PISA-like problems on students’ mathematical literacy using the context of Jakabaring sport city

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Abstract. Challenges for developing countries must certainly have students with high mathematical literacy abilities. The fact was Indonesian students in PISA math rankings are still not good; it because of the low mathematical literacy abilities of students. This article aimed to know the potential effects of PISA mathematics problems on students mathematical literacy abilities. The method in this study used a design research type of development study with the preliminary and formative evaluation stages. The evaluation flow at the prototyping stage was a formative study including the self-evaluation stage, expert review and one-to-one, small group, and field test. In this article, the discussion of the study was about the results of students’ answers in the field test stage, questions that have potential effects that give rise to mathematical literacy abilities namely communication ability, mathematical ability, representation ability, reasoning, and argument ability, choose strategies to problem-solving ability, and use language and symbolic, formal and technical operation ability. With the dominant ability was communication ability.

1. Introduction

Facing the challenges in the 21st century, one of them is having students with high literacy skills where students are not just understanding but can use it in everyday problem solving [1]. The ability of mathematics literacy can be developed in PISA type questions. PISA or Program for International Student Assessment is an international assessment for 15-year-old students every 3 years with the goal of knowing and assessing students' abilities and skills [2]. Mathematical literacy ability is the ability to use mathematical knowledge and understanding in facing the challenges and use of mathematics in daily life [3,4]. The ability of students not only in math counting but also how students use it in analyzing complex problems which can use PISA questions in measuring mathematical literacy abilities in solving problems [5,6].

Based on the fact from the results of the 2015 PISA study on mathematical literacy, Indonesia is ranked 62 out of 70 participating countries [1]. The low mathematical literacy abilities of students occur because students are less accustomed to solving problems that are appropriate to the situation and lack of teaching materials during the learning process [7, 8]. Indonesian students have difficulty in solving mathematical problems such as PISA problems which use context and turn it into a mathematical problem [9].

The effort that can be done is to design problems that are suitable with the characteristics of PISA and train students through the provision of PISA questions routinely using contexts that are close to students’ activity [10,11]. In relation with this, students are given PISA type questions to train high-level abilities of students [12]. Previous related studies on the development of PISA questions helped students understand mathematical learning, such as the Development of Mathematical Questions in the PISA Model to Measure Mathematical Reasoning Capabilities [13].
Several studies conducted by other researchers such as the Development of PISA Like Mathematical Questions on Change and Relationship Content for Junior High School Students [14] and Development of Mathematical Problems in the PISA Model on Quantity Content to Measure Mathematical Problem Solving Abilities of Middle School Students [15]. Many studies have been conducted on the development of mathematical problems such as PISA, but no one has used Context. Where the use of context in mathematics learning can make mathematical concepts more meaningful because from that context can make abstract mathematical concepts that are easily understood by students [16,17]. Therefore researchers are interested in the context of Jakabaring Sport City. Jakabaring Sport City complex or commonly called Jakabaring Sport City is an integrated sports facilities complex located in Palembang; South Sumatra Indonesia located 5 kilometers southeast of Palembang, opposite the Musi River Ampera Bridge in Jakabaring Sebrang Ulu 1 [18].

Learning mathematics itself is related to everyday life where daily activities can not be separated from the application of concepts related to mathematics [19]. One approach that is suitable for use in mathematics learning that emphasizes context and situation is the PMRI approach where this learning approach will direct students to understand mathematical concepts through prior knowledge related to students’ daily activity so students can find their mathematical concepts so that student learning more meaningful [20,21]. Through PMRI, it can make the learning process more useful and can please the students [22] as well as approaches that provide opportunities for students to be active during the learning process where students are asked to build students’ understanding of the concepts just learned [23]. Based on the description above, the purpose of this article is to find out the mathematical literacy abilities of students that appear in the field test trials of class X of high school students.

Many researchers have researched PISA [13,14]. Then, research on mathematical literacy has also been done by many previous researchers [24,25]. In this article, it will be different from the previous study, this article discussed students’ mathematical literacy abilities that arise when field tests are conducted. Therefore the purpose of this article is to find out the potential effects of the mathematical type of PISA using the Jakabaring Sport City tourist context on the mathematical literacy abilities of X class high school students.

2. Method
The method used in this study is design research of development study type with two stages, namely preliminary and formative evaluation. In the prototyping stage, the assessment used formative evaluation with several steps, including self-evaluation, expert review and, one-to-one, small group, and field test [26]. Where the subjects of the study were tenth-grade students from senior high school age 15 years old. The preliminary stage, analyzed the PISA framework and the 2013 curriculum, then the researcher designed the instrument. Next, the researcher conducted a self-evaluation in the formative evaluation stage. The researcher re-evaluated the initial prototype then analyzed and produced a prototype 1.

Next, to the expert review stage, prototype 1 was evaluated and assessed by experts to be validated based on content, constructs, and language. Along with the expert review, the one-to-one stage was also carried out. The results of the expert review and the one-to-one trial results are used to revise the product and produce prototype 2. Then prototype 2 was tested in the small group stage, which was used to determine the practicality of the problem that had been developed. The result of the revision in the small group stage was called prototype 3 and tested in the field test phase. The field test stage was carried out on 34 students in high school to determine the potential effects of problems developed on students’ literacy abilities. Where to find out students about literacy skills that arise, student answers were analyzed based on problems and saw indicators of mathematical literacy skills based on the 2015 PISA framework.

3. Result and Discussion
In the preliminary stage, researchers analyzed the 2013 curriculum and PISA framework and the researchers designed an instrument that included questions, question cards, and scoring rubrics and supporting instruments such as lesson plans (RPP) and teacher's instructions. Then the researchers designed mathematical problems such as PISA where researchers developed mathematical problems
from genuine PISA math problems. In creating problems in PISA questions that were developed against students' mathematical literacy abilities, researchers used the Jakabarining Sport City Tourism context in Palembang ranging from tours to photo stop, bowling, bicycle, menu, pocket money, chair, scale, track. From this preliminary stage, it produces the initial prototype. Furthermore, self-evaluation was carried out in the formative evaluation phase, where the researcher reviewed and re-evaluated the initial prototype that has been previously designed and produced a prototype 1. This study produced nine-question of mathematical problems against students’ mathematics literacy abilities.

Here are the characteristics of the questions that have been developed towards students' mathematical literacy abilities, the number 1 used the context of photo stop content change and relationship with the ability to employ process and predict the level 2. Number 2 used the context of bowling content change and relationship with the ability to employ process and predict level 3. Number 3 used the context of bicycle content change and relationship with the ability to employ process and predict the level 5. Number 4 used the context of menu content quantity with the ability to formulate process and prediction level 1; then number 5 used the context of menu content quantity with ability to formulation process and level 3 prediction. Number 6 used the context of pocket money content uncertainty and data with the ability to employ process and predict the level 4. Number 7 used the context of chair content uncertainty and data with the ability to interpret process and predict level 6. Number 8 used the context of scale content space and shaped with the ability to employ process and predict the level 2. Number 9 used the context of track content change and relationship with the ability of the process of interpreting process and prediction of level 5. The following was a math problem of number 3 questions that have been developed in Figure 1.

![Osi cycling around the football stadium was 6 rounds with an average time of 03 minutes 54 seconds.](image)

| Round to- | Record Time (Minutes) |
|----------|-----------------------|
| 1        | 04 minutes 25 seconds |
| 2        | 03 minutes 19 seconds |
| 3        | 03 minutes 48 seconds |
| 4        | 03 minutes 20 seconds |
| 5        | 03 minutes 10 seconds |

How many the minimum time that Nessy has to achieve in the 6th round to winner from Osi? Explain your answer!

**Figure 1. Math Problem of Number 3**

At the expert review stage, prototype 1 was assessed by several validators in terms of content, constructs and language, based on comments and suggestions from the validator to improve the sentence on the question so will not confuse students when reading the questions. Along with the expert review stage, the one-to-one stage was also conducted on three students of class X to see the response and obstacles of students when completing the PISA problem. Validity is seen from the comments and suggestions revised by the validator in the expert review stage and based on the students' responses to the one-to-one stage. From the comments and opinions of the validator and the results of the one-to-one trial, the problem was revised again and produced a prototype 2.

In the small group stage, prototype 2, which was the result of revisions from the expert review and one-to-one stages, was tested on six students with different abilities. Based on the results of this stage
both when learning and testing can be concluded that students have been able to understand and understand the instructions and questions on the questions, most students have been able to answer and have no difficulties than can answer correctly, but there are still students who are not thorough and occur mistakes when reading and understanding questions. The small group stage in unit 3 concerning the context of bicycle, found that there were sentence sentences that made some students confused, namely in the sentence “Then Nessy followed but only complete five rounds with record time” so that the sentence on the problem was revised “Look Nessy behind Osi who follows but only complete five rounds with the following record time”. Based on the small group stage, the developed questions were revised and obtained a valid and practical prototype 3. Practicality is seen from the ease of students in understanding problems in the problem.

The prototype 3 was then tested at the Field test stage carried out at the for 34 students in Senior High School. All students work on prototype 3 to find out the potential effects of the questions developed on students' mathematical literacy abilities. Based on the results of the field test stage, it was found that in number one, the math literacy abilities that emerged was communication ability and representation ability. Number 2 the abilities that emerged was communication ability, choose strategies to problem-solving ability, reasoning and argument ability, use language and symbolic, formal and technical operation ability. Number 3 the abilities that emerged was communication ability and mathematics ability. Number 5 the abilities that emerged was communication ability and mathematics ability. Number 6 the abilities that emerged was communication ability and mathematics ability. Number 7 the abilities that emerged was communication ability, mathematics ability, use language and symbolic, formal and technical operation ability. Number 8 the abilities that emerged was communication ability. Then number 9 that abilities that emerged were reasoning and argument ability.

The following was a student strategy to answer number 3 problems in the field test stage in Figure 2.

In figure 2 showed the student's strategy in unit 3. From the results of the student's work, it can be seen that the problem can bring up communication abilities (K.1) because students can read, understand, and write problems to articulate solutions and showed solutions involved in finding estimated time the average required in the sixth round. Students could write the process of reaching a solution.

From the results of the student's work, it can be seen that the question could give rise to mathematical abilities (K.2) because students could write and operated the intent of the problem on the mathematical form by determining the average time required in Nessy's sixth round by connecting to the average number Osi average time that has been informed on the question. Students can use understanding contexts to solve mathematical problems.
Furthermore, from the students’ answer strategies, they emerged the ability to use language and symbolic, formal and technical operations (K.6) because they played a role in determining the timing of each time needed by using the X symbol for each round like X1 for the first round and X2 for the second round etc. Students can use formal forms based on complete mathematical definitions and rules.

From the answers of students, there were 76% of students can read, understand, and write from information to reach a complete and correct solution. This showed that students were able to apply communication ability. Furthermore, 70% of students can write and operate problems in the problem to the solution in mathematical form. This showed that students could apply mathematical ability. Next, 55% of students can use variables as symbols in determining the initialization of each time that requires a symbol. This showed that students were able to apply the ability to use language and symbolic, formal, and technical operation ability.

Based on the results of the field test, it was found that in this article, there were six students’ literacy abilities that emerged from the whole problem, and the most dominant was communication ability. A total of 8 questions elicit communication ability in it. This is by Lindquist and Elliott's statement [27] that the importance of communication ability in mathematics learning is because communication is fundamental to teaching, learning, and accessing mathematics.

4. Conclusion
Mathematical problems such as PISA which have been developed using the context of Jakabaring Sport City Tourism in Palembang on students’ mathematical literacy abilities in this article have met the criteria of potential effects and were by the PISA framework. The questions that have been developed have a potential effect on students' mathematical literacy abilities during the field test stage where mathematical literacy abilities that emerge are communication ability, mathematics ability, representation ability, reasoning, and argument ability, choose strategies to problem solving ability, use language, operations, symbolic, formal and technical ability. The most dominant ability is communication ability.

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