form of discourse, which requires understanding the meaning of each sentence (Merta et al., 2020). The low scientific literacy of students is because the teacher needs to be more proficient in relating learning material to real examples in the surrounding environment (Showati et al., 2023). Students' low scientific literacy impacts the lack of response, overcoming problems in the surrounding environment (Shofawati et al., 2023). Student assessment is part of planning and implementing school learning (Minarti et al., 2023). To find out, indicators of scientific literacy are needed, one of which was compiled by Gormally et al. (2012) which consists of nine indicators by grouping them into two parts, namely first understanding the method of questions that lead to scientific knowledge, second organizing; analyze; and interpreting quantitative data and scientific information. Then five indicators were selected, including (1) evaluating the use of scientific information; (2) interpreting basic statistics; (3) graphical representation of the data; (4) solving problems using quantitative skills; (5) justifying the conclusions and predictions (Firdaus et al., 2023).

Scientific literacy can be measured through content, namely material on the human respiratory system. This material is included in the context of scientific literacy: the application of science and technology; health and disease; natural resources; environmental quality, hazard; and the boundaries of science and technology (OECD, 2019). The Merdeka curriculum contains the term learning outcomes (LOc), designed to continue reinforcing learning that focuses on competency development (Nurrohamah &

Seli, 2023). LOc is the minimum competency that students must achieve for each subject (Riswakhyuningsih, 2022). At the junior high school level, LOc is in phase D. In this phase. Students are expected to be able to identify organizational life systems and carry out an analysis to find the relationship between organ systems and their functions as well as abnormalities or disorders that arise in specific organ systems (digestive system, circulatory system blood, respiratory and reproductive systems). From this LOc, learning objectives (LO) will be formulated, and later students are expected to be able to understand the material and have scientific literacy skills (Kemendikbud, 2021). The human respiratory system is essential because it includes what is in students and is related to everyday life (Elisa et al., 2019). In the human respiratory system, students generally need to gain more knowledge of processes/mechanisms because they cannot be observed directly by students (Pahlifi et al., 2019).

Scientific literacy can be measured with test instruments based on scientific literacy competencies associated with content, one of which is an essay test. The essay test allows students to arrange answers according to their way of thinking and better see complex learning outcomes (Putri et al., 2022). So the purpose of this study was to analyze the validity of the junior high school scientific literacy instrument developed on the material of the human respiratory system using the five indicators of scientific literacy from Gormally et al. adaptation (2012) combined with LO for use in Indonesia's Merdeka curriculum. The scientific literacy instrument was developed based on the selected scientific literacy indicators and content, requiring an instrument valid for the purpose.

RESEARCH METHOD

The main problem of this research is how appropriate the scientific literacy test developed on respiratory system material can be applied to the Merdeka curriculum. The research is quantitative and descriptive by calculating the validity using Aiken's validity and turning it into a form of assessment to get the validity category (Yudha, 2023). The literacy test instruments developed were then validated and reviewed by three validators: two experts and teachers. The subject of this study was the instrument for the junior high school scientific literacy test on the topic of the respiratory system and its validity based on substance, construction, and language/cultural aspects (Lukman et al., 2023). Before validating experts in their field, development procedures are carried out, which include: (1) Identifying the purpose, (2) Concept analysis, (4) formulation of learning, (5) instrument development, (6) validation, (7) science literacy instrument (Falah et al., 2021) in **Figure 1.**

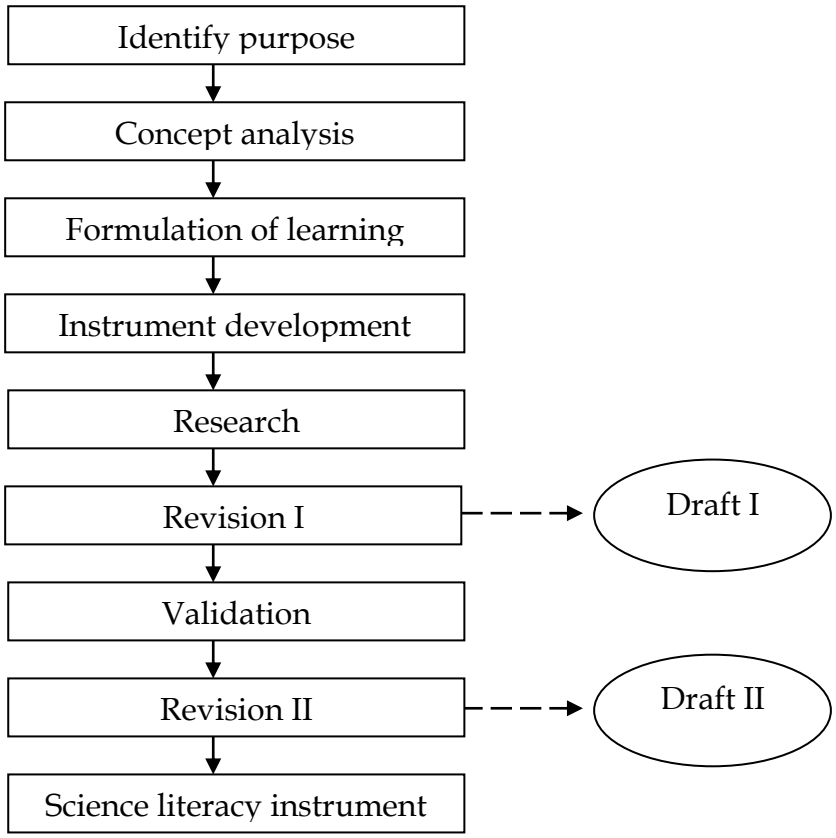


Figure 1. Research design (Adapted by Falah et al., 2021).

The feasibility of the scientific literacy test instrument can be measured from the results of validation by experts using a validation sheet. The validation sheet contains instructions and requests to the validator to provide suggestions for improvement and provide an assessment (Siagian et al., 2023). The validation sheet is equipped with a choice of scores 1-4 (Likert scale) with the numerical score categories as in Table 1.

Table 1. Likert scale score criteria.

Validation Score	Criteria
1	Very poor
2	poor
3	good
4	Very good

(Adapted Sugiyono, 2015)

The data obtained were then analyzed quantitatively, namely with Aikens validity — calculation as in Equation 1.

$$V=\sum S / [n(c-1)] \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Information:

V : Validity

S : The difference between the score given by the validator and the minimum score (S=r=lo)

n : Multiple validators

lo : The lowest rating number (e.g., 1)

c : The highest rating score (e.g., 4)
r : The number given by the appraiser

(Aiken, 1985)

The results of Aiken's V calculations range from 0 to 1. The results of these calculations can be seen on average and then converted into Table 2.

Table 2. Validity criteria of the scientific literacy test.

Validation score interval	Validity criteria
$V \leq 0.8$	High valid
$0.40 \leq V \leq 0.80$	Valid
$V < 0.4$	Not valid

(Bayu et al., 2023)

RESULTS AND DISCUSSION

Results

The developed scientific literacy test instrument consists of 16 essay questions which are based on the indicators of scientific literacy adapted by Gormally et al. (2012) and adapted to the LO of respiratory system material in the Merdeka curriculum. Indicators of scientific literacy and learning objectives are as in Table 3.

Table 3. Indicators of scientific literacy and LO.

LO	No Question
1. Students can relate the structure of organs and their functions to the human respiratory system by evaluating scientific information and interpreting basic statistics.	1-3
2. Students can analyze the working mechanism of human breathing through problem-solving with quantitative skills.	5-7
3. Learners can connect factors that affect the respiratory system through representations and summarizing data.	8-11
4. Students can associate diseases or disorders of the human respiratory system by predicting quantitative data and interpreting basic statistics.	4, 12
5. Students can provide solutions to maintain the health of the human respiratory system by evaluating scientific information and justifying conclusions or predictions from quantitative data.	13-16

The results of validating the scientific literacy test instrument in each aspect for all item numbers have been summarized in Figure 2.

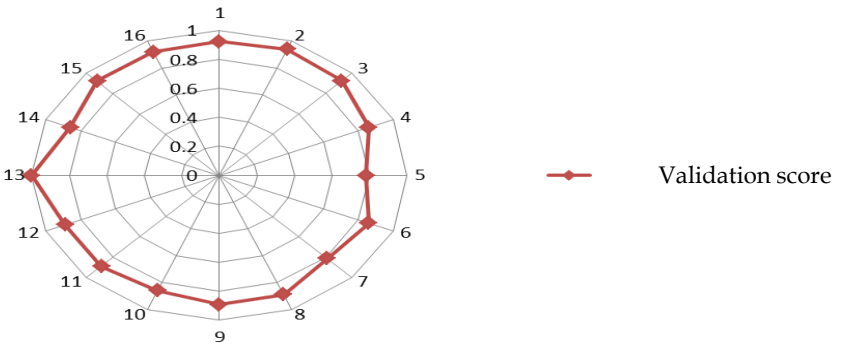


Figure 2. Validation results on the substance aspect.

Figure 2, no. 1-16 shows the items in Table 3—indicators of scientific literacy. The red line shows the validation score obtained for each item in Table 2—the validity criteria for the scientific literacy test. On the substance aspect, it can be seen in Figure 2. where the literacy test instrument is validated based on; (1) the questions match the indicators, (2) the questions match the assessment objectives (scientific literacy indicators), (3) the material matches the curriculum content given to students, (4) the material is conceptually correct. Based on Figure 2. The validity score in the range of 0.8 consists of items 4.60-12.14, then the range of 0.90 consists of items no. 1-3, 15.16. The lowest score is 5, 0.78, and the highest is 13, with a validation score of 1. In number 5, referring to Table 2, it is still declared valid, so almost all questions have a validity value on the substance aspect above 0.80 with very valid results and can be used.

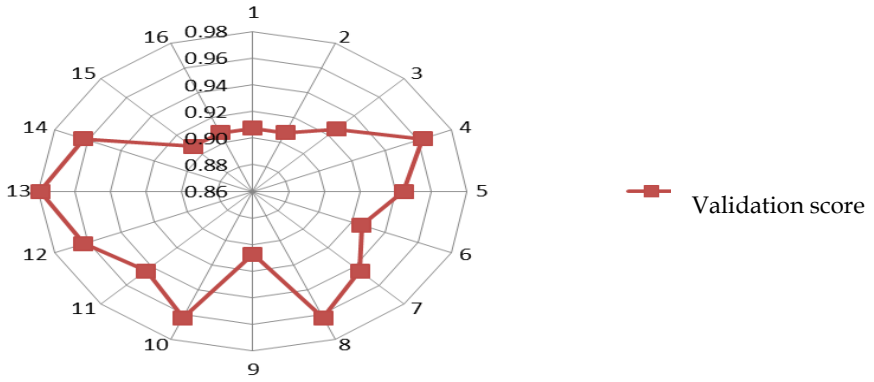


Figure 3. Validation results on construction aspects.

The construction aspect can be seen in Figure 3. where the literacy test instrument is validated based on; (1) the formulation of sentences in the form of interrogative or commanding sentences that demand a description answer, (2) the main questions are formulated briefly and clearly, (3) the statements in the item questions do not provide clues to the answer key, (4) the item questions do not depend on the answer previous questions, (5) the stimulus (description, picture, table, graph, or diagram) works, (6) there is a rubric/guideline for scoring. Based on Figure 3. The lowest validity score is 0.91 at numbers 1, 2, 9, 15, and 16, while the highest score is 0.98 at number 13. Overall, the questions are in the 0.90 range, so referring to Table 2, the construction aspect has valid and usable results.

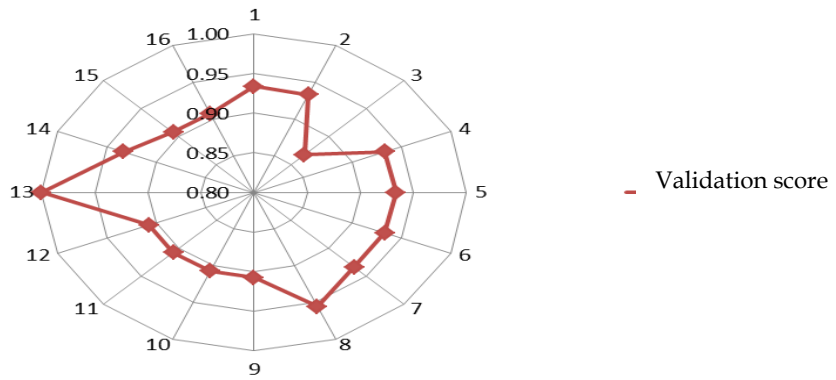


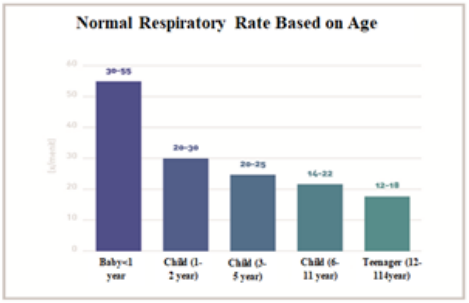
Figure 4. Validation results in the language aspect.

Based on Figure 4. In the language aspect, the literacy question instrument is validated based on; (1) using language following the rules of Indonesian, (2) using

communicative language, (3) not containing elements that harm other people, (4) no typos and (5) the sentence structure is not the same as the textbook. The validation score is 0.90 at numbers 1, 2, 4-12, and 15-16. The lowest validity score is at number 3 of 0.87 and the highest score at number 13 is 1. So referring to Table 2, the construction aspect has very valid results and can be used.

The three validators have validated scientific literacy instruments to determine the validity and are given suggestions for improvement. The results of the review and revision of the developed scientific literacy instruments can be seen in Table 4.

Table 4. Results of recommendation and revisions of scientific literacy instruments.

Recommendation	Revision
Replace the word suspect because using the word "analysis" is not appropriate for written language for students.	*Read the article below!* **Laryngectomy for smoking patients** The most common cause for having a laryngectomy is cancer of the larynx. Every day, about 13,000 patients are diagnosed with laryngeal cancer. However, only about 3,000 patients undergo laryngectomy. Laryngeal cancer is most often experienced by severe sufferers. A total laryngectomy is performed to remove the entire larynx. Lymph nodes around the larynx will also be removed if you have cancer. The doctor will make a permanent hole in the neck to help the patient breathe. **Source:** https://www.docdoc.com/id/info/procedure/laryngectomy **Question:** 1. Will the breathing of a laryngeal cancer patient who has had a laryngectomy be the same as that of a normal person? If **yes/no** *provide your arguments*! 2. Can you guess that the person can still speak well? Change the word analyze according to the recommendation in number 2.
The sentence is changed to "Based on the table above, in the event of a fire, which one should be prioritized for oxygen gas assistance? Explain your reasons."	*Look at the graphic data below to answer questions no. 10 and 11!*  The chart data shows normal respiratory rates by age from infants under one year old to adolescents. **Question:** 10. Based on the graph above, what information can you get? 11. Based on the table above, if there is a fire, which should be prioritized to get oxygen gas assistance? *Include your argument!* Change the sentence according to the recommendation in number 11.

<table>
<tr><th>Recommendation</th><th>Revision</th></tr>
<tr><td>It should be emphasized that what is meant is the activities contained in the table.</td><td>Look at the table below to answer questions no. 8 and 9!
A student finds out the factors that affect his friend's respiratory rate. The data collected as follows.
Table. Respiratory frequency based on activity
<table><tr><th rowspan="2">Body activity</th><th colspan="3">Frequency in minutes</th></tr><tr><th>1st calculation</th><th>2and calculation</th><th>3rd calculation</th></tr><tr><td>Lie down</td><td>18</td><td>18</td><td>18</td></tr><tr><td>Sit down</td><td>19</td><td>18</td><td>18</td></tr><tr><td>Stand</td><td>19</td><td>18</td><td>19</td></tr><tr><td>Go down the stairs 1 time</td><td>22</td><td>22</td><td>23</td></tr><tr><td>Run 10 meters</td><td>26</td><td>24</td><td>24</td></tr></table>Question:
8. Based on the table above which type of body activity produces the greatest frequency? Include your argument!
9. Based on the table above, if the next day the child is fasting, which activities are recommended and avoided at 12 noon? Include your argument!
Change the sentence according to the recommendation in number 9.</td></tr>
</table>

The results of the item validation for each aspect are then calculated by means and can be seen in Table 5.

Table 5. Results of the validation of scientific literacy test instruments.

No	Aspect	Score average	Category
1	Substance	0.89	High validity
2	construction	0.94	High validity
3	Language	0.93	High validity

Discussion

The assessment research and the process of analyzing scientific literacy abilities of junior high school students must be based on indicators of scientific literacy in terms of two aspects, namely understanding inquiry methods that lead to scientific and organizational knowledge, analysis, and interpretation of quantitative and scientific data—information (Mulbar et al., 2021). The test instrument will be valid if it meets the construction, material, and language requirements (Suastika et al., 2023). Based on Table 5, the lowest average score is on the substantive aspect, namely 0.89, then on the construction aspect, with the highest score of 0.94 and language 0.93. Questions on the substance aspect must be able to convey learning objectives, in this case, scientific literacy (Sjöström & Eilks, 2018), so that even though the average score shows a low score, it still has a value of ≤ 0.80 so it is categorized as very valid. The validity number is close to 1 or equal to 1, and the validity value of an item or question is higher (Windianovi, 2019). It can be seen that each aspect has a value of V ≤ 0.80, so it can be categorized as very valid and can be used.

Refers to scientific literacy as an individual's ability to explain phenomena scientifically, interpret data and evidence scientifically, and evaluate and design scientific investigations (OECD, 2017). Pohan (2020) states an increase in student learning outcomes in the essential aspects between numeracy and literacy. For this reason, a valid instrument is needed to see conceptual achievements and scientific literacy. The essay test is diagnostic because it gives accurate results (Qomariyah et al., 2023). The items of scientific literacy generally require good thinking skills and are no

longer in the form of guesswork, so the essay instrument is considered very appropriate. Students' scientific literacy skills can be improved with various efforts, one of which is with an evaluation tool in the form of an assessment instrument that supports teachers in evaluating scientific literacy abilities (Novita et al., 2021). The instrument can also be used as a formative assessment in the Merdeka curriculum (Ardianti et al., 2022). The ability of students' scientific literacy in Indonesia can be increased simultaneously by providing a literacy-related curriculum (Martinah et al., 2021).

Ghazali (2016) states that presenting the validity value of an instrument is essential to make it easier for other researchers to believe in the quality of the data. A good instrument is an instrument that is valid or relevant to the competencies to be developed (Safi'i et al., 2021). A valid instrument can collect (measure) valid data (Mawardi, 2019). In other words, it can measure what should be measured (Bayu et al., 2023). The test instrument is prepared by paying attention to; can measure the desired learning outcomes, reflecting selected content, being designed according to objectives, being valid and reliable, and is generalized to different subjects (Dachliyani et al., 2019). Based on Table 3**.** 16, Scientific literacy test instruments have included indicators of scientific literacy, namely (1) evaluating the use of scientific information; (2) interpreting basic statistics; (3) graphical representation of the data; (4) solving problems using quantitative skills; (5) justifying the conclusions and predictions (Firdaus et al., 2023). The instrument is also adapted to the LO, namely finding the relationship between organ systems and their functions and abnormalities or disturbances that arise in the respiratory system of human organs so that it can be used in the Merdeka curriculum.

There are several examples of suggestions for recommendations for improvement. Cartono et al. (2015) state that in making instruments that fulfill existing aspects, an evaluation can be carried out based on the considerations of a group of professional experts (field of experts). So that revisions are still being made so that the instruments developed are truly feasible to implement, as in Table 4. The results of the review and expert judgment are then used as the primary basis for instrument improvement to producing an authentic assessment instrument. After making improvements, it can be concluded that the entire instrument of science literacy has valid criteria and can use in the independent curriculum.

CONCLUSION

Fundamental Finding: Based on the research that has been done, the instrument of science literacy on the respiratory system has been developed, which is suitable to use to assess scientific literacy for junior high schools in Indonesia's Merdeka Curriculum. The instrument has high validity with a value of V ≤ 0.80 in all three aspects: the material substance of 0.89, construction of 0.94, and language of 0.93. **Implication:** This research aims to provide scientific literacy instruments by the LO of the Merdeka curriculum. **Limitation:** Research is limited to the validity, which can encourage scientific literacy, but has not yet reached the implementation of instruments for students. **Future Research:** There is a need for further research to assess students' scientific literacy abilities with this instrument so that teachers can find solutions to train scientific literacy.

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*Putri Apriliyani, S.Pd. (Corresponding Author)
Postgraduate Programme, Science Education Study Program
Universitas Negeri Surabaya,
Continuing Program Development, Jl. Unesa Lidah Wetan, Surabaya, East Java, Indonesia.
Email: putriapriliyani.21024@mhs.unesa.ac.id

Prof. Dr. Endang Susantini, M.Pd.
Postgraduate Programme, Science Education Study Program
Universitas Negeri Surabaya,
Continuing Program Development, Jl. Unesa Lidah Wetan, Surabaya, East Java, Indonesia.
Email: endangsusantini@unesa.ac.id

Dr. Yuliani, M.Si.
Postgraduate Programme, Science Education Study Program
Universitas Negeri Surabaya,
Continuing Program Development, Jl. Unesa Lidah Wetan, Surabaya, East Java, Indonesia.
Email: yuliani@unesa.ac.id