Developing PISA-Like Mathematics Problems Using Indonesian Food Context

L Sulistiani* and Zulkardi
Universitas Sriwijaya, Jl. Srijaya Negara, Bukit Besar, Palembang, Indonesia

*Email: liasulistiani4546@gmail.com

Abstract. This study aims to generate the valid and practical PISA-like mathematics problems on uncertainty and data using Indonesian food context. It also aims to see the potential effects of the problems towards the high school students' mathematical ability. This study used a design research methodology with the type of development study which was divided into two stages, namely preliminary stage and formative evaluation stage. This study produced valid and practical PISA-like mathematics problems on uncertainty and data content which have a potential effect on the senior high school students’ mathematical literacy ability. The validity was determined based on the expert review, while the practicality was determined based on one-to-one and small group assessment. Based on the students answer, it was found that the problems had potential effects that arouse the ability, communication, reasoning and argument, representation and devising strategies for problem-solving.

1. Introduction
The holder of an important role in the progress of a country is quality education. High or low education, both formal and informal is influenced by various factors. These factors can be sourced from students, instructors, the environment and facilities that support the learning process [1]. All of that affects students' reasoning abilities. Students' reasoning abilities can be improved through mathematics.

Mathematics is a basic science that must be owned by every student. Because math can make it easier to learn other subjects and can be applied in everyday life [2]. In line with this, the 2013 curriculum not only emphasizes understanding the concept but also on how the concept can be applied in various situations. As well as students' ability to reason about how to solve a problem.

To measure the quality of education and reasoning abilities students can go through the PISA (Program for International Student Assessment) study [3]. PISA is an international study, one of which is to assess reading, mathematics and science literacy achievements, 15-year-old school students [4]. This reasoning ability is included in students' mathematical literacy abilities. Based on research conducted by PISA, it was found that students' mathematical literacy skills were still low, this could be seen from Indonesia which was always ranked in the 10 lowest countries of the countries that participated in PISA [5]. The results of the study conducted by PISA found that the average international score of mathematical literacy skills was 500 meaning that it was at level 3, while the average score of Indonesian mathematics literacy students was at the lowest level of the six levels of mathematical literacy abilities set by PISA [6], namely 1 with a score of 375 and only on level 3 that can be achieved by Indonesian students. The results of the PISA study show that there are differences in literacy abilities that can be achieved by Indonesian students.

Some studies related to mathematical literacy including [7] low to high ability students are not familiar with questions that require logical thinking and applicative solutions. Salim and Prajono [8] found that students' mathematical literacy skills were still low due to incomplete learning resources...
related to mathematical literacy. In line with that, study found that the average percentage of mathematics literacy skills of students in the State Junior High School in Konawe District was still low, which only reached a value of less than 60% for each level level in the PISA type of math literacy questions [9].

In addition to focusing on students' mathematical literacy skills to be better, it also requires a context for the question students will solve. The context that is already known by students so that the reasoning process of students in solving the problem will be much better and easier. The context of Indonesian food is one that can be used. Based on the things described above, researchers are interested in developing a type of PISA problem using the Indonesian food context in uncertainty and data content.

2. Method
The method used in this study was design research with the type of development studies. This study consisted of two main stages; preliminary and formative evaluation stages [10,11]. In the formative evaluation stage following the developing flow, the steps included self-evaluation, expert reviews, one-to-one, small group and field test [12].

In the preliminary stage, we determined and analyzed the place and subjects of the study. The subjects of this research were the tenth-grade students of Senior High School. Also, we conducted the analyses of curriculum. Next, we designed the problem set which included the problem grids, problem cards, and scoring rubric. Then, the next stage was the formative evaluation. In the formative evaluation stage, the first phase was self-evaluation. It is the phase where the researcher evaluates his own instructional [12]. In this phase, we evaluated and re-examined the PISA-like mathematics set prepared previously. The result was called prototype I. Then, it proceeded to the expert reviews and one-to-one phases simultaneously. The experts assessed prototype I by evaluating it based on the content, constructs, and language.

In the same time, the one-to-one phase was also conducted. At this phase, the prototype I was tested to three students. The students employed were the tenth graders of Vocational High School by having different abilities. They were one student with high ability, one student with medium ability, and one student with low ability. We made the results and findings in the expert reviews and one-to-one phases as a consideration to revise the Prototype I. The result of the revision was called Prototype II. Prototype II was tested in a small group phase. Six tenth-grade students of Senior High School with different abilities. The six students were two students with high ability, two students with medium ability, and two students with low ability. The comments and findings at this small group phase were taken into consideration in revising the Prototype II. The revision of Prototype II was called Prototype III.

3. Result and Discussion
This research produced two items of PISA-like mathematics problems on uncertainty and data content using Indonesian food context which was valid and practical. However, in this paper, the researchers only covered one problem using Indonesian food context at third level.

3.1. Preliminary Stage
At this stage, we performed student analysis to find out the 15-year-old student and the students who had the low, medium and high ability, curriculum analysis, and analysis of PISA problems to develop PISA-like mathematics problems based on the PISA framework. In the preliminary stage, we designed mathematics problems of PISA-like on uncertainty and data with Indonesian food context.
Juminah sells various kinds of food for breakfast in her stall. She sells Lontong Kuah Santan, Nasi Uduk, Nasi Kuning and Nasi Goreng as the main dishes. There are also various choice of side dishes, namely boiled eggs, omelette and fried chicken. How many possibilities are the pairs of side dishes that Hafiz can buy in Juminah’s stall?

Figure 1 shows that one of the PISA-like mathematics problems using Indonesian food context.

3.2. Formative evaluation

3.2.1 Self evaluation

At this stage the researcher evaluates and reviews the initial prototype that was made at the preliminary stage based on the characteristics that became the focus of the prototype. The characteristics that are the focus of the prototype are in terms of content, constructs, and language.

3.2.2 Experts reviews and one-to-one

At this stage, question validation is examined in terms of content, constructs and language by one expert. In addition, researchers also asked for opinions from two experts who were experienced practitioner as expert validators. The following are expert review and student comments

| Table 1. Comments of experts and student validation |
|---------------------------------------------------|
| **Validation** | **Comments/Response** | **Revise** |
| Expert review | • Images such as only sweeteners are not used for calculations in their completion. | • The researcher concluded that it was corrected according to Mrs. Rini’s suggestion, which was to make the word "various kinds of food" just sell breakfast. Then "There are several choices of side dishes ...” only available side dishes. |
| Students | • Confused about how to solve the problem. | |

Translation:

Juminah menjual berbagai macam makanan untuk sarapan pagi. Seperti lontong kuah santan, nasi uduk, nasi kuning dan nasi goreng. Terdapat beberapa pilihan lauk yaitu telur rebus, telur dadar dan ayam goreng. Bagaimana kemungkinan pasangan makanan tersebut yang dapat dibeli oleh Hafiz dalam warung Bude Juminah?

Figure 1. The PISA-like problem before revision
3.2.3 Small group

The revised questions based on comments/suggestions on expert reviews and one-to-one are called prototype 2. The prototype 2 was tested on the small group stage consisting of 6 students of SMK Negeri 1 Palembang with different abilities, namely 2 students with high ability, 2 students with moderate abilities, and 2 students with low abilities. The implementation of the small group trial was held at SMK Negeri 1 Palembang. Below are the results of student answers

![Figure 2. Students A answer](image1)

In the picture is the student's answer strategy. From these results it can be seen that the students' answers give rise to communication skills because students can read and write down all food and side dishes in the question. This shows an indicator of communication skills, namely writing down the process in reaching the solution and concluding the mathematical results [13]. But for students' answers figure 2 is not complete because it does not conclude the results that have been obtained.

In addition, the results of the workmanship show the ability to choose a strategy to solve the problem because it is in accordance with the indicator of choosing a strategy to solve the problem [14], that is, can use the strategy through procedures that lead to known solutions and mathematical conclusions. From the students' answers, it is seen that he uses a tree diagram for the solution.

![Figure 3. Student B answer](image2)

Students' answers in figure 3 shows the ability to choose a strategy to solve a problem because it is in accordance with the indicator of choosing a strategy to solve a problem that is to be able to use strategies through procedures that lead to known solutions and mathematical conclusions [15]. From the picture, the students' answers are obtained by registering. In addition, it also raises communication skills with its indicators, namely writing down the process of reaching a solution and concluding mathematical results. Based on these answers, students have been able to complete correctly and completely because they have come to the conclusion.
From the results of the student's work in figure 4, it was seen that students' answers gave rise to communication skills. In addition, it also raises the ability to use language and symbolic, formal and technical operations because students can put food into A, B, C, D and for the side dish to be X, Y, Z. This is in accordance with the indicators of the ability to use language and symbolic, formal and technical operations, namely students can use formal forms based on mathematical definitions and rules completely.

The results of the student worksheet analysis show that most students can solve the problem well using the context of Indonesian food. Based on the results of expert review, one-to-one, and small groups, it can be concluded that the problem of using the context of Indonesian food that has been designed is categorized as valid and practical. Not only visible from the results of expert reviews, but also from students' responses and understanding in completing problem. On this case, almost students can solve the problem well using the context of Indonesian food. Practicality is illustrated by the results of the small group phase which is a problem can be understood for the probability of learning, easy used because they can solve problems well.

4. Conclusion
This study produced PISA-like mathematics problem with rice contexts. The validity was viewed from the assessment of experts regarding content, constructs, and language, as well as from students' comments on the clarity/readability of the problems in the one-to-one stage. Practicality was based on the interviews and student work on the small group stage. Based on the analysis of students strategies, it was found that the problems had potential effects that increase the ability to use communication ability, reasoning and argument, and representation ability.

5. Acknowledgments
The researcher would like to thank teachers and students in high school who have helped in the research process. And also, to the supervisor, Mr. Zulkardi who has guided from the beginning so that this paper can finally be completed. Apart from that, the researcher also thanked the head of department, Mr. Darma, and also the staff.

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