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DESIGNING MATHEMATICS PROBLEM BASED ON PISA TASK USING THE ETHNOMATHEMATICS CONTEXT

Andi Dian Angriani[1]

[1]Doctoral Program in Mathematics Education, Universitas Negeri Makassar
[1]Universitas Islam Negeri Alauddin Makassar

e-mail: dian.angriani@uin-alauddin.ac.id

ABSTRACT

This study aims to determine the procedure and assess the quality of developing mathematical problems using the ethnomathematics context. The method used was design and development research. The outcomes of this research were mathematical problems using the ethnomathematics context, which measured mathematics literacy ability. The content validity results based on the validator indicated that the test items were valid after being assessed using the content validity ratio and content validity index. In the reliability test, the mathematics problem using the ethnomathematics context was reliable. Based on the analysis results obtained, the average literacy ability of the students was in the medium category. Therefore, developing PISA-like mathematics problems using the ethnomathematics context as a learning resource could facilitate students learning mathematics.

Keywords: Mathematical task, PISA, ethnomathematics context

1) INTRODUCTION

Mathematics learning provides opportunities for students to construct abilities such as problem-solving, reasoning, and mathematical communication (Ahonen & Kinnunen, 2015; Darma, 2018; Lin, Tseng, & Chiang, 2017; Wilkinson, Bailey, & Maher, 2018) and can practice critical thinking skills (Das, 2019; Fouze & Amit, 2018; Ismail, Nursalam, Angriani, & Kusumayanti, 2021; Pratama & Retnawati, 2018). In the 2013 curriculum, students must develop skills in math problems related to everyday life. One of the international standard evaluation programs to measure student skills is the Program for International Student Assessment (PISA), organized by the Organization for Economic Cooperation and Development (OECD) (Hewi & Shaleh, 2020). PISA mathematical problems require the ability to apply the concept and how the concept can be applied in various situations and the ability of students to reason and argue about how the problem can be solved. The students are said to solve problems by applying previously acquired knowledge into new, unfamiliar situations (Nasution, 2019) on three major components of the mathematical domain: context, content, and competency clusters (Johar, 2012). PISA problem-solving skills in mathematics are called mathematical literacy, whivh is one of the components needed to construct the 21st century skills.

Mathematical literacy is an idea that is used to define the knowledge and competencies needed to apply mathematics to aspects of personal and social life to become a contributing citizen (Bolstad, 2020). Mathematical literacy is essential to face the industrial revolution 4.0 (Sutama et al., 2020). Mathematical literacy ability is important because it can improve human resources (Masjaya & Wardono, 2018). It helps someone understand the role or use of

mathematics in everyday life (Muzaki & Masjudin, 2019). However, Indonesia's mathematical literacy results are still low, with a score of 379, and are ranked 72 out of 79 countries. Students are not familiar with solving contextual issues like PISA tasks (Novita, Zulkardi, & Hartono, 2012) and have limited high-level skills (Putri & Zulkardi, 2018). It can be seen from testing the PISA results of Indonesian students. Students still have difficulties solving mathematics problems that require Higher Order Thinking Skills (HOTS) because Indonesian students are accustomed to solving problems whose level of thinking is limited to knowledge and application (Putri & Zulkardi, 2018).

The problem faced by the teacher is the lack of specially designed questions following students' potentials and characters. It is assumed that students' prospects using reasoning in answering each question have not been maximally developed. Students need to be trained to develop mathematical reasoning skills in the learning process so that real problems should be given to students to practice and solve (Miguel & Silva, 2015; Yuanita, Zulnaidi, & E., 2018). In addition, teachers need to be given socialization about what and how the characteristics and framework of PISA questions by developing and adapting PISA model questions to be implemented in the learning process in the classroom. Many studies are related to the development of mathematical problems similar to PISA. Among them was the research designed PISA-like mathematics tasks using experiences and challenges (Zulkardi & Kohar, 2018), designed PISAComat (Nusantara, Zulkardi, & Putri, 2021), developed a mathematical problem based on the PISA level of space and shape content (Nasution, Fauzi, & Syahputra, 2019), developed PISA-like questions were using Jambi context (Charmila, Zulkardi, & Darmawijoyo, 2016) and PISA-like questions using Aquatic in Asian Games context (Maharani, Indra Putri, & Hartono, 2019), as well as the development of online-based PISA model mathematics problems (Kertayasa, 2019). Phenomena in everyday life can attract students' interest in learning mathematics through a culture called ethnomathematics (Sembiring, Hadi, & Dolk, 2008).

Ethnomathematics represents mathematics in everyday life related to culture to increase students' interest and motivation (Manoy & Purbaningrum, 2021). Ethnomathematics is a bridge between culture and mathematics to preserve Indonesian culture through education (Wardono, Mariani, & Kurniat, 2021). Ethnomathematical nuances are effective in learning, especially in mathematics learning can improve students' mathematical literacy skills (Kurniati & Mariani, 2020; Zaenuri et al., 2019). Therefore, this study was conducted to design PISA-like mathematical problems using the ethnomathematics context to measure a students' mathematics literacy ability.

2) METHODS

This study used the Research and Development (R&D) method. The research involved four stages, namely, (a) the preliminary, (b) the self-evaluation and design, (c) the prototyping and, (d) the field test stages (Tessmer, 1993). The product developed in this study was PISA-like mathematics problems using Mathematical literacy to measure the students' mathematical literacy ability. The test subject in this study was the eighth-grade students of SMP Negeri 3 Sungguminasa, South Sulawesi. The design of the development is presented in Figure 1.

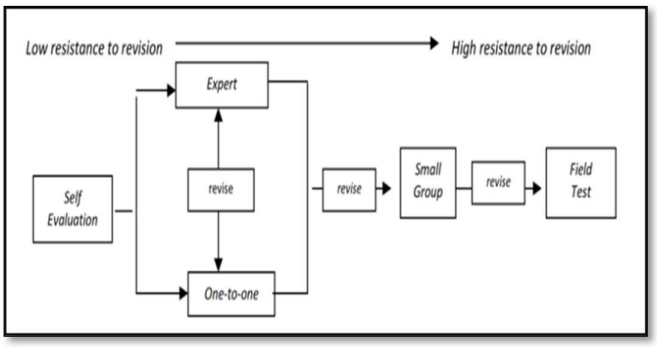

Figure 1. Tessmer Design Development

The data collection instruments used in this study were: (a) validation sheet to measure the validity of students' mathematical literacy abilities and other research instruments, (b) student questionnaire sheet, and (c) a test to investigate the students' mathematical literacy abilities.

3) RESULTS

The process of developing PISA-like mathematics problems using mathematical literacy through 4 stages was broken down as follows:

Preliminary Stage

This stage began by collecting several references related to this research, namely research on developing mathematical problems similar to PISA, including PISA questions. Then, the researcher determined the place and subject of the research trial, the eighth-grade students of SMP Negeri 3 Sungguminasa. After deciding the location and subject, observations were conducted to identify students' learning activities and mathematical literacy abilities at the school. The procedure used in this observation was an interview. It was carried out to mathematics teachers at the school.

Self-Evaluation Stage

This stage aimed to design mathematical problems PISA-like in the mathematical literacy based on the results of the preliminary stage. The designed questions consisted of a grid and filled-in test questions and assessment guidelines. In this stage, there are four activities, namely curriculum analysis, material analysis, student analysis, and design. The curriculum reviewed in the first analysis stage was the 2013 mathematics curriculum of SMP Negeri 3 Sungguminasa, which aimed to improve students' mathematical literacy abilities.

Student analysis focused on the eighth-grade students as the subjects. Students' mathematical abilities in SMP Negeri 3 Sungguminasa were diverse based on observations and interviews with mathematics teachers. There were those with low, medium, and high skills. In general, students' mathematical literacy abilities have never been explored by either teachers or other researchers. Material analysis was an activity to identify the main concepts used in the mathematics material test of SMP Negeri 3 Sungguminasa. Based on the curriculum analysis, it was found that the material to be used in developing the questions was in accordance with the material in the 2013 curriculum of mathematics. The material is statistics.

After those three analyses were carried out, the next step was to design mathematical problems of PISA-like mathematical literacy, including test grids, test questions, and assessment guidelines. The researcher's initial stage was to design questions based on the material that had been analyzed and based on indicators of mathematical literacy abilities called prototype I. The researcher designed ten questions. The questions created are problems related to phenomena in

everyday life, in this case, the current phenomenon of the Covid-19 pandemic. The researcher also made a test grid and material for the validator to check those question validity. The test grid was designed to refer to the achievement indicator and the cognitive domain of each question. In addition, the researcher also created assessment guidelines that were used to facilitate the researcher herself, teachers, or other researchers in providing an assessment of the test results that students had done.

Prototyping Stage (Validation, Evaluation, and Revision)

This prototyping stage aimed to produce prototyping II of the developing questions revised based on input from expert review. They consisted of 3 people; 2 lecturers of the Department of Mathematics Education, Faculty of Tarbiyah and Teacher Training, Alauddin State Islamic University Makassar, and 1 mathematics teacher from SMP Negeri 3 Sungguminasa. They checked and corrected tools for measuring mathematical literacy abilities. In the validation stage, the validator assessed aspects related to the designed instrument.

Based on the first validation of the development of the mathematical problems of PISA-like using mathematical literacy, three questions must be revised. After being revised, the content validation was carried out again to the previously assessed experts. Thus, the results of the second validation indicated that the 10 items reviewed by 3 validators have shown that these items supported the validity of the test. Then, from the results of the Content Validity Ratio (CVR), the Content Validity Index (CVI) value was obtained, which was the average of the CVI of all items of 1 categorized "very appropriate" about the topic to be analyzed.

After all research instruments were considered valid, the next step was to conduct a one-to-one test, namely testing on a small scale, which aimed to determine the level of readability of the questions by selecting three of the eight-grade students of SMP Negeri 3 Sungguminasa. They were peer students who were non-subjects of research trials, each with high, medium, and low abilities based on the value of learning outcomes known by the mathematics teacher who taught them. Based on the results of the 8 statement items with predetermined criteria and the analysis result of the student response questionnaire on the questions developed, 75% of students gave a positive response in the one-to-one trial, and 25% of students gave a negative response. The results of the analysis one-to-one test were used as a reference for revision.

Here was the PISA-like mathematics problem using mathematical literacy given to students.

Salah satu toko kue ternama di kota Makassar setiap harinya memproduksi kue khas Makassar, yaitu bolu rampah. Untuk membuat sebuah bolu rampah, toko tersebut membutuhkan bahan-bahan sebagai berikut.

Nama Bahan	Takaran
Tepung terigu	200 g
Gula merah	120 g
Gula pasir	100 g
Margarin	80 g
Telur ayam	5 butir

Memasuki bulan Desember 2021, stok bahan-bahan yang tersedia di gudang toko tersebut sebagai berikut.

Nama Bahan	Persediaan
Tepung terigu	18000 g
Gula merah	10800 g
Gula pasir	10000 g
Margarin	6400 g
Telur ayam	450 butir

Dengan stok bahan-bahan tersebut, berapa buah kue bolu rampah yang dapat mungkin dibuat selama bulan Desember?

Figure 2. The First Problem

English translation of Figure 2:

One of the famous cake shops in Makassar city produces a typical Makassar cake every day, namely rampah cake. To make a rampah cake, the shop requires the following ingredients.

Ingredients	Dose
Flour	200 g
Brown sugar	120 g
Sugar	100 g
Margarine	80 g
Chicken eggs	5 items

Entering December 2021, the supply of ingredients available in the shop's warehouse is as follows.

Ingredients	Supply
Flour	18000 g
Brown sugar	10800 g
Sugar	10000 g
Margarine	6400 g
Chicken eggs	450 items

How many rampah cakes can possibly be made during December with these ingredient supplies?

In Figure 2, students were asked to determine the number of cakes based on the existing ingredients.

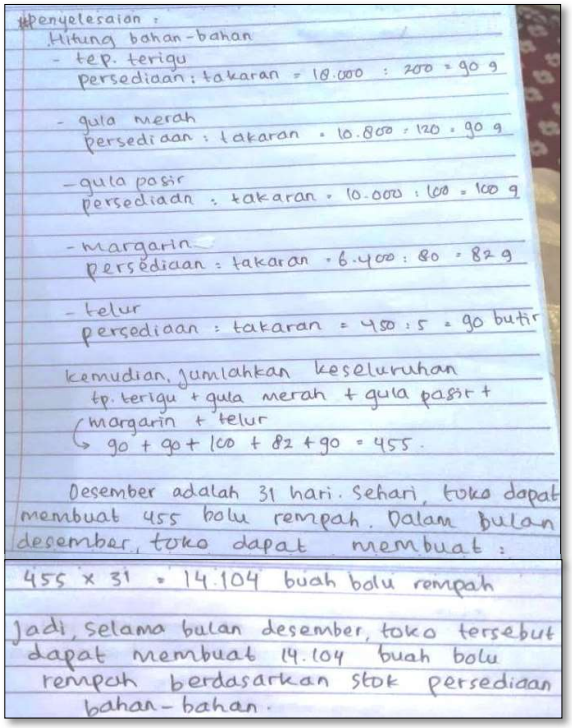

Figure 3. The Answer

English translation of Figure 4:

Answer:

Solution

Counting the ingredients

- *Flour*
  Supply : dose $= 18000 : 200 = 90$
- *Brown sugar*
  Supply : dose $= 10800 : 120 = 90$
- *Granulated sugar*
  Supply : dose $= 10000 : 100 = 100$
- *Margarine*
  Supply : dose $= 6400 : 80 = 82$
- *Egg*
  Supply : dose $= 450 : 5 = 90\ items$

Then, add up the whole

flour + brown sugar + granulated sugar + margarine + eggs

90 + 90 + 100 +82 + 90 =455

December has 31 days. The shop can produce 455 rampah cakes in a day. in December, the shop can produce: 455 x 31 = 14104 rampah cakes

Therefore, during December, the shop can produce 14104 rampah cakes based on the supply of ingredients.

Based on the transcript above, students began to solve problems by reading the question. They read the question carefully then finished it well. Students understand what they wanted in the question.

After being revised in the PISA-like mathematics problem using 'make *rampah* cake', a small-scale trial was conducted to determine the readability of the questions by taking six eighth-grade students. These students were not the subject of this research trial, consisting of 6 students, and every 2 students got low, medium, and high abilities. Based on the analysis result, the average positive response of students was 75%, and the average negative response of students was 25%. There were more than 50% of students giving a positive response. Therefore, the student response questionnaire met the "achieved" criteria.

Field Test

The most important stage in this research was conducting a field test to see the reliability and difficulty level of mathematical problems of PISA-like of mathematical literacy. The field test was conducted on 29 students of SMP Negeri 3 Sungguminasa. Students were asked to complete 10 questions in 2 x 45 minutes online. In the field test, the average positive response of students was 76.93%, and the average negative response of students was 23.07%.

The reliability test analysis was shown in the following table based on the field test results.

Table 1. Reliability Test Results

Cronbach's Alpha	N of Items
.851	10

Based on table 1, the level of reliability of the measuring instrument for mathematical literacy abilities of questions tested at SMP Negeri 3 Sungguminasa. The reliability of the questions was 0.781. The result indicated that the questions developed were in the "high" category. It meant that the measuring instrument was reliable.

In addition to the reliability test, the researcher also tested the difficulty levels to measure mathematical literacy abilities instruments. The items of the measuring instrument can be determined as good if they have a level of difficulty in the interval 0.30-0.70. This finding showed that the items were not too difficult and easy. The difficulty level of the measuring instrument developed was also obtained from the data on student works in the field test. The results of the analysis of the difficulty level of the measuring instrument for mathematical literacy abilities were shown in the following table.

Table 2. Analysis Result of Difficulty Level of Mathematical Problems of PISA-Like of the Mathematical Literacy

No.	Index of Difficulty	Category	No.	Index of Difficulty	Category
1	0.46	Medium	6	0.50	Medium
2	0.89	Medium	7	0.31	Medium
3	0.50	Medium	8	0.50	Medium
4	0.65	Medium	9	0.57	Medium
5	0.31	Medium	10	0.60	Medium

Based on Table 2, there were several categories of difficulty levels at the trial stage which were divided into three categories, namely questions that were classified as easy with a difficulty level of < 0.30, medium with a difficulty level of 0.30-0.70, and difficult with a difficulty level of > 0.70. All of the questions were in the medium category, and the average result was 0.529 in the medium category.

Following the quality criteria of the measuring instrument, several items measured the ability to mathematical literacy that were determined to have a poor level of difficulty if they were too easy and too difficult. The more people answered a question, the more easily the question was categorized. On the contrary, the less a question was answered, the more difficult it was.

Then, the analysis of the discriminatory power of the items was carried out. Suppose the discriminating power was greater than or equal to 0.3. In that case, the item would be accepted. If the discriminating power was between 0.2–0.29, the item would be revised. If the discriminating power was below 0, 2, it would be rejected. The distribution of discriminating power analysis can be presented in table 3.

Table 3. Analysis Result of Discriminating Power of Mathematical Problems of PISA-Like of the Mathematical Literacy

No.	Discrimination Item	Category	No.	Discrimination Item	Category
1	0.33	Accepted	6	0.22	Revised
2	0.21	Revised	7	0.37	Accepted
3	0.41	Accepted	8	0.35	Accepted
4	0.36	Accepted	9	0.43	Accepted
5	0.22	Revised	10	0.35	Accepted

Based on table 3, it could be concluded that the analysis result of the PISA-like mathematics problem using mathematical literacy obtained 7 questions with accepted decisions and 3 questions with revised decisions. Based on this empirical data, the 3 questions needed to be reviewed or revised.

The last step was to analyze the level of mathematical literacy skills by calculating each student's score after answering the given question. The analysis of student mathematical literacy test results is shown in the following table.

Table 4. Analysis of Field Test Results

Number of Questions	Students' Score	F	P (%)	Category
10 Questions	80< *Value*≤100	0	0.00	Very High
	60< *Value* ≤80	6	20.68	High
	40< *Value* ≤60	14	48.27	Medium
	20< *Value* ≤40	8	27.58	Low
	0≤ *value* ≤20	1	3.44	Very Low
	Number of subjects	29	100	
	Average	49.48		Medium

Based on the data analysis to measure the students' mathematical literacy skills of SMP Negeri 3 Sungguminasa, out of the 29 students subjected to the measuring instrument trial, no student had a very good level from the test results of mathematical literacy ability. Six students (20.68%) were categorized as having high mathematical literacy skills. There were 14 students (48.27%) categorized medium, eight students (27.58%) categorized low, and one student (3.44%) categorized very low in mathematical literacy capabilities. If averaged, the results were 49.48 and in the medium category. Several factors caused the low mathematical literacy skills. One of them was formal education that took place now tended to be stuck just struggling to hone the aspect of remembering and understanding, which was a low order of thinking. Students were asked to receive only the things conveyed by the teacher. Students had difficulty understanding abstract concepts with teacher-center learning methods, as students often solved certain problems but failed if the context of the problem was modified (Keiler, 2018). It was one of the reasons why students were not used to using high-level thinking, for example, PISA-like mathematics problems to measure the mathematical literacy skills. However, the development of PISA-like mathematics problems using mathematical literacy as a learning resource could facilitate students learning mathematics, finding solutions, using reasoning, and being associated with mathematical ideas in mathematical literacy.

4) CONCLUSION

The process of developing PISA-like mathematics problem using mathematical literacy consisted of four stages, namely: (a) preliminary stage, which was the search for references to PISA-like mathematical problems and determined the place of the research trials; (b) self-evaluation stage; analysis of curriculum, students, and materials was conducted before designing a PISA-like mathematics problem using Mathematical literacy; (c) Prototyping stage, which was to test the validity of the questions that have been developed; (d) Field test stage, had been implemented at SMP Negeri 3 Sungguminasa to determine the level of mathematical literacy ability, reliability, difficulty level, discriminating power, and field test analysis. Based on the analysis results obtained, the average mathematical literacy ability of class VIII SMP Negeri 3 Sungguminasa students was 49.48 in the medium category. Therefore, it could be concluded that teachers need further efforts to provide PISA-type mathematical problems that could stimulate students'

mathematical literacy abilities. Moreover, Mathematical literacy, which was used as a learning resource, helped students combine other problems with mathematical literacy.

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