DEVELOPMENT OF SCIENCE LITERACY ASSESSMENT INSTRUMENTS IN SCIENCE LEARNING USING CONTEXTUAL LEARNING MODELS FOR JUNIOR HIGH SCHOOL

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Abstract. In order to address the lack of reliable scientific literacy assessment tools in many schools, it became necessary to develop new instruments. Unfortunately, most teachers had not previously conducted comprehensive scientific literacy assessments or used assessment tools that followed independent curriculum assessment guidelines. As a result, this study was undertaken to create a valid and reliable scientific literacy assessment tool for junior high school students. The assessment tool utilized five scientific literacy indicators: understanding phenomena, explaining phenomena scientifically, using scientific evidence, solving problems, and identifying scientific problems in the earth and solar system. The 4D research and development method was employed in this study, with the development stages simplified to 3D. Research instruments included validation sheets and scientific literacy tests. The final product is a scientific literacy assessment tool consisting of 16 essay questions. Results from content/expert validity testing by material and language experts were 0.83%, and the empirical validation results of the 16 essay questions as a whole were deemed valid. Additionally, reliability testing yielded a value of 0.960, indicating very high reliability. Testing the hypothesis on the left side showed that at least 61% of students possessed scientific literacy abilities, with the same proportion found to be at the developing and advanced stages. However, 11% of students were still in the beginning stages, indicating that they had not yet met the learning objectives criteria.

Keywords: assessment instruments, contextual learning models, science literacy

INTRODUCTION

Scientific literacy is a person's ability to use their knowledge in the fields of science, technology, and society by thinking logically. The information obtained shows how far people use knowledge and skills to face real-life challenges, not just mastery in the school curriculum, as can be seen from the results of the PISA assessment (OECD, 2012). Scientific literacy refers to a person's ability to identify issues related to science and technology to base decision-making (Affriyenni et al., 2022). Based on this statement, science education has a role and obligation in forming citizens who are scientifically literate.

According to data from the Trends in International Mathematics and Science Study (TIMSS), the scientific literacy scores of Indonesian students in 1999, 2003, 2007, 2011, and 2015 were respectively 492, 510, 471, 426, and 397. Based on the PISA report just released on Tuesday 3 December 2019, Indonesia's reading score is ranked 72nd out of 77 countries, and its science score is ranked 70th out of 78 countries (OECD, 2018). Toharudin in Windyarini (2017) revealed that the understanding of science learning, which leads to the formation of students' scientific literacy, does not seem to be well understood by science teachers. The learning process and evaluation tools used are still conventional and rely on conceptual

Published by Chemistry Education Study Program, Universitas Lambung Mangkurat
pISSN: 2086-7328, eISSN: 2550-0716. Indexed in SINTA (Rank 3), IPI, IOS, Google Scholar, MORAREF, BASE, Research Bib, SIS, TEI, ROAD and Garuda.
Received : 25-08-2023, *Accepted* : 09-02-2024, *Published* : 03-04-2024

mastery, so students are not familiar with scientific literacy skills. From these problems, it turns out that there are still many teaching staff who have not implemented scientific literacy assessments, one of which is a junior high school in Lamongan which stated that the school does not have a standard assessment instrument. This is because teachers have never developed and lack understanding in developing science learning assessment instruments. The instrument used by the teacher cannot be said to be suitable for use because the teacher used an instrument that had never been tested before (valid and reliable). Teachers have never carried out detailed and comprehensive scientific literacy assessments, nor have teachers used assessment instruments that follow the independent curriculum assessment guidelines.

Therefore, it is necessary to develop a product in the form of a scientific literacy assessment that includes a grid, questions, answer keys, and scoring guidelines to measure the scientific literacy abilities of junior high school students and increase students' interest in reading as well as to encourage increased scientific literacy abilities of the students themselves, using five indicators of scientific literacy, namely understanding phenomena, explaining phenomena scientifically, identifying scientific problems, using scientific evidence and solving problems in the earth and solar system, as well as using contextual learning which functions to help teachers link the material they teach with students' real-world situations and encourage students to make connections between the knowledge they have with its application in their daily lives.

Several previous studies that had positive results or were said to be successful were related to this research, namely those related to scientific literacy assessment instruments in science learning using contextual learning. The first was research conducted by Nisa and Samini with the title "Effectiveness of Using the Ethnic Science Integration Module in Problem-Based Learning to Improve Students' Scientific Literacy." This research aims to determine the effectiveness of using training material modules integrated into science in students' scientific literacy learning. The population of this study was class VIII students of SMP 1 Jati Kudus. The second research was conducted by Septa, and Andhika (2020) with the research title Development of Literacy Assessment Instruments in Natural Sciences (IPA) Learning on respiratory system material. The results of the research showed that the assessment instruments carried out were efficient, effective and had a positive impact. This also increases students' interest in reading related to science learning. Thus, based on the research above, the researcher took research with a similar title but has the latest, namely the learning method carried out, using contextual learning methods.

As a result, based on the description above, it is necessary to develop products in the form of assessment assessments and test items to measure students' scientific literacy abilities as faced by educators in junior high schools. The researchers are encouraged to carry out research and develop assessment instruments entitled "Development of Scientific Literacy Assessment Instruments in Science Learning Using Contextual Learning Models in Middle Schools."

METHOD

This research used a 4D development model. In developing, 4D there are 4 stages for designing research designs from developing scientific literacy assessment instruments, namely define, *design*, *develop*, and dissemination (Ai, 2020). The stages in 4D development are described as follows.

Definition Stage (*define*)

The results of the definition stage (*define*) described the discussion of initial and final analysis, student analysis, concept analysis, task analysis, and specifics of learning objectives as follows:

a. Start-finish analysis

The initial analysis began by analyzing the Educational Unit Operational Curriculum (KOSP) implemented in schools and then identified the characteristics of students and the problems that occurred in science learning experienced by teachers.

b. Learner Analysis

Student analysis was carried out to know the characteristics of students and the level of students' abilities. Middle school level students are on average 12-13 years old. At this stage, students begin to speculate about the ideal qualities they want in themselves and others so that there is harmony between the scientific literacy assessment instruments developed and the characteristics possessed by students. Thus, this contextual learning model can be applied to class VII SMP students to carry out learning activities in the classroom and nature.

c. Task analysis

aims to identify learning outcomes (CP) that are studied by the researchers and then analyzed into a set of required competencies. Based on the analysis of scientific literacy that must be achieved by students on the topic of the solar system, a contextual learning model was chosen based on the content aspect, namely how students understand phenomena that occur related to the material provided, the process aspect, namely identifying and explaining phenomena and proven by scientific theory and the context aspect, namely how to solve problems from the questions given.

d. Concept analysis

is an important step to fulfill the principles of building concepts on subjects related to relevant aspects of scientific literacy in the scientific literacy assessment instrument being developed. The assessment instrument developed was used to train students' scientific literacy skills on the material "Earth and the Solar System." Identification of this concept can be seen through CP in the phase D science understanding element, namely "Students can elaborate their understanding of the relative position of the earth-moon-sun in the solar system and understand the structure of the earth's layers to explain natural phenomena that occur in the context of disaster mitigation."

e. Specification of learning objectives

The formulation of learning objectives aims to summarize the results of concept analysis and task analysis to determine the behavior of the research object. Based on the results of concept and task analysis, learning objective specifications were developed from learning outcomes in the science understanding element.

Planning Level (*design*)

At this stage, a design was carried out which was used to form a scientific literacy assessment design. In this stage several steps must be taken, namely:

a. Preparation of a grid regarding the material of the earth and the solar system

The purpose of preparing the grid was to determine the scope and be used as a guide for creating questions and to provide a link between each question item and each learning objective and indicator of scientific literacy;

b. Preparation of question papers/scientific literacy tests

The stage in preparing the questions was to arrange the questions in essay form. Essay questions were a form of question that requires students to answer them in the form of describing, explaining, discussing, comparing, giving reasons, and other similar forms according to the demands of the question using their own words and language. The questions prepared as literacy assessment standards are 16 essay questions, the questions created were adjusted to the learning objectives that had been prepared;

c. Preparation of scoring guidelines (rubric)

The assessment rubric was grouped into 4 criteria, namely: beginning to develop criteria with a score of 1, beginning to develop criteria with a score of 2, developing criteria with a score of 3, and advanced criteria with a score of 4.

Development Stage (*develop*)

In this development stage, there are several stages carried out, including:

a. Validity test

The resulting product was then tested for validity in 2 ways, namely content validity (by experts) and empirical validity. Expert validation was carried out by 3 experts who validated the material, construction, and language. The validation results were processed using the Aiken's V coefficient, where the V value was interpreted in the range between 0.00 to 1.00 as a good or bad content validity coefficient and this value is a measure of whether or not the overall content validity is supported (Aiken, 1985). The interpretation of expert validation is seen through several criteria, where if the validity is $0.80 < V < 1.00$ then the criteria are very high, if the validity results are $0.60 < V < 0.80$ then the criteria are high, if the validity results are $0.40 < V < 0.60$ then the criteria are sufficient, and if $20.20 < V < 0.40$ then the criteria is low and if $0.00 < V < 0.20$ then the criteria is very low.

Meanwhile, empirical validity was carried out using statistical tests based on the magnitude of the correlation coefficient between item scores and the total test score. If the correlation coefficient of the item score with the total score is positive and significant then the item is valid based on the internal validity measure. The correlation coefficient value of the item score is compared with the correlation coefficient value in the r-table. If the correlation coefficient of the item score with the total score is greater than the correlation coefficient from the r-table, then the item correlation coefficient is significant and the item is empirically valid.

b. Reliability test

After conducting a validity test, both content/expert and empirical validity, the next thing to do was carrying out a reliability test, where the reliability test is an index that shows the extent to which a measuring instrument is used twice to measure the same symptom and the measurement results obtained are relatively consistent. The reliability test of the test instrument was determined using Cronbach's Alpha formula via SPSS by comparing r_{ii} and r_{table}. The test instrument is said to be reliable if $r_{count} \geq r_{table}$.

c. Limited trial

After the product was declared valid and reliable, a limited trial was carried out on 45 class VII students at SMP Negeri 1 Sarirejo in the even semester of the 2022-2023 academic year. Sample selection was carried out randomly through simple *sampling* because all variances are homogeneous. The

research design uses a *one-shot case study*, where the results of the group that was given treatment were then observed.

Table 1. Series of limited trial activities

Trial Time	Outline of Learning Activities
Meeting I	1. The teacher gave questions to students.
	2. Students worked on questions given by the teacher.
Meeting II	3. The teacher explained material about various celestial bodies and their functions to students using a contextual approach.
Meeting III	4. The teacher gave questions and *tests* to students.
	5. Students worked on questions given by the teacher.

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The data obtained was in the form of students' scientific literacy abilities which were then analyzed using descriptive statistics by calculating the average percentage of total student answers in each category for each scientific literacy indicator. The percentage results are then interpreted using the Criteria for Completion of Learning Objective using the value interval approach which is presented in Table 2.

Table 2. Interval criteria for achievement of learning objectives

Present	Criteria
0 - 40% (Early Developing)	Not yet achieved, revisions on all parts
41 - 60% (Starting to Develop)	Have not reached completeness, revisions in the necessary areas
61 - 80% (Develop)	It has reached completion, no need for revisions
81 - 100% (Proficient)	Having reached completion, it needs enrichment or more challenges

After getting the students' scientific literacy ability scores, a hypothesis test (t-test) was carried out using a one-sample t-test. The hypothesis in this research is a descriptive hypothesis which was tested using left-hand statistical tests assisted by SPSS. In a one-tail test, it is located on one side only, namely on the left side with an error level of α of 5% (Sugiono, 2016).

RESEARCH RESULTS AND DISCUSSION

Instrument Development

The development of the assessment instrument in this research has five indicators of scientific literacy with 16 items. The five indicators, namely understanding phenomena, explaining phenomena scientifically, identifying scientific problems, using scientific evidence, and solving problems adapted to the learning objectives that have been developed (Durasa et al., 2022).

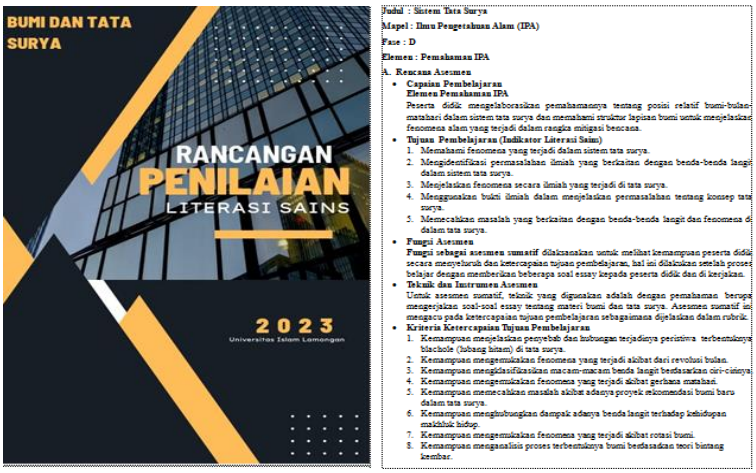

Figure 1. Science Literacy Assessment Instrument Plan

Table 3. Scientific Literacy Indicators and Learning Objectives

No	Aspects of science literacy	Scientific literacy indicators	Sub Indicator of Scientific Literacy (Learning objectives)	Number of Questions	Question Number
1.	Content	Understanding the phenomenon	Understand the phenomena that occur in the solar system	4	1,2,7,11
2.	Process	Identify scientific problems	Identify scientific problems related to celestial bodies in the solar system	3	4,8,16
		Explain phenomena scientifically	Scientifically explain phenomena that occur in the solar system	3	5,13,14
		Using scientific evidence	to explain problems regarding the concept of the solar system	4	3,6,9,10
3.	Context	Solving problems	Solve problems related to celestial bodies and phenomena in the solar system.	2	12,15
Total Question Items				**16**	

Instrument Validity and Reliability

One of the important stages in this research is designing an instrument through measurement which is equipped with validity and reliability tests (McDonald et al., 2019). The validity of the indicators for each question item shows that the extent of the measuring instrument for each question item obtained by trial and error is limited.

a. Instrument Validity

After the instrument has been prepared, it was validated by the validator. This instrument was tested involving 2 science education lecturers and 1 science teacher from the school where the research was conducted to determine the results of the validity and reliability of the instrument.

Table 4. Content/expert validation results of the Scientific Literacy Assessment Instrument

No	Assessment Aspects	Validator	V Value	Criteria
1	Material Aspects	Validator I	0,88	Very high
2	Construction Aspects	Validator II		
3	Language Aspects	Possessor III	0,83	Very high
V Value of Overall Aspect				**0.86 (Very High)**

In Table 4, the average value of the 3 (three) validators in the material aspect and language aspect, obtained a value of 0.83 with very high criteria. Apart from the data above, researchers also analyzed empirical validity tests using correlation values (Wang et al., 2018). The results of the instrument validation data are shown in the bar chart image in Figure 2.

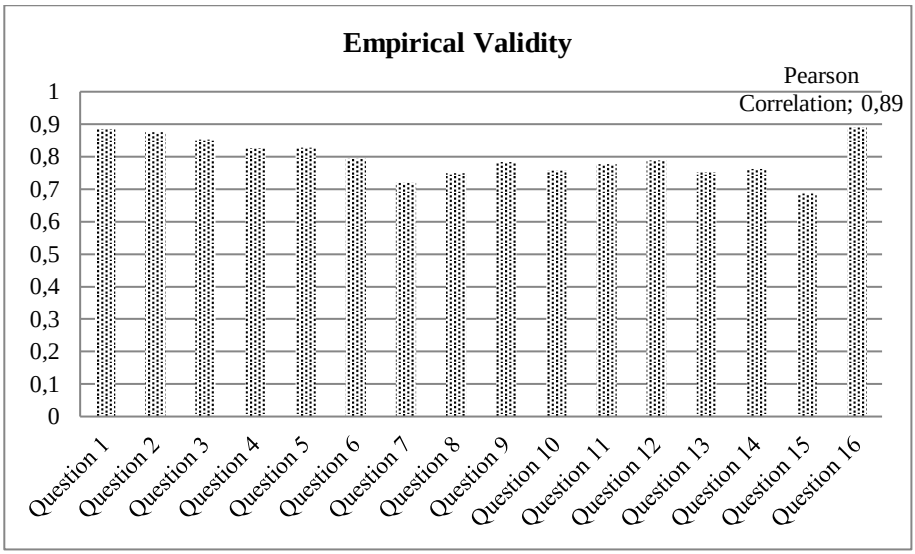

Figure 2. Bar diagram of R-value results count on Empirical Validity

From the bar diagram in Figure 2, the empirical validity of the instrument contains 16 items with five indicators of scientific literacy which are assessed as valid or not (McDonald et al., 2019). The validity of this instrument is useful for assessing or determining whether a product is suitable for development by asking experts or specialists as validators (Hayes & Coutts, 2020). The data obtained from the validity results revealed that the 16 essay items were valid as a whole and described. This data

was obtained and analyzed using the SPSS version 25 program to find out the instrument validity (Connor, 2023).

Reliability of Test Instruments

In developing the scientific literacy assessment instrument, each existing question item was assessed for internal consistency (Correlation, 2023). This is also a measurement carried out to measure the extent to which the items in the scale are measured in terms of each indicator. The following are the results of reliability analysis using the Cronbach alpha coefficient for 16 test items which are based on the scientific literacy assessment instrument development instrument (Zainab et al., 2017).

Table 5. IBM SPSS Statistics 25 Instrument Reliability Output

Reliability Statistics	
Cronbach's Alpha	N of Items
0.96	16

Based on the reliability test analysis, the results obtained were 0.960. The interpretation of the instrument's reliability level can be seen in Table 5. Table 5 shows that the assessment instrument created has a very high level of reliability. A test instrument is declared reliable if the calculated r value is greater than the r table (Ardianti et al., 2022). This means that the instrument prepared is a good quality assessment instrument in terms of its reliability.

From the data obtained by the researcher and in his opinion, assessing instruments for developing scientific literacy specifically for students, especially middle school class VII, it can increase students' interest in reading, (Dewanti, 2022) increasing motivation to learn so that it can improve students' scientific literacy abilities in carrying out this assessment, especially in determining the final results after carrying out research regarding the assessment of instruments used to develop a product that can be used by students and educators, whether it can improve students' abilities as seen based on the Criteria for Completion of Learning Objectives' score, whether it has been exceeded or not exceeded.

Based on the results of validity and reliability tests on the use of assessment instruments, valid and reliable instruments can be obtained (Dewanti et al., 2021). The results of this research are strengthened by previous research which states that the research instruments used are instruments that have valid criteria (McDonald et al., 2019). According to (Wirayasa et al., 2021) an instrument is suitable for use if the instrument meets the requirements, namely validity, reliability, level of difficulty of the questions, and different powers. Based on the analysis that has been carried out, the question items essay can be developed in the use of assessment instruments for students, namely that they have good validity and high reliability so that they can be used in research. (Santoso & Prodjosantoso, 2020). From the data obtained by researchers and according to the opinion of previous research, scientific literacy in junior high school students can increase and can increase the ability to read, interest in learning, and ability to do essay questions in the form of scientific literacy (Arsitawati et al., 2020).

Measurement of Scientific Literacy Based on Criteria for Completion of Learning Objectives

In developing the scientific literacy assessment instrument, each question item was also measured based on the Criteria for Completion of Learning Objectives. This

aims to find out whether the student has exceeded the Criteria for Completion of Learning Objectives, and is carried out using the left-hand *one-sample t-test* with a total sample of 45 students. From the test results, the left side states that Ho is accepted and Ha is rejected, which indicates that the scientific literacy assessment exceeds the Criteria for Completion of Learning Objectives.

Table 6. Left Party Test Results for Students' Scientific Literacy Skills

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Post Test Score	45	77.91	12.382	1.846

One-Sample Test

	Test Value = 61					
	T	Df	Say. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Post Test Score	9.162	44	0.000	16.911	13.19	20.63

Apart from that, there are several stages in determining whether students have reached the Criteria for Completion of Learning Objectives or not, namely through analysis of the assessment rubric which has been prepared using several criteria, namely: initial developing stage, beginning to develop stage, developing stage and advanced stage.

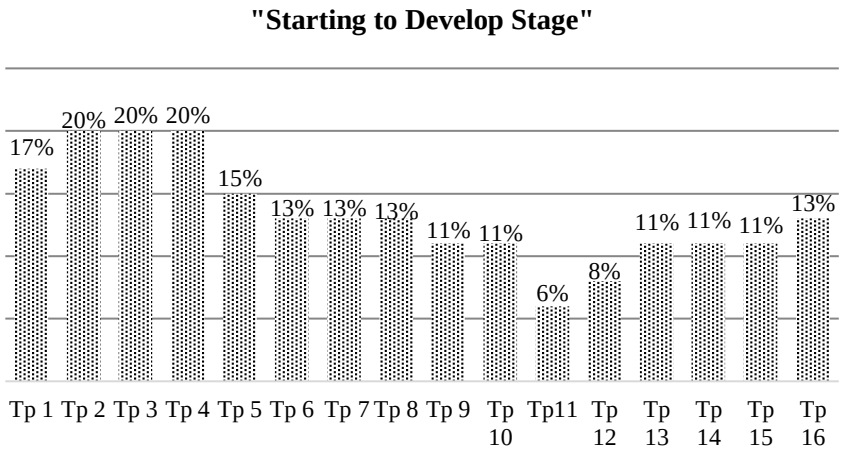

Figure 3. Percentage of students who reach the "Starting to Develop" criteria for each scientific literacy question item

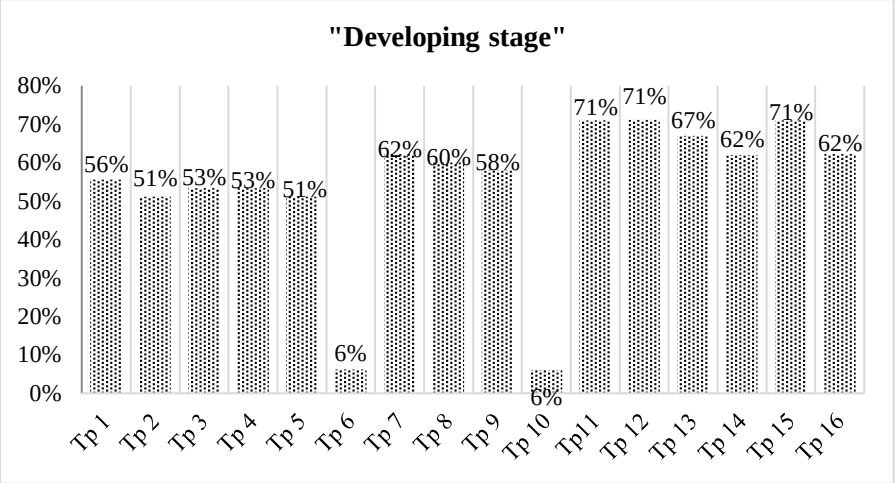

Figure 4. Percentage of students who reach the "Developing" criteria for each scientific literacy question item

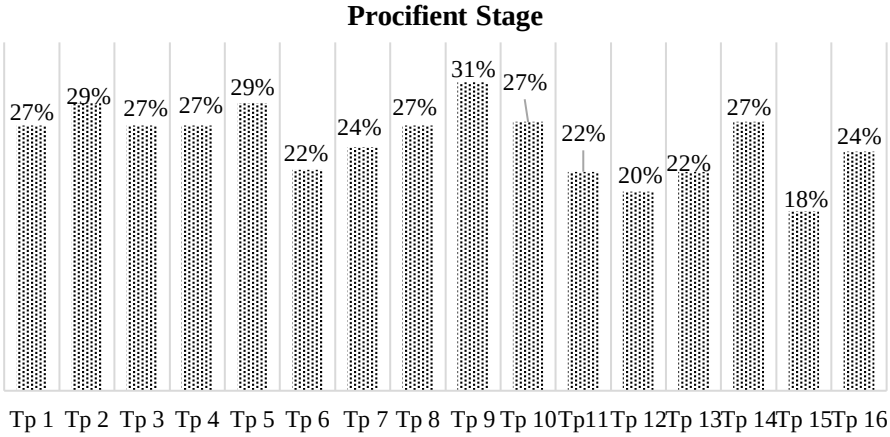

Figure 5. Percentage of students who reached the "Proficient" criteria for each scientific literacy question item

From the data above, it can be concluded that overall, of the scientific literacy scores obtained by students, the highest percentage of scores obtained by students was 33% and the lowest percentage of scores obtained by students was 11%. A total of 15 students obtained a percentage score of 81 - 100% with the criteria of having achieved completeness which is included in the advanced stage, requiring enrichment or more challenges. A total of 25 students obtained a percentage score of 61 – 80% with the criteria of having achieved completeness which is included in the developing stage, no need for remedial. A total of 5 students obtained a percentage score of 41 – 60% with the criteria of not having reached completeness, remedial in the required parts which are in the beginning to develop stage, remedial needs to be carried out. It can be concluded that 89% of students have achieved the Criteria for Complete Learning Objectives and 11% of students have not achieved the Criteria for Complete Learning Objectives (Hasanah, 2023).

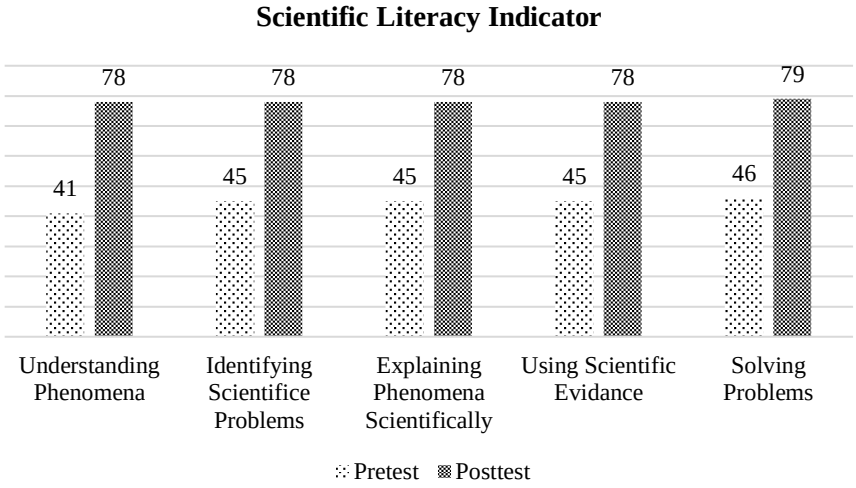

Figure 6. Scientific literacy scores from pretest and posttest for each indicator

Based on the bar diagram image in Figure 6, the results obtained were an increase in scientific literacy indicators during the pretest and posttest, the highest score was in the content aspect of the indicator of understanding phenomena. This is because this indicator has increased starting from the pretest, where initially the average student score was 41, rising in the posttest to 78. Thus, this shows that students who initially experienced difficulties when working on the questions were then given treatment in learning. Contextual learningis easily accepted by students and they no longer experience problems in working on questions in measuring scientific literacy (Hidayat & Widjajanti, 2018). This means that contextual learning can improve students' scientific literacy abilities (Fatmala et al., 2017).

In the implementation of the independent curriculum, after conducting an assessment and obtaining student score criteria, there is a follow-up plan for students who have not met the Learning Objectives (TP), follow-up at the end of the learning and enrichment topics. Follow-up is given to students who get a percentage score of 0 – 60%. Enrichment is given to students who get a percentage score of 81 – 100%.

In the scientific literacy assessment design that has been prepared by researchers, follow-up activities include inviting students to review material on the earth and solar system if students are still at the stage of developing, and follow-up activities include inviting students to view or watch videos on YouTube and observing videos about solar system material if students are already at the developing stage, while follow-up/enrichment consists of asking students to provide more answers about the earth and solar system material if students are already at the advanced stage. In this study, researchers did not carry out follow-up learning due to limited research time.

The overall hypothesis testing that has been described, shows that the development of scientific literacy assessment instruments is proven to be able to train students' scientific literacy skills. The contextual learning model has the advantage of being able to design learning that is student-oriented to create active learning. A group work system that can train students' cohesiveness. The assessment instrument developed is equipped with a cover consisting of an assessment design, grid, question items, answer key scoring guidelines, and assessment instruments that make it easier

for teachers to carry out learning and provide assessments to students after the learning has been carried out. This shows that the assessment instrument developed can train students' scientific literacy skills as demonstrated by the value of each question item on the Criteria for Completion of Learning Objectives.

The application of the contextual teaching and learning model itself is a holistic learning process, aimed at helping students understand teaching material and relate it to the context of students' daily lives (personal, social, and cultural context) so that they are knowledgeable and have skills (Artawan et al., 2023). The application of the contextual model supports the implementation of the Independent Curriculum currently being implemented. Learning in the Independent Curriculum is designed to take into account the development and level of achievement of students so that it is right on target with students' learning needs which leads to meaningful and enjoyable learning (Fahlevi, 2022). This makes a learning model characterized by student-centeredness the right choice as a form of implementing the Independent Curriculum. One learning model that is student-oriented is the contextual learning model. Learning using a contextual model has also implemented differentiated learning principles as a form of implementation of the Independent Curriculum (Angyanur et al., 2022). In implementing differentiated learning, learning activities respect students' uniqueness, diversity, and creativity, the learning process is varied, and fun, and it motivates students to learn according to their intellectual development (Implementation & Merdeka, 2023).

The benefit of this research is that it provides innovation related to how to improve students' scientific literacy skills and learning methods for teachers to teach science learning in a fun way. Able to create students who are more independent, and creative in solving problems and able to increase students' interest and attention to science subjects, especially to improve students' scientific literacy skills (Amri et al. 2013). So that they can provide input to improve the quality of education at the school. As a means to develop various effective strategies to develop a better education system.

CONCLUSION

Based on the results of the research that has been carried out, it is concluded that the preparation and development of the instrument for assessing scientific literacy questions as a whole are declared valid and reliable, and contextual learning can improve scientific literacy skills both in the aspects of context, content, and process. Based on the results of statistical tests, contextual learning can significantly increase students' scientific literacy on earth and solar system material. This increase is supported by the activities of good students and teachers.

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