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DEVELOPMENT OF SCIENCE LITERACY TEST INSTRUMENT ON TEMPERATURE, HEAT AND EXPANSION MATERIALS AT SMP NEGERI 8 MEDAN

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ABSTRACT

This study aims to determine the feasibility of a science literacy test instrument based on content validity, item validity, reliability, level of difficulty, discrimination power, and effectiveness of distractor options, as well as teacher responses to the developed test instrument. The research and development of this test instrument used the ADDIE model which consists of 5 stages, namely analyze, design, develop, implement, and evaluate. The study was conducted at SMP Negeri 8 Medan through 2 stages of product trials, namely small group trials with 10 test participants from grades VIII-9, and large group trials with 30 test participants from grades VIII-8. The results of content validity based on the assessment of 5 validators, 25 questions were declared valid and suitable for use. Based on the small group trial, 20 questions (80%) were declared suitable for use and 5 questions (20%) were not suitable for use. In the large group trial, the results of the item validity of 20 questions (100%) were declared valid. The reliability value of the instrument was 0.735 with a high reliability interpretation. Based on the level of difficulty, 20 questions (100%) were obtained with moderate criteria, based on the discrimination power, 6 questions (30%) were obtained with good criteria and 14 questions (70%) with sufficient criteria, based on the effectiveness of distractor options, 20 questions (100%) were obtained with very effective criteria. The teacher's response to the developed test instrument obtained an average value of 89.90% with very good criteria. Based on the results of the data analysis, 20 questions on the developed science literacy test instrument were feasible to use and could measure students' science literacy levels.

Keywords: Literacy, Science, Instrument, Development

INTRODUCTION

Science literacy is very important from elementary to tertiary education, especially in developing countries (Suwono et al., 2022). Indonesia as a developing country needs to foster the science literacy of its citizens to strengthen scientific knowledge and thinking skills that are relevant to facing life's problems. Evaluation plays an important role as a tool to measure the achievement of learning objectives (Martinah et al., 2022). The development of test instruments that focus on science literacy aims to enable students to master the skills of answering questions and applying their knowledge in the context of everyday life. Atta et al. (2019) in their research explained that the science literacy test instrument developed can improve students' science literacy skills during the learning process in the classroom. Of course, this is in accordance with the statement of Zetterqvist & Bach (2023) which explains that the science literacy test instrument will emphasize students to be able to identify whether the conclusions obtained can be justified by the data or evidence found, so that it will support the hypothesis previously put forward.

In order to strengthen the importance of literacy, the Indonesian government through the Ministry of Education and Culture has issued an education policy as stated in Permendikbud Number 23 of 2015 concerning the Development of Character. The aim is to encourage reading habits among students (Wardhana & Hidayah, 2021). One of the steps taken is the implementation of the Minimum Competency Assessment (AKM) to evaluate students' thinking skills, especially in reading literacy and numeracy. These steps were taken considering that current education aims to make students have in-depth knowledge and understanding, while encouraging a spirit of lifelong learning. With the AKM, students have the opportunity to improve their literacy and numeracy skills, encourage them to develop critical thinking skills, and enable them to solve various problems in various contexts (Wijaya & Dewayani, 2021). This literacy and numeracy then become dimensions assessed in PISA, known as reading literacy, mathematics literacy, and science literacy. The main step that needs to be prepared is the development of literacy and numeracy based on the best practices contained in the PISA test (Kartono & Ghasya, 2022). Teachers must guide students in improving their text analysis skills and understanding the concept of reversal of writing, while also practicing analytical skills using numbers. By emphasizing literacy and numeracy, we can teach students to think positively and prepare them to use numbers in facing various challenges in everyday life.

Until now, test instruments have not focused enough on science literacy skills such as the application of science in everyday life, critical thinking skills to deal with problems, and scientific process skills. According to Chasanah et al. (2022), the learning process and test instruments used still focus on mastering concepts, so that students are not accustomed to developing science literacy skills. Added by Coppi et al. (2023) in their research, stating that many science literacy test instruments in various countries are still not appropriate and there is no presentation and identification of the validation process of the instruments developed in whole or in part. However, there are also some researchers who have developed scientific literacy instruments, such as Hardinata, A. and Permanasari, A. (2017) who produced a scientific literacy measurement tool on the theme of global warming. There are even those who have developed question books such as Hardinata, A. et al (2024) who produced a collection of scientific literacy questions that are suitable for use. For this reason, efforts are still

needed to develop science literacy test instruments at various levels of education and various learning topics (Maulida & Sunarti, 2022). This aims to train and accustom students to working on questions related to science literacy. Through this approach, it is hoped that there will be an increase in students' science literacy skills. Science literacy is very relevant to understanding natural phenomena that occur in everyday life (Rosidah & Titin, 2017). One of the science topics that is often encountered regarding phenomena and applications in everyday life is temperature, heat, and expansion. This material is studied in phase D of junior high school in according to the Independence Curriculum. The concepts in the material of temperature, heat, and expansion are closely related to various aspects of students' lives, both in the home environment and their surroundings (Mulder & Siswanto, 2023). Therefore, it is important to encourage students' reasoning and ability to think creatively during the teaching and learning process.

Based on interviews with science teachers at SMP Negeri 8 Medan, the test instruments commonly used in schools focus more on questions than on science literacy. Many of the questions that are compiled are still not adjusted to the indicators in the PISA framework, this is because science teachers at SMP Negeri 8 Medan have never received training to compile science literacy questions according to the indicators in the PISA framework. Although science teachers at SMP Negeri 8 Medan already know what science literacy is, compiling evaluation questions that are adjusted to the indicators in the PISA framework is still a difficult part. Given the limitations of teachers who still use questions from textbooks and questions sourced from Google as material for compiling evaluation questions. Therefore, it is necessary to develop a science literacy test instrument at the school, so that students can get used to working on questions with a science literacy approach. Measuring science literacy is crucial to determine the level of students' understanding of the science concepts they have learned.

Based on the explanation, the development of scientific literacy test instruments still needs to be done. So, the researcher is interested in designing a study entitled "Development of Scientific Literacy Test Instruments on Temperature, Heat and Expansion Materials at SMP Negeri 8 Medan". Through the development of this test instrument, it is hoped that educators can compile scientific literacy questions that can support the improvement of the quality of education, especially in scientific literacy skills.

PURPOSE

The focus of this research is: 1) to determine the feasibility of the science literacy test instrument on the material of temperature, heat and expansion at SMP Negeri 8 Medan based on expert validation; 2) to determine the level of suitability of the test instrument based on validity, reliability, discrimination power, level of difficulty, and distractor options of the scientific literacy test instrument developed; 3) to determine the teacher's response to the science literacy test instrument on the material of temperature, heat, and expansion at SMP Negeri 8 Medan using a questionnaire.

RESEARCH QUESTION

Based on the background of the problem above, the formulation of the problem in this study is: 1) How is the feasibility of the science literacy test instrument on the material of temperature, heat and expansion at SMP Negeri 8 Medan based on expert validation; 2) How is the level of feasibility of the test instrument based on the validity, reliability, discrimination power, level of difficulty, and distractor options of the

developed science literacy test instrument; 3) How are teachers' responses to the science literacy test instrument on the material of temperature, heat, and expansion at SMP Negeri 8 Medan.

METHOD

This study uses the type of development research or research and development (R&D). The main objective is to produce a product in the form of a science literacy test instrument on the material of temperature, heat, and expansion. To achieve this goal, the researcher used the ADDIE (Analyze, Design, Develop, Implement, and Evaluate) development model. The ADDIE development model is a development model that is suitable for developing educational products and other learning resources (Branch, 2009).

The research was conducted at SMP Negeri 8 Medan, located at H. Bahrum Jamil, SH. Nr. 96 Street, Medan City, North Sumatra Province, Indonesia. The research was conducted during the odd semester of the 2024/2025 academic year, namely from August to September 2024.

The research subjects in this study include two subjects. The first subject is a validator consisting of 3 expert lecturers and 2 science teachers. The second subject is class VIII students at SMP Negeri 8 Medan, who were involved in two stages of the trial, namely a small group trial of 10 people and a large group trial of 30 people.

The object of research in this study is the feasibility of the science literacy test instrument with the aim of improving students' understanding of science literacy on the material of temperature, heat and expansion.

The research design used is a model developed by Branch (2009), namely the ADDIE model development design. The research design in the ADDIE development model includes five stages, namely analyze, design, develop, implement, and evaluate. The ADDIE development model has the advantage of being simpler, more organized, and widely used in designing effective learning programs and products that have been validated by experts (Soesilo & Munthe, 2020). The ADDIE development model will help ensure that the materials or products produced are effective and in accordance with learning needs.

RESULT AND DISCUSSION

The results of this study describe the process of developing a science literacy test instrument on the material of temperature, heat, and expansion. The science literacy test instrument produced in this study follows the ADDIE model development procedure, which starts from the analyze stage, design stage, develop stage, implement stage, and ends at the evaluate stage.

However, in this article, the focus of the explanation is only on the validation results by expert validators, and the validation of items carried out, and practical analysis through responses from teachers.

1. Expert Validation of Science Literacy Test Instrument

Validation of the test instrument was carried out by the validator based on the validation questionnaire designed at the *design* stage. The validated test instrument was the draft I test instrument, the draft I test instrument was validated by 5 validators. The validators consisted of 3 expert lecturers from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan. Meanwhile, the other 2 validators are science teachers.

The results of the assessment by the validator, out of 32 questions assessed, 25 questions were declared valid and 7 questions were declared invalid because the Content Validity Ratio (CVR) value did not meet the minimum CVR value. The more experts agree, the higher the CVR value of the

question item. Then if all experts agree, the CVR value is 1 (Lawshe, 1975; Wilson et al., 2012). The content validity ratio category involves a minimum CVR value based on the number of validators who assess. In this study, because the Validators consisted of 5 people, the minimum value was 0.99. This means that if the CVR value exceeds 0.99, then the question is considered valid. Conversely, if the CVR value is below 0.99, the question is declared invalid.

2. Validity Test of Science Literacy Question Items in Small Groups

In a small group trial, the validated and revised draft II test instrument was tested on 10 students in grades VIII-9. The test results were then analyzed to determine the validity, reliability, level of difficulty, discrimination power, and effectiveness of the distractor options.

2.1.Validity

The validity test of the test items was conducted using the point biserial correlation formula. The results obtained are then referred to as r_{count}. Then r_{count} will be compared with r_{table}, which is the critical value of point biserial with a significance level of 5% ($\alpha = 0.05$). The test participants consisted of 10 students, thus the r_{table} value is 0.623. A test item is considered valid if the $r_{count} > r_{table}$ (0.623). Of the 25 test items, 20 were declared valid, while 5 were invalid. The results of the analysis of the validity of the test items in the small group can be seen in Table 1 and Figure 1 below.

Table 1. Results of the Validity Test of Question Items in Small Groups

Criteria	Question Item Number	Quantity
Valid	1,3,4,6,7,8,9,10,11,12,14,15,16,17,19,20,21,22,23,25	20
Invalid	2,5,13,18,24	5
	Total	25

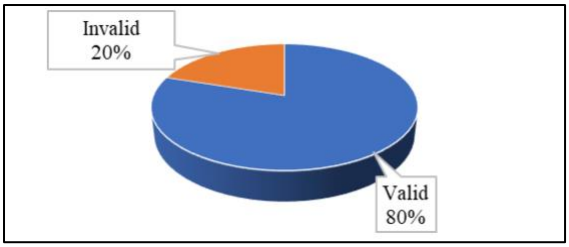

Figure 1. Pie Chart of Test Results of Validity of Question Items in Small Groups

2.2.Reliability

Based on the reliability analysis using the Kuder Richardson formula (KR-21), the test instrument reliability value was obtained at 0.891 which indicates a very high level of reliability. This indicates that if the test is repeated at different times, the results will tend to be consistent. This finding is in line with Yusup opinion (2018) which emphasizes that an instrument can be considered suitable for use if the KR-21 reliability coefficient value exceeds 0.70 ($r_{11} > 0.70$).

2.3.Difficulty Level

Based on the analysis of the difficulty level of the science literacy test instrument, of the 25 questions tested, 2 questions were found with the criteria, 20 questions with medium criteria, and 3 questions with easy criteria. According to Arikunto (2018), a good question is a question that is not too easy and not too difficult. According to Farida (2017), the follow-up to the results of the difficulty level analysis are as follows: 1) Questions with a good level of difficulty (moderate category) should be stored in the question bank and can be used in the next test. 2) Questions with difficult criteria can be discarded and not used again, or can be revised to be stored and reused, or still used for tests that are strict. 3) Questions with easy criteria should be discarded and not used again, or can be revised to be stored and reused, or still used in tests that are formal. The results of the analysis of the level of difficulty of the test instrument in the small

group trial can be seen in Table 2 and Figure 2.

Table 2. Results of Analysis of Difficulty Levels in Small Groups

Criteria	Question Item Number	Quantity
Difficult	5, 19	2
Moderate	2, 3, 4, 6, 7, 9, 10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25	20
Easy	1, 8, 11	3
Total		25

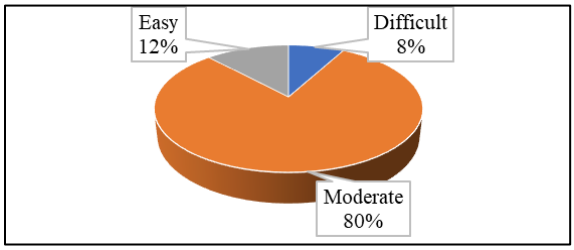

Figure 2. Pie Chart of Results of Difficulty Level Analysis in Small Groups

2.4.Differential Power

Based on the analysis of the discriminatory power of the science literacy test instrument, from 25 questions tested, 5 questions were obtained with very good criteria, 8 questions with good criteria, 7 questions with sufficient criteria, 3 questions with poor criteria and 2 questions with poor criteria. According to Fitriani (2021), as a follow-up to the analysis of discriminatory power, question items that have shown good discriminatory power (sufficient, good, and very good criteria) should be stored in a question bank. The results of the analysis of the discriminatory power of the test instruments in the small group trials can be seen in Table 3 and Figure 3.

Table 3. Results of Differential Power Analysis in Small Groups

Criteria	Question Item Number	Quantity
Very Good	4, 10, 14, 20, 22	5
Good	6, 7, 9, 15, 16, 19, 21, 23	8
Enough	1, 3, 8, 11, 12, 17, 25	7
Bad	2, 13, 24	3
Not Good	5, 18	2
Total		25

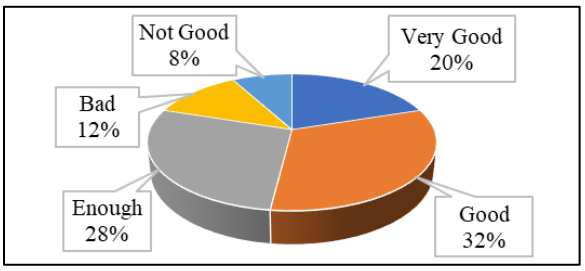

Figure 3. Pie Chart of Results of Differential Power Analysis in Small Groups

2.5.Effectiveness of Distractor Options

Based on the analysis of distractor options on the science literacy test instrument, from 25 questions tested, 4 questions were obtained with very effective criteria, 15 questions with effective criteria, and 6 questions with less effective criteria. According to Fitriani (2021), as a follow-up to the analysis of the effectiveness of distractor options, question items with good distractor option effectiveness (very effective and effective criteria) can be stored in a question bank for reuse in subsequent tests. The results of the distractor option analysis in the small group trials can be seen in Table 4 and Figure 4.

Tabel 4. Results of Distractor Option Analysis in Small Groups

Criteria	Question Item Number	Quantity
Very Effective	5, 13, 19, 22	4
Effective	3, 4, 6, 7, 8, 9, 12, 14, 15, 16, 17, 18, 20, 21, 25	15
Less Effective	1,2,10,11,23,24	6
Not Effective	-	0
Total		25

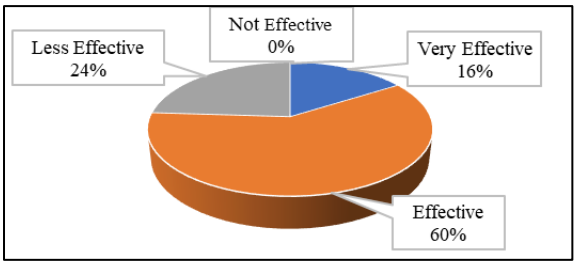

Figure 4. Pie Chart of Results of Distractor Option Analysis in Small Groups

Based on the results of the analysis of the questions that had been tested on small groups, out of 25 questions, 18 questions were accepted and declared feasible, 2 questions were revised, and 5 questions were rejected and declared unfeasible. According to Sahwan (2016), follow-up to the results of the analysis of the validity of question items that are declared valid can be saved in a question bank and can be used again in the next test, while questions that are not valid should not be used or replaced with more appropriate ones.

3. Validity Test of Science Literacy Question Items in Large Groups

The large group trial used the final draft test instrument, which was a revision based on the analysis of the small group trial. The test was conducted on 30 students in grades VIII-8. The collected data were then analyzed to determine the validity, reliability, level of difficulty, discrimination power, and effectiveness of the distractor options.

3.1.Validity

The validity of the test items was evaluated using point biserial correlation. The results obtained are then referred to as rhitung. Then rhitung will be compared with rtable, which is the critical value of point biserial with a significance level of 5% (α = 0.05). The test participants consisted of 30 students, thus the rtable value is 0.361. The test items can be declared valid if the rhitung value > rtable (0.361). Of the 20 test items, 20 test items were declared valid. The results of the analysis of the validity of the question items can be seen in Table 5 and Figure 5.

Table 5. Results of the Validity Test of Question Items in Large Groups

Criteria	Question Item Number	Quantity
Valid	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	20
Invalid	-	0
Total		20

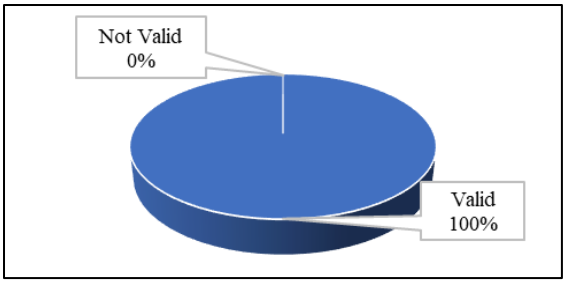

Figure 5. Pie Chart of Test Results of Validity of Question Items in Large Groups

3.2.Reliability

Based on the reliability analysis using the Kuder Richardson formula (KR-21), the test instrument reliability value was obtained at 0.735 which indicates a high level of reliability. This indicates that if the test is repeated at different times, the results will tend to be consistent.

3.3.Difficulty Level

Based on the analysis of the difficulty level of the science literacy test instrument, of the 20 questions tested, 20 questions had a moderate level of difficulty. The results of the analysis of the level of difficulty of the test instrument in the large group trial can be seen in Table 6 and Figure 6.

Tabel 6. Results of Analysis of Difficulty Levels in Large Groups

Criteria	Question Item Number	Quantity
Hard	-	0
Moderate	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	20
Easy	-	0
Total		20

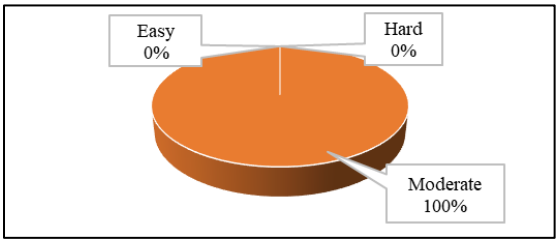

Figure 6. Diagram Pie Hasil Analisis Taraf Kesukaran Pada Kelompok Besar

3.4.Differential Power

Based on the analysis of the discriminatory power of the science literacy test instrument, of the 20 questions tested, 6 questions were obtained with good criteria and 16 questions with sufficient criteria. The results of the analysis of the discriminatory power of the test instruments in the large group trial can be seen in Table 7 and Figure 7.

Table 7. Results of Differential Power Analysis in Large Groups

Criteria	Question Item Number	Quantity
Very Good	-	0
Good	1, 6, 8, 10, 12, 19	6
Enough	2, 3, 4, 5, 7, 9, 11, 13, 14, 15, 16, 17, 18, 20	14
Bad	-	0
Not Good	-	0
Total		20

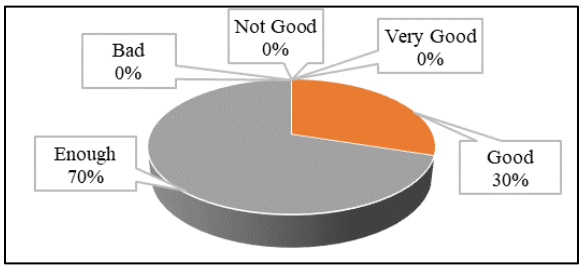

Figure 7. Pie Chart of Results of Differential Power Analysis in Large Groups

3.5.Effectiveness of Distractor Options

Based on the analysis of distractor options on the science literacy test instrument, of the 20 questions tested, 20 questions were found to have very effective criteria. The results of the analysis of the effectiveness of the test instrument's distractor options in large group trials can be seen in Table 8 and Figure 8.

Table 8. Results of Distractor Option Analysis in Large Groups

Criteria	Question Item Number	Quantity
Very effective	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	20
Effective	-	0
Less effective	-	0
Not effective	-	0
Total		20

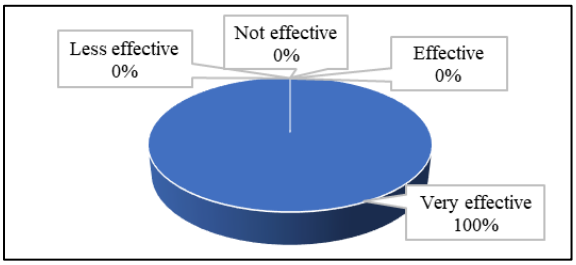

Figure 8. Pie Chart of Results of Distractor Option Analysis in Large Groups

Based on the analysis results, all 20 questions tested were declared suitable for use.

4. Practicality Analysis of Questions According to Science Teacher Responses

The practicality data of the test instrument was obtained from the responses of science teachers through the teacher response questionnaire. Teachers were asked to respond by providing an assessment of the final product of the test instrument from each aspect of the assessment. From the results of filling out the questionnaire, an average value of 89.90% was obtained with a very good category, meaning that teachers showed a positive response to the test instrument so that the developed science literacy-based test instrument can be stated as practical in carrying out the assessment process. These results show that the science literacy test instrument can be used as an assessment instrument because it has very good practical value overall. The results obtained are in line with research conducted by Azizah et al. (2023), which states that the practicality of an assessment instrument means the conveniences in implementing the test instrument. Furthermore, the percentage of assessment for each aspect can be seen in Table 9.

Table 9. Practical Data Analysis Results

Nr.	Assessment Aspects	Percentage	Criteria
1.	Material a. Suitability of material b. Suitability of science concepts	84,00%	Very good
2.	Science literacy Compliance of questions with PISA 2018 framework indicators	93,33%	Very good
3.	Construction a. Completeness and clarity of test instruments b. Effectiveness of answer options	88,00%	Very good
4.	Grammar a. Effectiveness of grammar use b. Appropriateness of communicative sentences and sentence unity c. Functionality of the presented article	94,28%	Very good
	Average	89,90%	Very good

CONCLUSION

Based on the results of the research and discussion, the following conclusions can be drawn regarding the development of science literacy test instruments on the material of temperature, heat, and expansion at SMP Negeri 8 Medan:

1. The scientific literacy test instrument on the material of temperature, heat, and expansion was declared suitable for use as many as 25 out of 32 questions that had been developed. This was obtained from the assessment of 5 validators consisting of 3 expert lecturers from the Faculty of Mathematics and Natural Sciences and 2 other validators were science teachers. Of the 32 questions assessed, 25 questions (78.12%) were declared valid and 7 questions (21.88%) were declared invalid.
2. After going through the field test stage, the developed test instrument was declared suitable for use as many as 20 questions based on the results of the analysis of the validity of the questions, reliability, level of difficulty, discriminatory power and effectiveness of distractor options. In the analysis of the validity of the questions, out of 20 questions tested, 20 questions (100%) were declared valid. In the reliability analysis, the reliability value of the test instrument was 0.735 with a high reliability interpretation. Furthermore, reviewed from the analysis of the level of difficulty, out of 20 questions tested, 20 questions (100%) were obtained with moderate criteria. Reviewed from the analysis of discriminatory power, out of 20 questions tested, 6 questions (30%) were obtained with good criteria and 14 questions (70%) with sufficient criteria. Reviewed from the analysis of the effectiveness of distractor options, out of 20 questions tested, 20 questions (100%) were obtained with very effective criteria.
3. The teacher's response to the developed test instrument obtained an average value of 89.90% with very good criteria. So that the developed test instrument can be used as a test instrument because it has a very good practical value overall.

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