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DEVELOPING PISA-*LIKE* MATHEMATICS TASK WITH INDONESIA NATURAL AND CULTURAL HERITAGE AS CONTEXT TO ASSESS STUDENTS MATHEMATICAL LITERACY

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Abstract

The aim of this research is produce a set of PISA-like mathematics task with Indonesia natural and cultural heritage as context which are valid, practical, to assess students' mathematics literacy. This is design research using type of development research with formative evaluation. A total of 20 students of SMP Negeri 1 Palembang. Beside, 10 experts were involved in this research to assess the feasibility of prototyping in terms of content, context and language. Walk through, documentation, questionnaire, test result, and interviews are way to collect the data. This research produced a PISA-like math task is as many 12 category of content, context, and process valid, practical and has potential effect. The validity came empirical evaluation of validation and reliability testing during small group. From the field test, we conclude that the tasks also potentially effect to the students' mathematical literacy in activating the indicators of each Fundamental Mathematical Capabilities.

Keywords: development research, PISA task, mathematics literacy, fundamental mathematical capabilities

Abstrak

Tujuan dari penelitian ini adalah menghasilkan soal PISA dengan konteks warisan alam dan budaya Indonesia yang valid dan praktis untuk menilai kemampuan literasi siswa. Penelitian ini adalah jenis penelitian *design research* dengan tipe *development research.* Penelitian ini menggunakan alur *formative evaluation.* Subjek dalam penelitian ini adalah 20 siswa kelas IX SMP Negeri 1 Palembang. Disamping itu, terdapat 10 dosen ahli yang terlibat dalam penelitian ini, baik dari dalam maupun luar negeri. Para ahli tersebut menilai kelayakan soal dari segi konten, konteks, dan bahasa. Proses pengumpulan data diperoleh dengan cara *walk through, documentation, questionnaire, test result,* dan *interviews*. Uji validitas dan reliabilitas soal dilakukan pada tahap small group. Pada tahap *field test,* diperoleh bahwa soal PISA dengan konteks warisan alam dan budaya Indonesia mampu memunculkan kemampuan literasi siswa berupa kemampuan dasar matematika.

Kata kunci: *development research,* soal PISA, literasi matematika, kemampuan dasar matematika

Badan Standart Nasional Pendidikan (BNSP, 2006) written that mathematics subject in the junior high school has several purposes. Students can understand the concept of mathematics, this means that they can be explain the relationship between concept and apply the concept or algorithm appropriately. Second, students can use the pattern and characteristics of the mathematics reasoning, making generalization in mathematical manipulation, compile evidence, and explain ideas and mathematical statement.

Third, solving the mathematical problems which include the ability to understand the problems, designing mathematical models, and completing the model and interpret the solution. Students should

communicate the ideas with symbol, tables, diagrams, or other media to clarify the issue. The last, the purpose of mathematics subject in the junior high school is to make student have respect for the usefulness of mathematics in the life. Base on the mathematics purpose, the can be seen that the curriculum has noticed the aspect of mathematical literacy.

PISA (Programme for International Student Assessment) is an international organization that evaluation the mathematical literacy skills of students in the world. The Organization for Economic Co-operation and Development (OECD, 2013) explain that the focus of PISA is the emphasis on students' skills and competencies obtained from school and can be used in everyday life and in various situations. PISA-like mathematics task requires students to have higher thinking skills, by combining their knowledge in solving mathematical problems (Wardhani, 2004).

But, in the reality the mathematical literacy of Indonesia students is lower than the other country. It's because they are not accustomed to work on the mathematical problems with high-thinking skills (Shadiq, 2007). In the other hand, Julaiha (2001) explained that the most of Indonesia students are not familiar with the PISA problems because the PISA problems using the realistic context. Jupri, et al (2013) adds that there are several things that make the students fail in PISA survey which is when the students formulate mathematical problems into formal form and when they have found the results, they don't proceed to the next step. Therefore, this research aims to produce a set of PISA-like mathematics task which are valid, practical, and has potential effect to the development of student mathematical literacy.

The definition of mathematical literacy in PISA 2012 is the capacity of students to formulate, employ, and interpret mathematics in a variety of context. Kusumah (in Aini, 2013) explain that mathematical literacy contains the ability to construct a set of questions, formulate, solve, and interpret the problems based on the context. Niss (in Aini, 2013) also express that mathematical literacy have several indicators, those are : (1) reasoning and mathematical thinking; (2) mathematical argumentation; (3) mathematical communication; (4) modeling; (5) submission of problems solving; (6) representation; (7) symbol; and (8) media and technology.

Mathematical literacy starts from realistic problems, which are categorized into category of context and content. The mathematical literacy process start from identifying the realistic problems and formulate the problem mathematically based on the concepts and relationship inherent in the problem. After getting an appropriate mathematical form of the problem, the next steps is to employ certain mathematical procedures to obtained mathematical results, which then interpret those back into the initial problems.

METHOD

This study is design research using type of development study. This study concern with iterative development using the formative evaluation in various consumer (Plomp & Nieveen, 2007). The formative evaluation contained in this research consisted of preliminary stage and prototyping

phase which includes self-evaluation, expert reviews and one-to-one, small group, and a field test (Zulkardi, 2002; Tessmer, 1993).

The development process started form preliminary steps by grasping, the concept related to development of mathematical literacy task and used it to design an initial prototype. Afterwards, this prototype was then self-evaluated before going into the next steps. In expert review, ten expert were involved to validate the task in term of content, construct, and language. For one-to-one phase, 4 students evaluated particularly on how they understand the information, for example, picture, or phrase, the task and not focus on how they answer the task.

These result gave significant suggestion and revising the task so that those could be re-evaluated in small group. The small group phase involved 10 students with various academic abilities to solve the task in 75 minutes. Here, we firstly obtained the data of how students perform in solving the task because by analyzing the variety of students answer. We used this data to assess students real performance in field test. The field test was involving 20 students of grade IX form SMP Negeri 1 Palembang.

RESULT AND DISCUSSION

Developing Tasks

In the preliminary stage, we conducted several steps; (1) examined the literature on developing mathematical task, framework of the PISA 2015, the relationship between the current curriculum and the PISA survey, (2) designed an initial prototype comprising a set of PISA-like task and its scoring, (3) determined the validators, (4) determined the research subject. At the stage of self-evaluation, we examined the initial prototype resulting prototype 1.

The prototype 1 then evaluated by validators or expert review and also through one-to-one phase that involving students. In the expert review phase, prototype 1 was assessed and evaluated by 10 experts, namely Prof. Kaye Stacey and Dr. Ross Turner, the mathematics expert group of PISA, the PMRI lecturers, Prof. Dr. Ahmad Fauzan, Prof Dr. Ipung Yuwono and Dr. Yenita Roza, Mathematics teachers, Nurjannah, M.Pd and Nadya Husenti, M.Pd, and the last Dr. Ariyadi Wijaya, Kamaliyah, M.Pd, Ni Luh Sakinah M.Pd, Ahmad Wahidul Kohar, M.Pd as PISA researcher. These expert reviewed the prototype 1 in terms of the content, the construct and the language. Afterwards, the researcher conducted a test to 4 students SMP Negeri 1 Palembang grade IX individually (one-to-one). The following is one of tasks example on this situation.

Before Revision

UNIT 3: BATIK

Basic competence: solving problems by estimating the unknown quantity by using graphics, algebra, and aritmatics.

7. Ana was ordered to buy *Kain Batik* in *Pasar Klewer*, a traditional market in Solo. After surveying the merchants in the market, Ana was interested to buy in the 2 shops having attractive offers, Toko Indrajaya and Toko Abadi.

   - Toko Indrajaya → selling kain Batik in Kilo with the price Rp 75000/Kg. For 5 Kg or more purchase, the price is Rp 70000/Kg. (Per-Kilo= the material is 8-12 meters in length, and 1,15 meters in width, based on the thickness and thinness of the material).
   - Toko Surya Abadi → selling kain batik per sheet with the price Rp 35000 – 45000 per sheet (depends on the the thickness and thinness of the material), the size is 115 × 200 cm.

   Which shop that Ana should choose? Give your reason!

8. If Ana is ordered to buy Kain Batik for her office uniform, consisting of 10 adult female and 15 adult male (note: all workers have a normal body size). Determine the minimum outgo to buy the uniform material based on the shop that Ana has chosen.

Figure 1. Task before revision

Table 1. Comments from Expert and Students on number 7

Validation	Comments/Responds	Revision
Expert review	The question is not clear. "*This is not clear, or not sufficient information. Does it mean that for the thickest material, 8 meters weighs one kilo, and for the thinnest material, 12 meters weights one kilo? If so, please state this more clearly, then I think the problem does have a solution in its current form (ie, you can disregard most of my other comments).*"	• Changing the question with the realistic question • Using different context
	Change the question with "*Which store should be chosen Ana in*	

	order to obtain a cheaper price?"	
Student	I don't know how to solve this problem, because for me is so complicated problem	
	This question need logical thinking, I can solve it by my self	

Table 2. Comments from Expert and Students on number 8

Validation	Comments/Responds	Revision
Expert review	The question is not clear. "I infer that you are mostly interested in the reasoning followed by the student to make this decision. You should frame your question to make it clear that this is your objective. For example, you could say "Give a detailed mathematical argument as to why Ana should choose Toko Indrajaya."	• Changing the question with the realistic question • Using different context
	Problem impressed related to the previous problem	
Student	The question no 7 and no 8 interrelated	
	The answer of number 7 influence the answer of number 8	

After obtaining some suggestion from both experts and students, the prototype 1 was revised become prototype 2. The following is the revised task based on the Table 1 and Table 2.

After Revision

Batik

7. Look the motif Batik Cirebon beside!
   Determine the 100^{th} colour of the Batik…

8. SMP Negeri 1 Palembang, plans to make batik uniforms for students. They choose Batik Jogja, Motif Batik Songket and Batik Solo. Students were asked to choose the batik. From the calculations, $\frac{2}{5}$ choose Batik Jogja, $\frac{5}{12}$ choose Songket and Batik motif as much as 440 students choose Batik Solo. Determine the total of all voice collected and batik which has the highest number of votes?

Figure 2. Task 1 after revision

Start from the result of expert review and one-to-one phase, the prototype 1 become prototype 2. After that, prototype 2 tested to small group consisting 10 students from ninth grader. The results show that the task has coefficient of high reliability of 0,70 but some task were empirically invalid. Therefore, the researcher reviewed each items developed primarily on the invalid task for discarded, maintained with revisions, or retained without revision. This decision was based on the result of activities: (1) giving a questionnaire that ask students opinions regarding the task they have did; (2) examining the distribution of student's answers; and (3) interviewing the students in the small group to investigate whether the student were not able to solve the task in the absence of the aid scheme or in the matter of readability issues.

The result of this evaluation resulted in prototype 3 which was then used in a field trial test involving 20 students in order to know the potential effect to the task as well as to assess the mathematical literacy of students when they solve the mathematics PISA problems that use Indonesia natural and cultural heritage as context.

Potential Effects of the Task

After the students completed work on the task, the researcher gave questionnaires to all the students, and interviewed 4 of them to obtain the data about the potential effect. The student responses regarding the questionnaire is shown below.

Tabel 3. Students Response in Activating FMC

No	Activated Fundamental Mathematical Capabilities	Response of students
1	Mathematizing	18 %
2	Communication	31%
3	representation	50%
4	Devising problems solving strategies	45%
5	Reasoning and argumentation	91%
6	Use of formal / symbolic language	45%

Based on the Table 3, 6 of 7 Fundamental Mathematical Capabilities to be use of students in solving the prototype 3. From the table, it also can be seen that the reasoning and argumentation were recognized by most students in solving problems. And the mathematizing were least used by students. Additionally, the table below show the response of students after working the task.

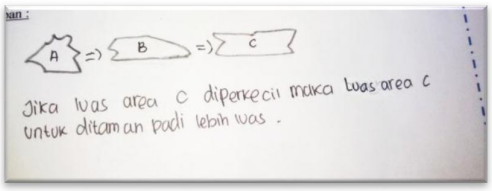
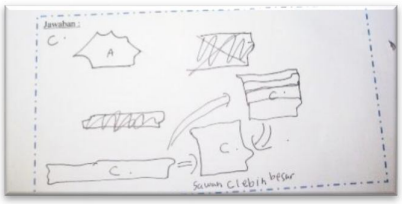


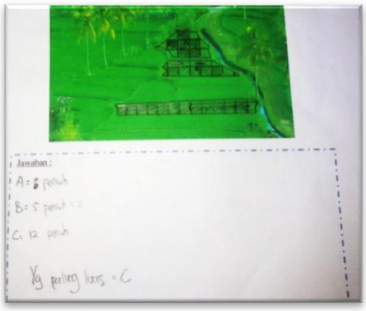
Table 4. Students Response on Prototype 3

How interesting are the task?	Response of students
I am interested and serious in working all the tasks	44%
I am only interested and serious in working certain tasks	55%
I am not interested in the tasks at all	1%

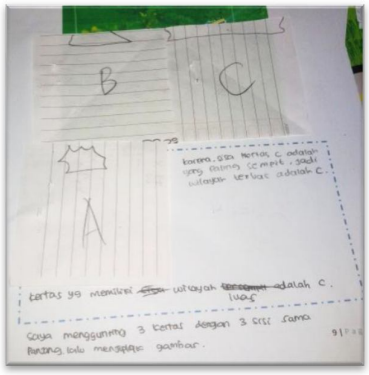
As a proof how students activate their FMC into mathematical process: formulate, employ, interpret in solving the tasks, the following are examples of students' work on task 10.The aim of the task is to know the students ability to estimate the area of field. (See Fig 3).



(a) (b)



(c)



(d)

Figure 3. The students answer on task 10

Form the figure 3 show that students have different ways to answers the task. Figure 3 (a) and (b) showed that students copying the picture in the same size and compare the picture. He found that the picture c have the large area than the other. Different way with (a) and (b), the figure 3 (c) showed that students compare the picture with small unit. And figure 3 (d) indicate that he use the some way with (a) and (b), but (c) copying the picture in the paper with the same size. After that, he compare the picture. All of the answers show that students using the various strategy to solve the problems.

CONCLUSION

This study produced set of PISA-like mathematics task with Indonesia natural and cultural heritage which valid and practical. Based on the result, prototype 3 has potential effect to assess the mathematical literacy of students, it shown by the student answers. Others indication of this effect are also seen from their seriousness and interesting when solving the task. Lastly, suggest teachers and other practitioners to use the task from study as tools in designing PISA problem based learning.

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