Difficulties of prospective teachers in solving mathematical problem: PISA on most difficult level

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Abstract. Difficulties in solving mathematical problems, especially non-routine problems, are not only experienced by students but also prospective teachers. The aim of this study was to determine the causes of students’ difficulties in solving mathematical problems specially PISA (Programme for International Student Assessment) on most difficult level. Seven prospective teachers of mathematics education from one of the universities in Aceh, Indonesia as respondents selected by purposive sampling. Respondents will take a part in the teaching program at school. Data obtained through a test and interviews were analysed descriptively. The findings show that the respondent has the most difficulty in presenting mathematical concepts, understanding information on the questions, and interpreting the data in the requested design. These three components are so related that it greatly influences the ability of students to solve mathematical problems, especially the word problem. Thus, the attention to these components is very important to do in learning mathematics.

1. Introduction
One of the objectives of learning mathematics is so that students can solve problems in daily life. Resolving mathematical problems is not as easy as solving math problems that only require procedural skills and mathematical concepts. According to Qin, Johnson, & Johnson (1995) there are two aspects of problem solving, namely problems delivered in sentences or using graphics; and explain the structure of the problem, objectives and plan of action.

In solving mathematical problems there are several difficulties that are classified in fact numbers, arithmetic, information, language and visual-spatial skills [2]. More clearly, Phonapichat, Wongwanich, & Sujiva (2014) mention some difficulties in solving mathematical problems, among others, understanding the context of problems that result in mathematical sentences, compiling assumptions from information to solve them, guessing answers without thinking because they do not understand problems, dislike read math problems, and don’t like reading old problems.

Based on the PISA results, the position of Indonesian students is still very worrying compared to other countries’ students for four studies. Starting in 2000 with the position of Indonesia ranked lower than the overall participating countries. The same thing for PISA 2012, Indonesia is also still in the bottom position and almost becomes the caretaker, which is ranked 64 out of 65 rankings with an average value obtained below the OECD value average [4]. Thus, an understanding of non-routine mathematical questions must also be introduced so that this study aims to describe the difficulties experienced by students in solving the most difficult PISA questions.
2. Methodology
The qualitative research design used aims to describe the problems in research. Not only the PISA problem solving process but also the obstacles and problems faced by respondents. Respondents consisted of six female students and one male student from one university in Aceh, Indonesia. The selection of respondents by purposive sampling, based on the length of study. This means that students who have completed a number of pre-requisite courses to take part in field practice. The aim is to identify students' difficulties in completing high-level questions so that they can equip them before carrying out teaching practices in schools. Data collection is done through tests and interviews. Then the data are analysed and described by adjusting the research objectives.

3. Result and Discussion
The test was conducted to determine the ability of students to understand and solve PISA questions. The PISA problem used is the original PISA problem (OECD source) which is translated in Indonesian for the most difficult level. Before the questions used in this study were selected, there were an average of four most difficult level PISA questions with three trials for junior high school students and also discussions with validators. This is done to get an overview of the settlement process that is done by students and the level of difficulty of the questions. From the results of student answers and discussions, three questions were considered difficult but there was a solution process with a variety of different answers. These three questions were then given to students to complete. However, in this article it is explained only the results of answers to one question from all students accompanied by several answer sheets in the picture.

The problem chosen is the 2012 level 6 PISA problem with Space and Shape content and Occupation context. The title is "Ice cream shop" which aims to find many circles that can be arranged in a field by following the rules and using a scale. Of the seven students, only two students correctly answered this question even though the design of the requested picture was not neat and inaccurate. Overall, almost all experience mistakes in understanding the problem where the information given to the question is not really applied correctly. Even though the information is very clear, it provides easy guidance in designing many designs that can be made in the seating area without using formulas.

Only 4 seat designs. $8 \times 10 = 80$ square of $0.5m$
1 design needs $3 \times 3 = 9$ square of $0.5m$
design a seat space = $0.5m$ or 1 square

![Figure 1](image1.png)

**Figure 1.** The correct answer of S-A but the design not presentable

The first respondent (S-A) answered the question correctly but was not neat in designing the picture. In the completion of the S-A do by summing all the squares in the area (seating area), and also calculating the number of squares needed for one chair design (one table and four chairs). However, the next process is not written on the answer sheet, directly the arrangement is four designs (Figure 1). In contrast, the second respondent (S-B) answered correctly by understanding the rules given to the
question without using calculations or formulas in the process of completion. By understanding these two rules, respondents immediately describe or design the arrangement of seats in the area provided.

Area of seating area is 4mx5m = 20m²
Using space between wall and seat design minimal 0.5m, so the area is 3.5mx4m = 14m²
One seat design needs 1.5m² (area). So, 14m² / 1.5m² = 96 seat designs

Figure 2. The incorrect answer of S-C in presenting mathematical concepts

Errors in understanding the information in the problem occurred in the other five respondents. This happens in interpreting the rules given, namely the distance of arrangement of chairs with walls less than 0.5m. Even though the requested distance is at least 0.5m. This resulted in the mathematical concept of "minimal" being wrong. In addition, the error in understanding the area needed for one design is 1.5m, in fact it is wide for one design, which is 2.25m (9 small sides). This happens because S-B is not able to interpret language or information on questions into the language of mathematics, especially for the word "minimal" which should be interpreted as "more than the same", but used as "less than" (Figure 2).

Figure 3. The incorrect answer of S-D on interpreting the data in the requested design

The answers of the fourth S-D respondents used the broad and circumstantial concept but it was not clear how to use it to get answers regarding the number of designs that could be arranged (Figure 3). Based on the results of interviews, it turned out that it was only around the seating area used to design it. From the circumference, the design is then designed which directly uses the help of images. The
The concept of "minimal" concept and area for one design (the number of small boxes for one design) causes an improperly designed arrangement. In other words, the ability to understand and interpret information contained in a question into an image is still low. The same thing happened in the answers of S-E respondents in Figure 4.

The answers to S-F respondents differ from other respondents. In this case, the S-F calculates the area of one design (arrangement of one table and four chairs) with a circle area approach according to the purpose of the question. However, an error occurs in the use of a circle area formula using diameter. As a result, the number of arrangements obtained 11 designs (Figure 5) without the design of the image. Based on the results of the interview, S-F tried to adjust the arrangement of the design in a circle as shown in the question. With this information, to find the number of arrangements according to S-F, it is easier to use a method to calculate the area divided by the area of one design. In this case, the S-F is also wrong in understanding the concept of "minimal" so that it ignores minimum rules which are interpreted as "less than". That is, the design arrangement can precisely touch the wall.

Based on some prospective teachers' answers to the most difficult PISA questions, there are some obstacles or difficulties found in almost all answers. When the respondent is unable to understand the
information and problems in the problem, as a result the concept used in solving the problem will be wrong so that it does not answer the purpose of the question. This is in accordance with the results of the study by Tambychik & Meerah (2010) that the ability to understand information is very important in solving mathematical problems.

In solving mathematical problems, a skill is needed based on understanding concepts and procedural abilities [6]. According to Tambychik & Meerah (2010) these skills are very supportive in the information processing process so they can solve the problem. Conversely, difficulties in mathematics are caused by a lack of mathematical skills especially problem solving because of interventions in cognitive abilities (Garnett, 1998; Geary, 2004).

4. Conclusion
In solving mathematical problems there are still various obstacles or difficulties experienced by students. Especially for PISA questions which aim to find many circles that can be arranged in a field by following the rules and using a scale, there are three aspects of difficulties experienced by almost all respondents. These difficulties are presenting mathematical concepts, understanding information on questions, and interpreting data in the requested design. The skills to understand and process information are most important in supporting the process of solving mathematical problems that can affect other aspects. These three aspects are interrelated and influence each other as the results of research Tambychik, Meerah, & Aziz (2010) that involves students in problems related to their abilities and cognitive abilities.

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