Content validity analysis on mathematical quantitative literacy instruments in elementary schools

D S Anggara1,*, Kadir2, and H Haribowo3
1Faculty of Teacher Training and Education, Pamulang University, Banten, Indonesia
2Deparment of Mathematics Education, UIN Syarif Hidayatullah, Jakarta, Indonesia
3Postgraduate Faculty, Jakarta State University, Jakarta, Indonesia

*Corresponding author: dameis_surya@yahoo.com

Abstract. This research is part of the development of mathematical quantitative literacy instruments for elementary school students. In this section, the purpose of this study is to analyze the content validity of the instrument. The instruments developed were 40 multiple-choice items constructed from interpretation, representation, calculation, assumptions, analysis, and communication skills. Furthermore, the instrument was assessed qualitatively and quantitatively by 6 experts with assessment aspects including 1) relevance of items to the dimensions of quantitative literacy, 2) relevance of items to item indicators, 3) clarity of items, 4) logicalness of all answer options, 5) fairness the language used, and 6) the functioning of the case descriptions / discourses / figures / tables / graphics in the items. The collected qualitative data were analyzed qualitatively and the collected quantitative data were analyzed using the Content Validity Index (CVI). The results show that 40 items each have a CVI value of more than 0.60 with an average of 0.98, it can be concluded that the items and quantitative literacy instruments for elementary school are valid based on content.

1. Introduction
Quantitative literacy is a person's ability to reason and think mathematically in quantitative content [1]. Furthermore, Sweet and Strand [2] explain that quantitative literacy refers to the ability to understand and manage statistical information. Also, Hallet [3] states that quantitative literacy is the ability to identify, understand, and use quantitative arguments in everyday contexts. Then, Mayes, et al [4] stated that quantitative literacy is the use of numbers and arithmetic in understanding phenomena to make decisions. So it can be concluded that quantitative literacy is the ability to reason in managing information in the form of numbers and statistics in various everyday contexts.

Quantitative literacy has 6 dimensions, namely: 1) interpretation, 2) representation, 3) calculation, 4) assumptions, 5) analysis, and 6) communication [1]. Referring to these dimensions, it can be concluded that quantitative literacy is part of mathematical literacy. This is because the dimensions of quantitative literacy have similarities with the objectives of mathematics in elementary school, namely understanding mathematical concepts, applying concepts, using reasoning, explaining mathematical ideas and statements, solving problems, and communicating mathematical ideas [5]. Besides, Otanrio Education [6] also states that quantitative literacy is a dimension of mathematical literacy, apart from spatial literacy and numerical literacy. Furthermore, Lange [7] states that mathematical literacy consists of spatial, numerical, and quantitative literacy.
Quantitative literacy has an important role in improving the quality of life in society. Quantitative skills are important for success in higher education, employment and to become active and wise citizens [8]. Then quantitative literacy enables a person to function in society [9]. To improve one's quality, one must become literate [10].

However, in reality, the quantitative literacy of Indonesian students faces many problems. As the results obtained from the Trend in International Mathematics and Science Study [TIMSS] in 2015, it was reported that the mathematics ability of class IV Indonesian students was ranked 45th out of 50 countries with the acquisition of 397 points [11]. Then also the results obtained from the Program for International Student Assessment [PISA] in 2015 reported that the math abilities of Indonesian students aged 15 years ranked 63 out of 69 countries. The ability of Indonesian students who are at level 5 and 6 is only 0.8% and those at levels below 2 are 42.3% of the total Indonesian student participants [12]. The above affirms that quantitative literacy is still low, reflecting its low mathematical skills.

Following up on this situation, it is necessary to increase quantitative literacy skills through the creation of effective mathematics learning. Learning process can run effectively if you pay attention to individual differences between students [13]. So a quantitative literacy test is needed so that teachers can find out individual differences to create effective learning. This test requires a good instrument, so research will be carried out on the development of a quantitative mathematical literacy instrument for elementary school students to produce content-valid quantitative literacy test items.

There are three types of validity, namely content validity, construct, and criterion validity such as predictive and concurrent validity [14,15]. Validity is based on test content based on logical analysis and expert evaluation of measurement content such as item subject, item format, and constituent sentences [16]. Besides content validity is related to the extent to which items include all the material or material to be measured, which is analyzed through the judgment of several experts [17]. Then content validity refers to the extent to which the instrument covers the whole concept [18].

Previous research on quantitative literacy has only focused on quantitative literacy assessment, without any analysis of the instruments used [8,19, 20]. Then the dimensions used only consist of the dimensions of belief, cognition, and disposition, so the novelty in this study is to analyze the content validity of quantitative literacy instruments with different constructs, which consist of dimensions of interpretation, representation, calculation, assumptions, analysis, and communication dimensions.

2. Methods
The Mathematical Quantitative Literacy Instrument for elementary school students was developed in the form of multiple choice items with a total of 40 items. These items are constructed based on the dimensions of quantitative literacy which include interpretation, representation, calculation, assumptions, analysis and communication. Furthermore, the instrument was assessed qualitatively and quantitatively by 6 experts with aspects of assessment which included: 1) the relevance of the item to the dimensions of quantitative literacy, 2) the relevance of the item to the question indicator, 3) the clarity of the item, 4) the logic of all answer options, 5) the standardization of the language used, and 6) the functioning of the case description / discourse / pictures / tables / graphics in the item. The data from the qualitative and quantitative assessment results were then analyzed using the guidelines presented in table 1 below:

| Types of Data Collected | Data analysis | Uses |
|-------------------------|---------------|------|
| Qualitative             | Qualitative Analysis | used as a guide in improving the content of each item being developed |
|                         | Content Validity Index (CVI) | used as a guide in determining the content validity of each item being developed. |

3. Results and Discussion
The validity of the content on this instrument is determined through item assessment by 6 experts consisting of 3 mathematical experts and 3 measurement experts with aspects of assessment which
include: 1) the relevance of the item to the quantitative literacy dimension, 2) the relevance of the item to the question indicators, 3) the clarity of the item, 4) the logic of all answer options, 5) the standardization of the language used, and 6) the functioning of the case / discourse descriptions, pictures, tables, graphics in the items.

The above refers to the opinion of Goodwin and Leech [16] which states that validity based on test content is based on logical analysis and expert evaluation of measurement content such as item items, item formats, and constituent sentences. Furthermore, the content of measurement as an aspect of expert judgment refers to the opinion of Mardapi [17] which states that the main guidelines in making multiple choice tests include the subject matter must be clear, the sentences used are according to the level of development of the test takers, the language used is standard, the location of the correct answer choices is determined randomly, all logical answer choices, the sentence length of the answer choices are relatively the same, there are no clues to the correct answer. The number of experts is in accordance with the opinion of Lynn [21] which states that the number of experts used in expert validation is at least 3 experts and not more than 10 experts.

The assessment process is carried out by assessing quantitatively and qualitatively on a question card that contains competency components, dimensions, indicators, item forms, assessments, and suggestions for improvement. The components above are summarized in the Question Cards presented in Figure 1 below.

Based on Figure 1, it can be explained that the expert's assessment of items is quantitatively carried out by putting a check mark (√) in the assessment column in the "Assessment Scale" section.

The quantitative assessment data obtained were then analyzed using the Content Validity Index (CVI) technique. CVI is a calculation of the proportion of items that get a score of 3 or 4 from experts [22]. The results of the content validity using the CVI technique above are presented in table 2 below.

| Item Number | Proporsi Item CVI/Expert | Mean 1-CVI | Information |
|-------------|--------------------------|------------|-------------|
| 1           | 1                        | 1          | Valid       |
| 2           | 1                        | 1          | Valid       |
| 3           | 0,83                     | 0,97       | Valid       |
| 4           | 0,83                     | 0,97       | Valid       |
| 5           | 1                        | 1          | Valid       |
| 6           | 1                        | 0,94       | Valid       |
| 7           | 1                        | 1          | Valid       |
| 8           | 1                        | 0,97       | Valid       |
| 9           | 1                        | 1          | Valid       |
| 10          | 1                        | 1          | Valid       |
| 11          | 1                        | 0,95       | Valid       |
| 12          | 1                        | 1          | Valid       |
| 13          | 1                        | 1          | Valid       |
| 14          | 1                        | 0,94       | Valid       |
Based on Table 4.2 above, it can be explained that the CVI (Content Validity Index) value on all items ≥ 0.60, which means that all items have valid criteria in their content, while for the overall CVI value is 0.98 ≥ 0.60, which means that the instrument has content valid criteria. The recommended CVI proportion ranges from 0.60 to 1.0 [23].

As for the qualitative assessment, it is carried out by providing a suggestion note on the Item Manuscript or the suggested correction column available on the question card. The following is a description of the results of the qualitative expert assessment of the developed quantitative literacy instrument:

**a. Suggestions and Improvements to Item Number 3**

Experts argue that the answer options in item number 3 need to be improved, so that the items are not too easy for students to answer. The following is shown in Figure 2 about the suggestions and results of improving item number 3.

**Figure 2.** (a) Suggestions and (b) Results of Improvements to Item Number 3
b. **Suggestions and Improvements to Item Number 4**

Experts argue that the clarity of item number 4 needs to be improved, such as an orderly pattern is made, and questions are directed so that students can answer the sixth pattern that is formed. The following is presented in Figure 3 regarding Suggestions and Results of Improvements to Item Number 4.

![Figure 3](image3.png)

**Figure 3.** (a) Suggestions and (b) Results of Improvements to Item Number 4

c. **Suggestions and Improvements to Item Number 15**

Experts argue that the clarity of item number 15 needs to be improved, such as the clarity of the first and second number sequences. The following is presented in Figure 4 about the suggestions and results of improving item number 15.

![Figure 4](image4.png)

**Figure 4.** (a) Suggestions and (b) Results of Improvements to Item Number 15

d. **Suggestions and Improvements to Item Number 30**

Experts argue that item number 30 will require more reasoning if changed to "The many balls that are not blue in the box are". The following is presented in Figure 5 regarding Suggestions and Results of Improvements to Item Number 30.

![Figure 5](image5.png)

**Figure 5.** (a) Suggestions and (b) Results of Improvements to Item Number 30

e. **Suggestions and Improvements to Item Number 33**

Experts argue that the clarity of item number 33 needs to be improved, as there must be an assumption on the basis of the area needs needed by each audience. The following is presented in Figure 6 regarding Suggestions and Results of Improvements to Item Number 33.
4. Conclusion

Based on the results of the research above, the CVI (Content Validity Index) value in 40 items exceeds 0.60, which means that all of these items have content valid criteria, while the overall CVI value is 0.98 exceeding 0.60 which means that the instrument has criteria content valid. So it can be concluded that each item and instrument as a whole has content valid criteria.

References
[1] Steen L A, 2001 Mathematics and democracy: The case for quantitative literacy NCED.
[2] Sweet S and Strand K, 2006 Teach. Sociol. 34 1
[3] Hallett D H, 2003 Quant. Lit. Why Numer. Matters Sch. Cholleges.
[4] Mayes R Forrester J Schuttlefield Christus J Peterson F and Walker R, Jul. 2014 The Matrix Numeracy 7.
[5] Permendiknas, 2006 Peraturan Menteri Pendidikan Nasional Nomor 22 Tahun 2006 Tentang Standar Isi Pendidikan Dasar dan Menengah.
[6] Education O, 2014, Leading Math Success: Mathematical Literacy, Grades 7-12. The Final Report of the Expert Panel on Student Success in Ontario.
[7] De Lange J, 2006 Mathematical literacy for living from OECD-PISA perspective.
[8] Burdette A M and McLoughlin K, 2010 Teach. Sociol. 38 3
[9] Wilkins J L M, 2010 Educ. Psychol. Meas. 70 2
[10] Irianto P O and Febrianti L Y, 2017 Proceedings Education and Language International Conference 1, 1.
[11] TIMSS & PIRLS, 2016 international result in mathematics (Chesnut Hill: TIMSS & PIRLS International Study Center).
[12] OECD, 2018 Pisa 2015 Result In Focus (OECD Publishing).
[13] Suwarsono S, 1987 Trait-Treatment Interaction dalam Pendidikan Matematika (Yogyakarta: IKIP Sanata Dharma Yogyakarta).
[14] Crocker L and Algina J, 1986 Introduction to classical and modern test theory. ERIC.
[15] Cohen R J Sverdluk M E and Phillips S M, 1996 Psychological testing and assessment: An introduction to tests and measurement (Mayfield Publishing Co).
[16] Goodwin L D and Leech N L, 2003 Meas. Eval. Couns. Dev. 36 3
[17] Mardapi D, 2008 Teknik penyusunan instrumen tes dan nontes (Yogyakarta: Mitra Cendekia).
[18] Van Saane N Slutter J K Verbeek J and Frings-Dresen M H W, 2003 Occup. Med. (Chic. Ill). 53, 3.
[19] Schuhmann P W McGoldrick K and Burrus R T, 2005 Am. Econ. 49 1
[20] Bookman J Ganter S L and Morgan R, 2008 Am. Math. Mon. 11510
[21] Lynn M R, 1986. Nurs. Res.
[22] Polit D F and Beck C T, 2006 Res. Nurs. Health 29 5
[23] Rempusheski V F and O’Hara C T, 2005 Nurs. Res. 54 6