Students mathematical literacy abilities in solving PISA type math problem with LRT context

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Abstract. One of the issues in mathematics education was many math problems requiring reasoning skills were included in the National Examination. This was part of the attempts to gradually adjust Indonesian standards to international standards such as PISA. The purpose of this article was to assess the potential effects of PISA-type math problem on students’ math literacy abilities. The method used in this article was design research type development studies, which consist of 2 stages, preliminary and formative evaluation. The preliminary stage consists of analysis and design. In the formative assessment consists of self-evaluations, expert reviews, one-to-one, small groups, and field tests. The potential effect of the problem was indicated by the results in the field test stage. The mathematical literacy abilities that emerge were communication skills, mathematics, representation, reasoning, and arguments, choosing strategies in solving problems, and the ability to use language, symbolic, formal, and technical operations. Communication skills dominate over other mathematical literacy abilities.

1. Introduction

One of the issues in mathematics education was many questions that require reasoning included in the National Examination. According to the Minister of Education and Culture [1], this was an attempt to equalize Indonesian standards with international standards such as PISA. PISA was one of the studies developed by several developed countries which incorporated in Organization for Economic Cooperation and Development (OECD).

PISA aimed to measure the abilities and skills of 15-year-old students in some literacy abilities; one of them was mathematics literacy [2]. Mathematical literacy could be interpreted as a person's ability to formulate, implement, and interpret mathematics in various contexts including the ability to do mathematical reasoning, using concepts and procedures and using facts to describe, explain or estimate a phenomenon [2]. There were eight abilities identified by Mogens Niss, and based on the 2003 PISA framework [3]. However, the 2015 PISA framework modifies this ability by reducing to be seven based on investigations of competency operations through previously managed PISA items [4]. The seven basic mathematical skills were communication, mathematics, representation, reasoning, and arguments, designing strategies to solve problems, using symbolic, formal and technical languages and operations, as well as the ability to use mathematical tools.

The 2015 PISA data showed that Indonesia experienced a slight increase in mathematical competencies based on the average value of 375 points to 386 points. Although PISA Indonesia's achievements experienced a slight increase, other countries also experienced a higher increase so that Indonesia was still ranked lower, namely 63 out of 69 countries [4]. Looking at the results of the PISA assessment, it can be said that Indonesian participants or students in mathematical literacy are still relatively low compared to the average achievement of other countries. One of the contributing factors...
was that it is not normal for students to meet and work on characteristics such as TIMSS and PISA [5]. This statement is in line with Kamaliyah's research [6] which states that it is not normal for Indonesian students to solve questions related to real contexts such as PISA as a factor causing low scores in mathematical literacy.

Many researchers had researched on PISA [7-10]. Research on mathematical literacy skills has also been carried out by many previous researchers [11-14]. In contrast to previous studies, in this article, the researcher will explain what mathematical literacy abilities will emerge at the time of field testing in line with the purpose of this article, to finding out the potential effects of the PISA type math problem on students' mathematical literacy abilities of class X Senior High School.

2. Method
The research method used was the design research method type of development studies. The process through two stages, preliminary and formative evaluation. The stages of the preliminary were divided into two, namely the analysis and design stages, while formative evaluation consists of self-evaluations, expert reviews, one-to-one, small groups, and field tests [15]. At the preliminary, researchers conducted student analysis, curriculum, context, PISA questions, and designed question instruments. Then do self-evaluation of the results of the design in the previous stage.

Furthermore, at the expert review stage, all the questions that have been designed are validated by experts using studies in terms of content, constructs, and languages. In line with the ongoing stage of expert review, a one-to-one phase was also carried out. Next, the researcher made revisions based on comments and suggestions in the expert review stage and the one-to-one stage. The next stage was the small group, then proceed with the field test. The field test stage was carried out to determine the potential effects of the questions developed on mathematical literacy abilities.

3. Result and Discussion
The first stage of the preliminary was the researcher did analyze the students by selecting high school students to be involved in one-to-one, small group, and field tests. Then the curriculum analysis is the 2013 curriculum applied at the pilot school. Furthermore, the researcher also analyzed the context in which the context used in this study was LRT. The researcher also analyzes the PISA questions and understands the 2015 PISA framework. In the design phase, the researcher designs all learning instruments such as the question grid, question card, assessment rubric, Learning Implementation Plan, and syllabus. The researcher also designed PISA type math problems. The result of this preliminary was called the initial prototype.

The second stage was the formative evaluation. The initial step of this stage was self-evaluation or self-assessment of the design results in the previous stage. The entire set of questions that have been evaluated was called prototype 1. The next step was to prototype one validation against expert reviews and one-to-one. In the expert review stage, all the questions that have been designed were validated by experts using studies in terms of content, constructs, and language. The validation process did by face to face and e-mail with four validators. In general, the validator states that the questions that have been designed can be said to be valid in terms of content, constructs, and language. Content validation can be seen from the suitability of the question device with the competencies in the PISA framework, while the relevance of the items with the PISA framework assessment form can be seen from construct validation, while to see the suitability and selection of appropriate words according to EYD can be seen from language validation. In line with the ongoing stage of expert review, a one-to-one phase is also carried out. Students involved in this stage are three high school students of class X. Next, the researchers conducted revisions based on comments and suggestions in the stage of expert review and one-to-one stage. After being revised, a prototype two was produced.

The next stage was a small group; prototype two tested on six students. The six students have divided into two groups; each group member has a heterogeneous level of ability. The small group stage was held twice. The revised results from this small group stage were called practical prototypes 3. Practicality saw from the ease of students understanding the problem.

Furthermore, prototype three was tested in the field test stage. Subjects in the field test stage were 34 high school students of class X. Field tests were conducted to determine the potential effects of the
questions developed on mathematical literacy abilities. Among the seven mathematical literacy skills, there were six abilities that arise including communication skills, mathematical abilities, representation abilities, reasoning and argument skills, ability to formulate strategies in solving problems and the ability to use language and symbolic, formal and technical operations.

Based on the results of the field test, it was found that in the first question, the ability that emerged was communication ability. The problem with two abilities that arise were communication skills and the ability to choose strategies in solving problems. The problem of the three abilities that arise were communication and mathematical abilities. The question of the four abilities that arise is communication and representation abilities. Next, the five abilities that arise were representation ability and reasoning and argument ability. The problem of the six abilities that arise were communication skills and reasoning and argument abilities.

Furthermore, the seven abilities that arise were communication skills, mathematics, and the ability to use language and symbolic, formal, and technical operations. Then the eight abilities that arise were representation ability and ability to use language and symbolic, formal, and technical operations. The problem of 9 abilities that arise was the ability to choose strategies in solving problems and communication skills. Here is one of the questions that students do during the field test:

**Figure 1. Question number 5**

From Figure 1 above, it can be seen that the command number 5 that students do is "add a line that represents the distance compared to the time for someone walking on the escalator, give your reason!". Whereas it was known that thick lines are people who just stand still on the escalator and thin lines are people who walk on ordinary stairs. In addition to adding lines, students' reasons were also needed in answering this question. Here is one of the students' answers to question number 5:
Based on Figure 2 above, it can be seen that MIR students use representation ability (K3) to solve problems. The ability of representation can be interpreted as choosing, interpreting to capture situations, interacting with problems, or presenting one’s work including graphics, tables, images, diagrams, equations, formulas, and concrete material. From Figure 2, it can be seen that MIR students represent the answer in graphical form by adding a line representing the person walking on the escalator. Furthermore, MIR students also write down the reason why they put the line at the top. This shows that the question number 5 can give rise to reasoning and argumentation skills (K4). This ability involves a process of logically rooted thinking that explores and connects problems so that a conclusion is drawn, examining the truth and justification of the solution to the problem. In addition to answers from MIR students, here were answers from other students who have different versions:

**Figure 2. MIR’s answer for number 5**

From Figure 3, it can be seen that MAA students answer question number 5 by generating representation ability (K3). But what is different from MIR students is the added line position in the middle means that the person who walks on the escalator was faster than the person who just stands still on the escalator but slower than the person who walks on an ordinary stair. But MAA students do not put it in the form of reason, meaning that the ability to argue students here is still lacking.

**Figure 3. MAA’s answer for number 5**
Of the total questions, there were six literacy abilities that emerge; the most dominating was communication skills. A total of 7 questions raise communication skills in it. By the NCTM statement [16] that mathematical communication needs to be used as a focus in learning mathematics so students can integrate and strengthen their mathematical thinking through communication. There are two reasons why communication was one of the discussions in learning mathematics. First, mathematics is a language for mathematics itself. Mathematics is not only a thinking tool that helps us solve problems and find solutions, but also as a tool to communicate thoughts about ideas. Second, learning and teaching mathematics involves at least two parties, namely teachers and students. In the process of teaching and learning mathematics, communication occurs by expressing thoughts and ideas to others through language. Also, the findings of this article are obtained from question number 5. There were only 5 out of 34 students, or as many as 14.7% of students can give their arguments, the rest only write answers by drawing lines on a graph without giving reasons. This shows that there are still many students who have not been able to involve reasoning abilities and arguments. Though mathematical reasoning is needed to determine right or wrong, a mathematical argument [17]. In line with Rusyani’s research [18] the students’ low reasoning ability was caused by mathematics learning in the class still depends on drill practice, so it did not give students the opportunity to express their knowledge whereas the PISA questions, in general, must involve mathematical literacy abilities such as reasoning abilities and arguments. This is in line with the expressions of Wardhani and Rumiati in [19], which state that PISA questions demand more problem-solving skills, reasoning, and arguments.

4. Conclusion
Based on the results and discussion, the researcher can conclude the contents of this article, namely the potential effect on the development of mathematical questions of the type of PISA in the LRT context indicated by the results in the field test stage. Of the seven mathematical literacy skills, there were six abilities that arise, namely communication skills, mathematical, representation, reasoning, and arguments, choosing strategies in solving problems and the ability to use language, symbolic operations, formal and technical. Communication ability was the ability that appears most while reasoning and argumentation abilities were the least mathematical literacy abilities.

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