International Journal of Social Science and Human Research

ISSN (print): 2644-0679, ISSN (online): 2644-0695

Volume 07 Issue 07 July 2024

DOI: 10.47191/ijsshr/v7-i07-62, Impact factor- 7.876

Page No: 5141- 5147

Content Validity Analysis of the PISA-Science Literacy Test for SMP Unismuh Makassar Students on the Topic of Optical Instruments

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ABSTRACT: This research aims to analyse the content validity of the PISA-science literacy test on the topic of optical instruments. The design of this test aims to measure the scientific literacy abilities of eighth grade students at SMP Unismuh Makassar. The design of this test was developed based on core competencies and basic competencies and adapted to scientific literacy indicators, especially in science learning material on the topic of Optical Instruments which includes aspects of explaining scientific phenomena, evaluating and designing scientific research, as well as aspects of interpreting scientific data and evidence which are then formulated into 5 questions in the form of essay questions. The method used in this research is the descriptive analysis method as content validity analysis based on Lawshe's formula calculations which have become known as the CVR and I-CVI coefficients. Content validity data was obtained from validation results from five experts with different expertise backgrounds in the field of science education. The expert validation results were then analysed to determine the level of content validity of the PISA-science literacy test which was developed using the Lawshe's formula. The research results showed that the CVR coefficient value obtained was 0.99 with a total of five expert judgments, so it was declared accepted. Further analysis was obtained by obtaining an I-CVI coefficient value of 0.99 with the appropriate category. Based on the CVR and I-CVI coefficient values, it can be concluded that the content validity of the PISA-science literacy test developed is in the appropriate category and supports the entire content of the test as a whole.

KEYWORDS: the PISA-science literacy test, CVR and I-CVI, Optical Instruments, Lawshe's Formula, and Content Validity.

I. INTRODUCTION

PISA defines scientific literacy as the capacity to use scientific knowledge and abilities, identify questions and draw conclusions based on existing evidence and data in order to understand and help researchers make decisions about the natural world and human interaction with nature (Rustaman, 2007). Scientific literacy can form students who are able to solve every existing problem, are able to make decisions, have scientific process skills which are part of the principle of learning outcomes to be able to judge in everyday decisions when they relate to other people and their environment (Bashooir, 2017 ; Toharudin et al., 2011; Wakhidah et al., 2022).

Data from the 2018 PISA assessment shows that Indonesian students obtained scores in terms of literacy, numeracy and science skills respectively, namely 371, 379 and 396 from the international average of 500 (Kemendikbud, 2019; Summaries, 2019). In other words, Indonesia is ranked 71st out of 79 countries in scientific literacy capabilities. PISA results data from 2000 to 2018 are shown in Table 1.

Table 1. PISA Data on Indonesian Student Abilities 2000-2022

Year	Aspects	Indonesian Score Average	International Score Average	Indonesian ranking	Number of Participating Countries
2000	Reading	371	500	39	41
	Mathematics	367	500	39	
	Science	393	500	38	
2003	Reading	382	500	39	40
	Mathematics	360	500	38	

Year	Aspects	Indonesian Score Average	International Score Average	Indonesian ranking	Number of Participating Countries
	Science	395	500	38	
2006	Reading	393	500	48	56
	Mathematics	396	500	50	
	Science	393	500	50	
2009	Reading	402	500	57	65
	Mathematics	371	500	61	
	Science	383	500	60	
2012	Reading	396	500	62	65
	Mathematics	375	500	64	
	Science	382	500	64	
2015	Reading	397	500	61	69
	Mathematics	386	500	63	
	Science	403	500	62	
2018	Reading	371	500	74	79
	Mathematics	379	500	73	
	Science	396	500	71	
2022	Reading	359	500	71	81
	Mathematics	366	500	70	
	Science	366	500	67	

One effort that can be made is to provide students with scientific literacy skills through learning strategies. To decide on the form of provision for scientific literacy learning, it is first necessary to map the level of scientific literacy abilities of junior high school students using appropriate, reliable and standard measuring instruments. Initial observation results show that the form of assessment used in science learning at eight grade SMP Unismuh Makassar was oriented towards measuring general learning outcomes and predominantly measures Lower Order Thinking Skills (LOTS) abilities. Furthermore, the use of technology in learning is starting to be optimized. Meanwhile, the development of learning assessments is still very limited. Based on this, it is considered important to develop a test that can measure scientific literacy abilities oriented to PISA for junior high school students at SMP Unismuh Makassar.

Science learning material related to the topic of Optical Instruments is science material which consists of various important concepts that must be taught to junior high school students in training their scientific literacy skills because the interaction of Optical Instruments material and its use in everyday life plays a central role in determining the structure of life and become the foundation for important technological developments in life (Bunawan et al., 2015; Warimun, 2010). Therefore, Optical Instruments material is important to develop in learning assessments, especially in the form of test instruments.

The instrument or test to measure students' scientific literacy skills in optical instruments are still very limited. Most test instruments related to optical materials focus more on conceptual knowledge of electricity and magnetism. Some examples of conceptual knowledge test instruments related to science material that have been developed include Conceptual Survey of Electricity and Magnetism (CSEM), Brief Electricity and Magnetism Assessment (BEMA), Electricity and Magnetism Conceptual Assessment (EMCA), Colorado Upper-division Electrostatics (CUE), and Critical Thinking skills in Electricity and Magnetism (CTEM) [20]. This test instrument focuses more on measuring students' level of difficulty (Gok, 2012; Pollock, 2009; Sadaghiani, 2011; Tiruneh et al., 2017). Meanwhile, test instruments to measure PISA-based scientific literacy skills related to optical instruments are still very few or even non-existent.

Appropriate assessment techniques for measuring students' scientific literacy abilities can be carried out using test instruments. The most effective and efficient form of test for exploring scientific literacy skills is a descriptive test similar to PISA. Some of the advantages of this form of test are that it can explore in depth and detail students' thinking processes through scientifically given answer patterns (Gurel et al., 2015; Kaltakci-Gurel et al., 2017). The forms of tests used in science learning so far have only been oriented towards learning outcomes with low level thinking abilities. The development of digital technology in Indonesia has grown rapidly. However, its use in the world of education, especially learning assessment, has not been widely developed (Desmita, 2012; Desmiwati et al., 2017; Surani, 2019).

A test is said to be good if it meets three characteristics, namely valid, reliable, and usable (American Educational Research Association American Psychological Association & National Council on Measurement in Education, 1999; Chiappetta & Russell, 1982; Groundlund, 2003; Haladyna & Rodriguez, 2013; Thorndike, 1971). A number of approaches to testing the validation of test instruments, namely content validation, construct validation, and criterion validation (Groundlund, N.E & Linn, 1990; Mehrens & Lehmann, 1991). Therefore, this research focuses on analysing the validation of the PISA scientific literacy test on the topic of optical instruments.

II. METHOD

The research method used was descriptive research method. This research is part of research into the development of the PISA scientific literacy test for SMP Unismuh Makassar students in Makassar City. The object of this research was the PISA-scientific literacy test. The subjects involved in proving the validity of the test content developed were five experts in the field of science education with their respective expertise backgrounds from science learning experts, science learning media, and science learning assessment. The instruments used in data collection in this research were questionnaire sheets that were easy to quantify and qualitative instrument study sheets.

The data analysis technique used in this research is a quantitative descriptive analysis technique. Data resulting from content validity carried out by experts were analyzed using the Lawshe's formula (Lawshe, 1975).

The results of expert judgment validation are processed quantitatively by determining the expert agreement coefficient value using the CVR and I-CVI equations formulated by Lawshe (1975). CVR content validity analysis using formulation.

$$CVR = \frac{N_e - \frac{N}{2}}{\frac{N}{2}} \ldots (1)$$

Information:

CVR = Content Validity Ratio

Ne = Number of experts who stated that the item was relevant

N = Number of experts who assessed

After determining the CVR coefficient, we determined I-CVI coefficient value. Determination of the I-CVI value was carried out using the equation as below.

$$I - CVI = \frac{N_e}{N} \ldots (2)$$

Information:

I-CVI = Item Content Validity Index

Ne = Number of experts who stated that the item was relevant

N = Number of experts who assessed

An item is said to be feasible if the CVR coefficient is in the range 0-1. However, determining whether a question item was accepted or rejected is done by comparing the calculated CVR value with the critical CVR value (Wilson et al., 2012). The critical value of CVR depended on the number of reviewers. This research used five reviewers so the critical CVR coefficient value was 0.99. Next, the item content validity index (I-CVI) value is interpreted using a number of categories. The content validity index of the test items is in the range 1-0 with category levels divided into three categories (Zamanzadeh et al., 2015) as shown in Table 2.

Table 2. Categorization of Interpretation of N-Gain Effectiveness

I-CVI Index Interval	Categorization of Content Validity
I-CVI ≥ 0,79	Eligible
0,0 ≤ I-CVI < 0,79	Revision
I-CVI < 0,0	Eliminated

III. RESULT AND DISCUSSION

The initial product produced in this research was a PISA scientific literacy test instrument to measure the PISA scientific literacy abilities of eighth grade students at SMP Unismuh Makassar, which consisted of five questions in the form of descriptions. The question item specifications are based on Core Competencies and Basic Competencies which are then developed into several question indicators that include scientific literacy indicators. Regarding scientific literacy abilities, these are findings from theoretical studies through analysis of journals and a number of other relevant references which are the main reference in designing a test instrument framework based on scientific literacy indicators.

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The scientific literacy framework according to (OECD, 2023) was the basis for determining indicators of the PISA-scientific literacy ability in designing test. This indicator of scientific literacy ability is distributed proportionally to five questions in the form of descriptions. The indicators of scientific literacy ability measured in this research consist of three aspects, namely the aspect of explaining scientific phenomena, evaluating and designing scientific research, as well as the aspect of interpreting scientific data and evidence which is then used as a reference in writing a grid of question items.

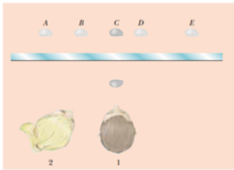
The PISA-science literacy test instrument grid is a reference for writing questions. Writing questions is done by paying attention to the writing rules that have been determined. The material tested in this test is spread across the sub-topics of flat mirrors, concave mirrors and convex mirrors. The distribution of question items is shown in Table 3.

Table 3. Distribution of questions in the Optical Instruments material

Number	Indicator/ Learning Objective	Number of Item	Science Literacy Indicators
1	Providing a table of the results of experiments on image formation in plane mirrors, students can formulate problems related to the nature of images formed by plane mirrors.	1a	Evaluating and designing scientific research
2	Providing a table of experimental results on image formation on a plane mirror, students can analyze the nature of the image formed by a plane mirror	1b 1d	Evaluating and designing scientific research Explaining scientific phenomena
3	Providing a table of experimental results on image formation on a plane mirror, students can conclude the nature of the image formed by a plane mirror	1e	Evaluating and designing scientific research
4	Giving a case, students can formulate a problem related to the nature of the image of an object by a concave mirror	2a	Evaluating and designing scientific research
5	Giving a case, students can analyze the nature of the image formed by a concave mirror	2b	Evaluating and designing scientific research
6	Giving a case, students can analyze the nature of the image formed by a convex mirror	3b	Interpreting data and scientific evidence
7	Providing a table of the results of experiments on image formation on a plane mirror, students can analyze the nature of the image of an object formed by a plane mirror	1c	Interpreting data and scientific evidence
8	Giving a case, students can conclude the nature of the image of an object formed by a plane mirror	4c	Explaining scientific phenomena
9	Providing a case accompanied by a picture, students can analyze the location of the image of an object in a plane mirror	4a 4b	Explaining scientific phenomena Evaluating and designing scientific research
10	Giving a case, students can analyze the nature of the image formed by a plane mirror	2b	Interpreting data and scientific evidence
11	Giving a case, students can conclude the nature of the image formed in front of a concave mirror	2c	Explaining scientific phenomena
12	Giving an illustration related to a concave mirror, students can analyze the location of the image of an object	5	Interpreting data and scientific evidence
13	Giving a case, students can formulate a problem related to the nature of the image created by a convex mirror	3a	Evaluating and designing scientific research
14	Giving a case, students can analyze the nature of the image created by a convex mirror	3c	Interpreting data and scientific evidence
15	Giving a case, students can conclude the nature of the image of an object formed by a convex mirror	3d	Explaining scientific phenomena

One example of the questions developed in this test was shown in Figure 1.

4. Perhatikan gambar berikut ini!



Seorang anak laki-laki (pengamat 1) berdiri di samping anak perempuan (pengamat 2) di depan cermin datar besar. Mereka keduanya berjarak sama dari cermin, seperti ditunjukkan pada gambar di atas. Kemudian sebuah batu diletakkan di depan cermin datar dan diamati oleh kedua anak tersebut.

a. Di titik manakah letak bayangan batu jika yang mangamati adalah anak laki-laki? Lukislah pembentukan bayangannya untuk meyakinkan jawaban Anda!

b. Jika yang mengamati adalah anak perempuan, di titik mana letak bayangan batu tersebut? Lukis pula pembentukan bayangannya!

c. Kesimpulan apa yang dapat Anda peroleh dari jawaban pertanyaan a dan b?

Figure 1. One example of the PISA- scientific literacy item

The PISA-science literacy test grid and scoring rubric that have been developed are then reviewed by experts. At this stage, the test content validation process is carried out by a panel review by five experts with a minimum educational background of a master's degree in education. These five validators have expertise in the field of science learning assessment, science content, and are experts in the field of science learning. These five validators provide an assessment of the test content which contains three main aspects, namely the accuracy of the content, the accuracy of question construction, and linguistic elements. The scores given for each aspect assessed are 0 and 1. If the question item corresponds to the aspect assessed, then it is given a score of 1 by ticking (√) in the column provided and giving a score of 0 if it does not correspond to the assessment aspect by ticking times (X) in the column provided on the judgment sheet. Qualitative item review is based on the following provisions: (1) Good, if the overall item review criteria in the material, construction and language aspects are all in accordance with the rules and supported by all reviewers (81-100%); (2) Not good, if the item does not fulfil at most one material aspect, three construction aspects and one language aspect (70-80%); (3) Not good, if the item does not meet all the established criteria (<69%). The results of the quantitative review of all the items are shown in Table 4.

Table 4. Results of Item review by Experts

Aspect	**Assessment Criteria**	**Assessments of Experts (%)**					**Information**
		1	**2**	**3**	**4**	**5**	
Content	Conformity of items with Core Competencies and Basic Competencies	95	97	90	95	98	
	Conformity of items to indicators and learning objectives	96	97	95	98	95	
	Conformity of items with the content being tested	95	97	95	95	96	
	Correspondence of items with scientific literacy indicators	90	95	95	95	97	
	The content of the material asked is appropriate to the grade level	87	93	90	85	90	
Item Construction	The main item is formulated briefly, clearly and firmly	95	96	97	95	96	
	Items do not depend on the answer to the previous question	95	96	96	97	95	
	The presentation of images, graphs and tables is clear and functional	80	79	76	79	80	
	The subject matter is free from multiple interpretations	96	98	98	95	100	
	Instructions for working on items are clearly formulated	100	100	100	95	97	
	The length of sentences between items has a balanced proportional size	98	95	96	97	95	
Linguistic Aspect	Writing items in accordance with Indonesian language rules	100	96	95	95	97	
	Writing item does not use certain regional languages	100	100	100	100	100	

Aspect	Assessment Criteria	Assessments of Experts (%)					Information
		1	2	3	4	5	
	Formulate communicative item sentences, using simple language, easy to understand and using words that students recognize	95	90	95	95	90	

Table 4 showed that the PISA scientific literacy test requires improvement. The material aspects were known to meet the criteria with a value range of 85% - 98% in the good category. The thing that was of concern in the material aspect was the criteria regarding the description of the content of the material being asked according to the grade level. Several experts agree that some of the material asked was too high for eighth grade junior high school students. Meanwhile, in the construction aspect, the assessment was in the range of 80%-100% meeting the criteria with an average of 93%. The construction aspect that needs to be revised was the unclear criteria for pictures, tables and graphs. Items that use pictures, graphs and tables should need to be paid more attention to whether the display of pictures, graphs or tables provides a function in answering the item or not, then the pictures need to be clarified so as not to give rise to double perceptions for students. In terms of the overall language aspect, it was good, only a few points need revision in the use of good subject, predicate, object and information rules so that the question stem can be directly understood by students. Based on the criteria for each aspect assessed, it can be concluded that there was one aspect in the PISA scientific literacy test instrument that does not meet the good criteria which needs to be revised. What needs to be revised is the use of unclear pictures or tables, so revisions need to be made to clarify the pictures, graphs or tables so that they have a function in the question items.

The results of the review of the questions by these experts were the basis for researchers to carry out revisions. Revisions were carried out maximally based on all input from validators. The instrument that has been repaired is then returned to the validator to see whether it meets expectations or not and was then assessed for each item. The results of the expert judgment were then analyzed using the CVR and I-CVI equations. The results of the calculation analysis showed that a CVR value of 0.99 was accepted for the number of SMEs (Subject Matter Expert) or validators of 5 based on the provisions regarding the permitted critical CVR value. Meanwhile, the I-CVI coefficient value was obtained at 0.99 in the appropriate category. From the results of the CVR and I-CVI content validation, it can be concluded that the PISA-scientific literacy test instrument has appropriate content validity for all question items.

IV. CONCLUSIONS

Based on the results of the analysis and discussion above, it can be concluded that the PISA-science literacy test instrument developed consists of 5 essay question items taking into account scientific literacy indicators, namely explaining scientific phenomena, evaluating and designing scientific research, as well as aspects of interpreting scientific data and evidence. The PISA-science literacy test instrument has met content validity with expert judgment, where the results of calculations using the CVR and I-CVI formulas obtained a coefficient value for both of them of 0.99 in the valid category. Based on the research results and conclusions presented, the researcher provides the following suggestions: (1) good test instruments before use should be discussed in a Focus Group Discussion (FGD) as well as socialization with education sector actors and experts in the field of measurement and evaluation science; (2) understanding and ability in preparing test instruments is very necessary to produce good instrument items; (3) It is recommended that instruments that are suitable for use according to experts need to be further analyzed, namely proving the validity and reliability of the construct..

V. ACKNOWLEDGMENT

The researcher would like to thank the research grant provider, namely Muhammadiyah Research Batch VII for the regular fundamental scheme. Apart from that, the researcher would also like to thank LP3M Muhammadiyah University of Makassar for providing support for all stages of the Batch VII Muhammadiyah Research Grant research until the publication of this research journal as a research output. Furthermore, the researcher would like to express his thanks to SMP Unismuh Makassar who acted as a research partner who had played a role in the process of completing this research..

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