KnE Social Sciences
ICMScE
International Conference On Mathematics And Science Education
Volume 2024

Research Article

Constructing Mathematical Literacy-Items with Corona Virus Disease as a Context

Fitri Anisa Kusumastuti*, Muh. Khaedir Lutfi, Ignatius Joko Dewanto, and Aeni Rohmawati

Departement of Mathematic Education, Tangerang Raya University, Kompleks Sudirman Indah blok E, Tangerang, Banten 15720, Indonesia

ORCID
Muh. Khaedir Lutfi: https://orcid.org/0000-0002-6110-7843
Ignatius Joko Dewanto: https://orcid.org/0000-0002-6208-3759

Abstract.
This research aims to produce a set of mathematical literacy items with Corona Virus Disease (COVID-19) as a context that is valid to assess students' mathematical literacy. The steps used in this study consist of analyzing, designing, theoretical validation, revising, limited testing to students, and evaluating. Written tests were conducted to collect 46 seventh-grade students in junior high school data. Mathematical literacy items consist of three items with three indicators and competency clusters. The indicators are formulating, employing, and interpreting mathematics. The results show that (1) the mathematical literacy items which are produced have been valid and practical, (2) have fair and good item discrimination, and (3) have easy, medium, and hard item difficulty, so they can be utilized to evaluate mathematical literacy ability.

Keywords: mathematical literacy, indicators, competency clusters.

Corresponding Author: Fitri Anisa Kusumastuti; email: fitrianisakusumastuti@gmail.com

Published: 3 April 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

1. INTRODUCTION

A novel coronavirus pneumonia, firstly identified in Wuhan, Central China and named as 2019-nCoV [1], has surged in the public. With the vast impact on students and youth globally [2], corresponding spread control policies and emergency actions are taking place. School closures are enacted in most countries, for example Indonesia. Schools and boarding schools are prohibited to open dormitories and conduct face-to-face learning [3]. During this time, teachers and education professionals have been asked to supply students with teaching material and instruct students directly via remote digital tools [4].

Mathematics, as one of the subject taught in school, is useful in understanding the situation [5]. As Freudenthal stated in 1983 "Our mathematical concepts, structures, ideas have been invented as tools to organise the phenomena of the physical, social and mental world." For instance, studying exponential growth [the rate at which things grow]

within the context of the spread of Coronavirus disease-19 (COVID-19) is meaningful. It not only gives students a real-world context in which to use the math, but also helps them understand global phenomena – they may hear about a disease spreading in China, but cannot make the connection without understanding how fast something like COVID-19 can spread in a dense population [6]. National Council of Teacher of Mathematics has showed the purpose of learning mathematics in five competencies namely mathematical problems solving, mathematical reasoning, mathematical connection, mathematical communication, and mathematical representation [7]. The fifth basic competency is actually an ability in mathematical literacy [8].

Mathematical literacy is an individual's ability to formulate, employ, and interpret mathematics in a variety of context[9]. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. There are three competency clusters of mathematical literacy in PISA framework: the reproduction, the connection and reflection cluster [10]. In reproduction cluster, the competencies including knowledge of fact and of common problem representation, performance using routine procedures, standard algorithms, and using technical skills. In connection cluster, student are asked to make relationship between several ideas in mathematics and some integrated information for solve a problem. In reflection cluster, the competencies include a reflectiveness about the process needed or used to solve a problem. Reflection cluster is the highest competency in PISA, namely the ability to reason by using mathematical concepts. In this study, we construct three mathematical literacy-items using COVID-19 as context and based on the cluster.

The previous study has showed how to construct mathematical literacy problems for geometry content [11]. The difference of this study with the previous one is we construct mathematical literacy items using COVID-19 context based on three competency clusters of mathematical literacy for students of grade VII.

2. RESEARCH METHOD

The research method used to construct mathematical literacy item includes: (1) analyzing; (2) designing; (3) theoretical validation; (4) revising; (5) limited testing to students; and (6) evaluating [12]. The researcher constructed three mathematical literacy items with COVID-19 as a context. Then, the mathematical literacy items were theoretically validated to experts. After being validated, the items were revised and tested on limited scale students who have learned the material before. The last step, researcher evaluate students answer using item-analysis.

3. RESULT AND DISCUSSION

3.1. Analyzing

The first step, researcher did analyze some journals, reports, books and articles about mathematical literacy. Researcher got some indicators and operational definitions of mathematical literacy ability. As opposed to the importance of this ability for students, the students still found some problems in solving mathematical literacy items [13]. Hence, it is important for educators to construct the items of mathematical literacy to evaluate students' mathematical literacy ability especially using a topic that relate to students' current situation, here researcher used COVID-19 as context.

3.2. Designing

The following things researcher did is designing mathematical literacy items. Researcher set up three mathematical literacy essay items on Quantity, Change and Relationship, and Space and Shape content. The indicators of the items based on three mathematical literacy processes; (1) formulating situation mathematically, (2) employing mathematical concepts, fact, procedures and reasoning solution of the problem, and (3) interpreting and communicating result or solution of mathematical problem [14]. Mathematical literacy items outline can be seen at Table 1.

TABLE 1: Mathematical literacy items' outline.

Item	Indicator	Title	Competency	Content
1	Formulating situation mathematically	Economic Growth affected by COVID-19	*Reproduction*	*Quantity*
2	Employing mathematical concepts, fact, procedure, and reasoning	Rooms for dad	*Connection*	*Change and relationship*
3	Interpreting and communicating result or solution of mathematical problem	COVID-19	*Reflection*	*Space and shape*

3.3. Theoretical Validation

The items that have been compiled are validated by three experts, teachers and two mathematics lecturers to see the suitability of the assessed indicators, context, and language so that they are easily understood by the students. The first validator gives recommendations that (1) mathematical literacy items must be connected to learning

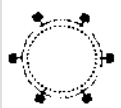
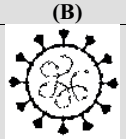
objectives and (2) the difficulty levels of items are adopted by mathematical literacy levels; Suggestion from the second validator for item 1 is declare the name of the countries that include in Asia. And the final recommendation from the third validator is to place the figures of the disease in line to make the students easy to compare the area.

3.4. Revising

Based on expert recommendation before, researcher revised the mathematical literacy items. Some changes that we did for our mathematical literacy items are changing some words, deleting redundant word, adding picture, and moving the items. Table 2. is the items' revision.

TABLE 2: Revision the mathematical literacy items.

<table>
<tr><th>No.</th><th>Mathematics Literacy Item</th></tr>
<tr><td>1</td><td>Reproduction Cluster

<u>ECONOMIC GROWTH AFFECTED BY COVID-19</u>
YOY Economic Growth Prediction Affected by COVID-19
<table>
<tr><td>-1.73</td><td>Hong Kong</td><td>-0.14</td><td>India</td></tr>
<tr><td>-0.41</td><td>South Korea</td><td>-0.14</td><td>Euro Area</td></tr>
<tr><td>-0.32</td><td>Brazil</td><td>-0.13</td><td>France</td></tr>
<tr><td>-0.29</td><td>Australia</td><td>-0.12</td><td>England</td></tr>
<tr><td>-0.25</td><td>Indonesia</td><td>-0.11</td><td>US</td></tr>
<tr><td>-0.22</td><td>Japan</td><td>-0.1</td><td>Canada</td></tr>
<tr><td>-0.16</td><td>Germany</td><td>-0.06</td><td>Italy</td></tr>
<tr><td>-0.15</td><td>New Zealand</td><td>-0.05</td><td>Spain</td></tr>
<tr><td>-0.15</td><td>South Africa</td><td>-0.05</td><td>Mexico</td></tr>
</table>
Question 1:
There are five countries in Asia showed in the predictions of economic growth due to COVID-19 infographic, namely Hong Kong, South Korea, Indonesia, India and Japan. Canada is the fourth country that has the best economic recovery based on the picture above. Determine what country growth rates should be pursued by countries in Asia to be equal to Canada. Show me your work!</td></tr>
<tr><td>2</td><td>Reflection Cluster
COVID-19
When news about COVID-19 spread throughout the country, a Yale University's Medical School biologist, Dr. Akiko Iwasaki, created a simple infographic to compare COVID-19 with other respiratory infections.
<table>
<tr><th>Name</th><th>Flu (A)</th><th>Covid-19 (B)</th><th>Stem cell (C)</th></tr>
<tr><td>Picture of the disease</td><td> 
Influenza Virus</td><td> 
SARS-CoV-2</td><td>  </td></tr>
</table>
Source:https://www.news10.com/news/coronavirus/comparing-coronavirus-to-the-flu-and-other-respiratory-illnesses/
Question 3:
Explain the method for estimating the area of picture B!</td></tr>
</table>

3.5. Limited Testing to Students

After being validated and revised, the items were tested on seventh grade junior high school students who had received the material previously. The students got 60 minutes to solve the items individually. The example of student's solution can be seen at Figure 1.

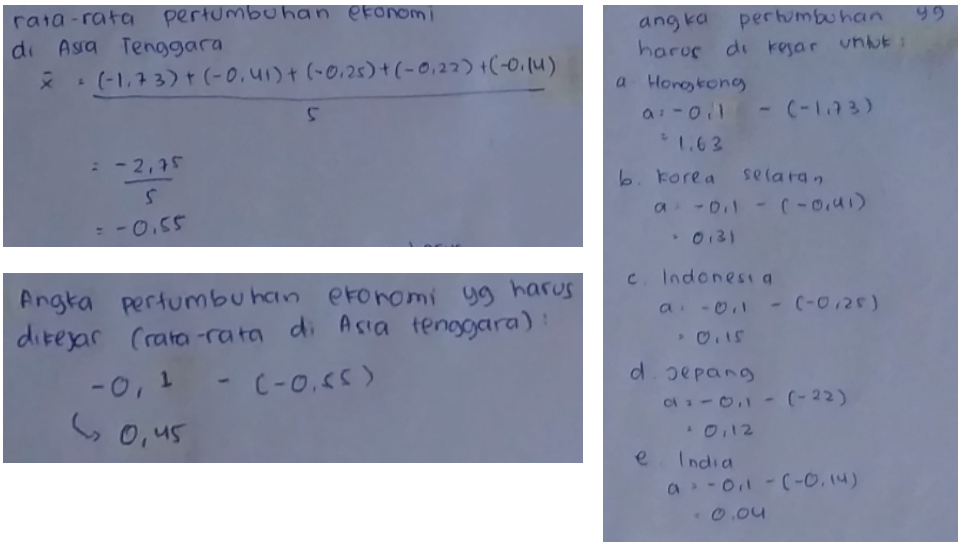


Figure 1: Example of students' answer on 1st item.

3.6. Evaluating

After being tested to students, the researcher continues to evaluate the students' answer using validity and reliability test, item difficulty and item discrimination test. The validity test is used to see the high and low validity coefficients on the mathematical literacy ability items. The following is the formula of Pearson's Product Moment correlation:

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\left(N\sum X^2 - (\sum X)^2\right)\left(N\sum Y^2 - (\sum Y)^2\right)}} \quad (1)$$

Description**:**

r_{xy}= Correlation coefficient of variables x and y

X = Score on each item

Y = Total score of each student

N = Number of students

Criteria: If r count > r Pearson's table, then the item is said to be valid

The reliability test is used to see the level of consistency of an item. Reliable item always shows consistent results when tested on the same respondent at different times.

Table 3: Correlation coefficient interpretation.

r_{xy}	**Interpretation**
$0.80 < r_{xy} \leq 1.00$	Very high
$0.60 < r_{xy} \leq 0.80$	High
$0.40 < r_{xy} \leq 0.60$	Moderate
$0.20 < r_{xy} \leq 0.40$	Low
$0.00 < r_{xy} \leq 0.20$	Very low

The reliability coefficient of the test device in the form of a description can be known using the Alpha formula[15]:

$$r_{11} = \left[\frac{n}{n-1}\right] \left[1 - \frac{\sum s_i^2}{s_t^2}\right] \text{with } s = \frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n} \quad (2)$$

Description**:**

r_{11}= Overall reliability test

n = Number of questions (items)

s_i^2 = Score of variances per item

s_t^2 = Total score of variances

The benchmark to show the degree of reliability of the evaluation tool is by using the Guilford criteria. The interpretation of the reliability correlation is as follows

Table 4: Classification of reliability.

Reliability (r_{11})	**Interpretation**
$0.90 < r_{11} \leq 1.00$	Very high
$0.70 < r_{11} \leq 0.90$	High
$0.40 < r_{11} \leq 0.70$	Medium
$0.20 < r_{11} \leq 0.40$	Low
$r_{11} \leq 0.20$	Very low

The next test is difficulty item test. The difficulty item of mathematical literacy item is determined by the formula of difficulty item. The interpretations of item discrimination levels of mathematical literacy are very hard, hard, medium, easy, and very easy [16]. The last test is the discrimination item test. The interpretations of discrimination item levels of mathematical literacy are very good, good, fair, poor, and very poor [16].

Based on the data processing of the students' answer using the Ms. software. Excel and IBM SPSS Statistics 24, the results of all of the test above presented in Table 4.

The Table 5. shows items 1, 2 and 3 can be applied to evaluate the mathematical literacy ability based on the test that has been done. Next, the discrimination item can distinguish students with high, moderate and low ability well. Third, reliability test

TABLE 5: The experiment results.

Item	r_{xy}	Validity Criteria	Reliability	DP	Discrimination Item Criteria	IK	Difficulty Item Criteria	Decision
1	0.690	High	0.678 High Criteria	0.30	Fair	0.70	Easy	Used
2	0.639	High		0.43	Good	0.60	Medium	Used
3	0.636	High		0.45	Good	0.45	Hard	Used

indicates that problems have good consistency to assess mathematical literacy ability. The last, difficulty test item represent all type of difficulty criteria.

4. CONCLUSIONS

Based on the result and discussion section, we can draw three conclusions. First, mathematical literacy items that constructed have been valid and practical to assess mathematical literacy. Second, the mathematical literacy items are had fair and good item discrimination for assessing mathematical literacy. Third, the level of difficulty of mathematical literacy items are easy, medium and hard.

Acknowledgments

The author would like to thank the head Mathematics Education Department of Universitas Tangerang Raya and all those who have assisted in the whole process of this research, from designing the instruments, conducting the research, to writing the report in the form of scientific work.

References

[1] Johnson M. Wuhan 2019 novel coronavirus-2019. Materials and Methods. 2020; 10(January):1–5.

[2] R. la Perouse and T. OECD. Impact and implications of the COVID 19-crisis on educational systems and households*: TUAC Secretariat Briefing*. 2020.

[3] Dirjenpendis. Keputusan direktur jenderal pendidikan islam nomor 2791 tahun 2020 tentang panduan kurikulum darurat pada madrasah. 2020; 1–17.

[4] Lutfi MK, Kusumastuti FA, Rusmayati M, Ss R. Wulansari. Persepsi orang tua siswa sekolah dasar terhadap pembelajaran online. *Tarbiyah wa Ta'lim: Jurnal Penelitian Pendidikan dan Pembelajaran*. 2021; 8(3): 171–179.

[5] NCTM, “COVID-19, Coronavirus, and pandemics – math resources: Teaching and using mathematics to understand our world.,” p. 19,.

[6] Asia Society. “Math and science education in a global age: What the U.S. can learn from China.,” p. 2006.

[7] NCTM. Principles and standards for school mathematics. Arith Teach. 2000;29(5):59.

[8] PISA, Result in focus: What 15 years olds know and what they can do with what they know., 2012.

[9] OECD, PISA 2012 assessment and analytical framework PISA 2012 assessment and analytical framework., 2013.

[10] Pisa for development assessment and analytical framework draft version, 03 May 2017 1. Oecd. 2017;(May):148.

[11] P.N. Malasari, T. Herman, and A. Jupri, “The construction of mathematical literacy problems for geometry.,” *Journal of Physics: Conference Series*. vol. 895, no. 1, p. 2017. https://doi.org/10.1088/1742-6596/895/1/012071.

[12] Gall WR. M. D., Gall, J. P., & Borg, Educational research: an introduction (7th ed.)., 2003.

[13] F.A. Kusumastuti, “Pengaruh Islamic Spiritual Intelligence (ISI) terhadap kemampuan literasi matematis siswa,” (2021).

[14] OECD. “PISA 2021 mathematics framework (DRAFT). 2nd draft 32-40.,” *Angewandte Chemie International Edition, 6(11), 951–952*. pp. 5–24, 1967.

[15] Suherman E. Evaluasi proses dan hasil belajar matematika. jurusan pendidikan matematika Universitas Pendidikan Indonesia, Bandung, 2003.

[16] Hendriana H, Sumarmo U. penilaian pembelajaran matematika Bandung. *Refika Aditama*, Bandung, 2014.