PISA-like mathematics problems using rice fields context in Karawang

I N Aini¹, Zulkardi², R I I Putri² and P Yaniawati³

¹Universitas Singaperbangsa Karawang, Jl. HS. Ronggo Waluyo, Jawa Barat 41361 Indonesia
²Universitas Sriwijaya, Jl. Srijaya Negara, Palembang 30128 Indonesia
³Universitas Pasundan, Jl. Sumatra No 41, Bandung 40117 Indonesia

E-mail: indrie.nooraini@staff.unsika.ac.id

Abstract. This research is development research which produces a PISA-like mathematics model using the context of rice fields in Karawang Regency. The method in this study is design research with a type of development studies consisting of preliminary, prototyping, and assessment stages. The evaluation flow in the prototyping stage is a formative study, including the stages of self-evaluation, expert review and one-to-one, small group, and field tests. In this article, the research discussion is in the expert review and one-to-one phases. Research subjects were three students of a junior high school in Karawang. Data collected with walkthrough based on expert reviews to obtain the valid PISA-like mathematics problems in content, construction, and language aspects, and interviews which used one to one interview. The results of the data analysis, it can be concluded that this study has produced a PISA-like mathematics model using the context of rice fields in Karawang which is valid.

1. Introductions
Mathematica literacy is interpreted as the ability to use knowledge and mathematical understanding effectively in facing challenges in daily life [1]. The main idea in mathematical literacy is the use of mathematics in daily life [2]. The 2015 PISA problem was developed based on four content, relationship content, space and shape, quantity, and uncertainty and data [3]. One of the PISA content related to planning is space and shape.

Moreover, the result from the survey of the Programme for International Student Assessment (PISA) on mathematical literacy in the last two periods showed that in 2012, Indonesia is ranked 64 out of 65 countries [4,5]. Then, in 2015, Indonesia is ranked 62 out of 70 countries with the score 386 from the OECD countries’ average score is 490 [6]. Based on these results, the importance of mathematical literacy is not along with the results and achievements obtained by Indonesian students in the International PISA survey.

In PISA, the level of questions describes students' skills in solving everyday problems that require mathematics in solving them. This skill is referred to as mathematical literacy which refers to the ability of students to formulate problems mathematically based on the concepts and relationships inherent in the problem, then apply mathematical procedures to obtain 'mathematical results' and reinterpret the results into related forms with initial problems.
Mathematics is a lesson that is closely related to daily life. Human activity in daily life cannot be separated from the utilization and application of concepts that exist in mathematics [7]. The cases those relate to the daily life of learners can be a starting point to learn a matter in school mathematics. The context or experience of students is used as the starting point of the mathematics learning process [8].

The students' difficulties in solving contextual problems were caused by a lack of mathematics textbooks in Indonesia which emphasized daily problem solving as tested in PISA [9]. Many of the questions found including national exams only test skills using mathematical procedures just like complicated calculations.

To help the teacher in introducing the PISA model mathematics problem, we need a source of teaching material that is relevant to the concept of the PISA question. One way is to develop a PISA model of mathematical problems related to everyday life. So that students can easily understand it.

One context that is close to students in Karawang regency which might be able to be raised as a context to develop the PISA model is Rice. The term Karawang is the granary of West Java because the land is mostly very fertile rice fields.

2. Method
This research involved seventh graders in junior high school. This research applied research development or development studies research design [10]. This study was conducted in two steps, namely the preliminary step, the prototyping step, and formative evaluation step [11]. In the preliminary step, the researchers analyzed the characteristics of PISA problems, the curriculum, and the students. In the prototyping step, the researchers designed the initial prototype including the question assessment rubric to be used.

In the formative evaluation, the first step was self-evaluation it is mean the researchers evaluated the prototype by themselves and the result was called Prototype 1. Then, the Prototype 1 was evaluated by the validators at the expert reviews step based on the content, construct, and language. Along with it, the one-to-one was undertaken where Prototype 1 was tested to three students. The result of the expert reviews stage and the one-to-one stage was used to revise Prototype 1, and it was called Prototype 2 [12, 13].

| Characteristics | Aspects Examined |
|-----------------|-----------------|
| Content         | The problem in accordance to characteristics PISA |
| Construct       | The problem according to the junior high school level |
|                 | In accordance with the PISA framework |
| Language        | The problem in accordance with the general guidelines of Indonesian spelling |
|                 | The language of the question and the question is clear |

Four questions developed in this research and the success criteria of this research are when PISA-like mathematics problems using the context of rice fields in Karawang is declared valid. The validity is obtained from the validation of experts. Experts referred to this study are experts in mathematics education. The Prototype 1 validation process of the expert review step was executed in three ways face-to-face review, mail/review (mails review), and panel review [12]. In conjunction with that, researchers tested students individually (one-to-one). The results of the expert review and one-to-one were used to revise the product.

Data collection techniques used in the study were documentation, walkthrough, and interview. The document used was PISA framework and the problems of PISA. The walkthrough was done with experts at the expert reviews phase. Experts provided feedback, comments or suggestions regarding content, constructs, and languages. From the walkthrough, results were used to revise the Prototype 1 to be combined with the one-to-one test to get the Prototype 2. Interviews were conducted with students when
students worked on the mathematics of PISA-Like at one-to-one. Interview results at the one-to-one stages were used as materials to revise the Prototype 1.

3. Result and Discussion

In preliminary stage, researcher analysis the characteristics of PISA problems in PISA 2015 Assessment Analytical Framework and PISA Results, it was found that PISA problems were identified in three mathematical processes: including formulating, employing, and interpreting, four mathematical contents: including change and relationship, space and shape, quantity, uncertainty and data, and four contexts: including personal, occupational, societal, and scientific. The main characteristics of PISA problems that the problems were designed using the context of real-life problems to enhance the ability of the students' mathematical literacy in solving problems in a variety situation [3].

From the analysis of the 2013 curriculum used in Junior High School, it was found that shape and space were studied by students in class VII on the material of the plane. Then, the researchers did the design phase by designing the PISA-like mathematics problems and assessment rubric to be used.

In the prototyping step of the evaluation path using formative evaluation, the phases were self-evaluation, expert review and one-to-one. At the self-evaluation phase, the researchers conducted an evaluation and reviewed their design results about the type of PISA that had been made [12,13]. The result was called Prototype 1 [5, 14]. Next, at the Expert reviews phase, the validation of prototype one was checked by an expert regarding content, constructs, and language. The validation process was done by sending the PISA type problem to the validator. The validators validating Prototype 1 were two professors from mathematics education department and a mathematics teacher from a junior high school in Karawang. The comments and suggestions from expert reviews were used to revise Prototype 1.

At one-to-one, prototype one was tested to 3 students who have low, medium, and high ability. The three students were MS, NA, and AC. The result of student's observation and the interview was used to revise prototype 1.

MS’s answer to one of the PISA-like mathematic problem is presented in Figure 1.

MS answered with the logic that the two unit price rice fields were the same, he divided the price of rice fields with the length of the rice fields. MS wrote that if the first rice field with the length of 20 meters having price IDR 200,000,000, then the price of 2 meters of the rice field is IDR 20,000,000. The second rice fields, MS added, with the length of 30 meters having price IDR 300,000,000, then the price of 3 meters of the rice field is IDR 30,000,000. Thus, both rice fields have price IDR 10,000,000 for each meter.

![Figure 1. MS’s answer](image)
The MS’s answer, of course, is wrong. Now we can further see the answer of NA as presented in Figure 2.

![Figure 2. NA’s answer](image)

In Figure 2, NA assumed that the second rice field had better value than the first one, because if the rice fields were bigger, then the price would be higher. Meanwhile, the third respondent, AC, did not answer at all.

The three respondents were wrong. They should have calculated the price of rice fields divided by the area of rice fields so that each price is known to be \( \frac{1}{g1865/g2870} \). Then the researcher conducted an interview with the three respondents. Broadly speaking they do not understand the command questions and they are not familiar with the questions presented. But after the researcher directed and gave an explanation of the purpose of the problem, which they finally understood and could work on.

The result of one-to-one based on students' opinions is that the mathematical problems with PISA model using Karawang's context can make children have reasoning thinking. Also, students felt unfamiliar with the illustration problems, so they had to read over and over again to understand it. Thus, the explanation must be more specific.

From students' answers and comments, it is known that they understand and can answer the given problem even though they do not answer perfectly. In the one-to-one stage, it is known that the students' ability to read problems and interpret the meanings into the average mathematical problem is takes a long time and need more explained for the low-ability students to understand it. This indicates that the students in the one-to-one stage generally understand the PISA-like mathematic problem. This means that PISA-like mathematic problem can be one of the alternative questions presented by teachers in the classroom.

In the expert review, the researcher asked the opinion of experts experiencing in mathematics education. Here are the feedback and suggestions from experts and colleagues about the designs that have been made, as presented in Table 2.

| No | Name                                      | Comments                                                                 |
|----|-------------------------------------------|--------------------------------------------------------------------------|
| 1. | Expert 1 (professor of mathematics education) | The issues should be referred to the indicator of learning in junior high school. |
| 2. | Expert 1 (lecturer of mathematics education) | It is better still present an interesting question and fit the context you want to research. |
| 3. | Expert 3 (teacher in junior high school) | Content needs to fit the characteristics of the PISA problem and in accordance with the PISA framework both regarding context, content, and process. However, the terminology selected is sometimes wrong, e.g. between money value and selling price. There are two types of money values namely nominal value and intrinsic value. While the purpose of the question questions is more comparing the selling price. |
Furthermore, the students also gave feedback about the mistyping sometimes happened in the writing of the problems. Then, we have revised according to the feedback.

PISA-like mathematic problems were developed by researchers and validated through one-to-one and expert reviews. From both steps mentioned, the researcher revised the problem editor by the general guidance of Indonesian spelling, eliminating the information and the irrelevant picture and fix the layout and display questions.

Based on the results of expert reviews and one-to-one, it can be concluded that questions designed are categorized as valid PISA-like mathematic problems. This conclusion is not only reflected in the responses provided by expert reviews, but also from the responses of the students.

4. Conclusion

The result of this research is the PISA-Like mathematics problems using the context of rice fields in Karawang. The first prototype of the developed text was valid based on expert review and one-to-one tests. The prototype is valid after content, construction, and language provisions.

References

[1] Steen L and Turner R 2007 Developing mathematical literacy Modeling and Application in Mathematics Education-The 14th ICMI Study ed W Blum, P Galbraith, H W Henn and M Niss (New York: Springer)
[2] Stacey K and Turner R 2015 Assessing Mathematical Literacy: The PISA Experience (Australia: Springer)
[3] OECD 2016 PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematics, and Financial Literacy (Paris: OECD)
[4] OECD 2013 PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem solving and Financial Literacy (Paris: OECD)
[5] Putri R I I and Zulkardi Z 2018 Higher-order thinking skill problem on data representation in primary school: A case study J. of Physics: Conf. Series 948 012056
[6] OECD 2016 PISA 2015 Result (Volume 1): Excellence and Equity in Education (Paris: OECD)
[7] Sarismah 2012 Penerapan Realistic Mathematic Education (RME) Untuk Meningkatkan Prestasi Belajar Siswa Pada Materi Segitiga Kelas VII-H SMP Negeri 7 Malang (Malang: Universitas Negeri Malang)
[8] Zulkardi and Putri R I I 2006 Mendesain sendiri soal kontekstual matematika Prosiding Konferensi Nasional Matematika ke-13 (Semarang: KNM)
[9] Jupri A 2016 Student difficulties in mathematizing word problems in algebra Eurasia Journal of Mathematics, Science and Technology Education 12 2481
[10] Akker J 2006 Educational Design Research (London and New York: Routledge)
[11] Nieveen N and Plomp T 2007 Formative Evaluation in Educational Design Research An Introduction to Educational Design Research (Enschede: SLO)
[12] Tessmer M 1993 Planning and Conducting Formative Evaluation (Philadelphia: Kogan)
[13] Zulkardi 2006 Formative Evaluation: What, Why, When, and How Retrieved from http://reocities.com/zulkardi/books.html
[14] Putri R I I and Zulkardi 2017 Fraction in shot-put: A learning trajectory AIP Conference Proceedings 1868 050005