

An Analysis of Student's Error in Solving PISA Problems

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Abstract— Based on PISA survey in 2012, Indonesia was only placed on 64 out of 65 participating countries. The survey suggest that the students' ability of reasoning, spatial orientation, and problem solving are lower compare with other participants countries, especially in Shouth East Asia. Nevertheless, the result of PISA does not elicit clearly on the students' inability in solving PISA problem such as the location and the types of student's errors . This case would consider on further research in finding students' error in solving PISA problem including its type and location. Therefore, analyzing students' error in solving PISA problem would be essential countermeasure to help the students in solving mathematics problems and to develop scaffolding. This paper will discuss the categories of the students' error analysis based on Newman analysis that consist of of reading and decoding, comprehending, transforming, processing and encoding. The result obtained from junior high school in Surabaya support categories on students' error from each four different context as (1) personal, (2) occupational, (3) social, and (4) scientific. Baed on the analysis of the study, it is found that there are 5 types of error which is made by the subject. They consist of reading error, comprehension error, transformation error, process skill error, and encoding error. The most common mistake that subject do is encoding error with a percentage of 26%. While reading is the fewest errors made by the subjects that is only 12%. Both transformation and process skill errors have the same percentage of the number of mistake is 24%. Lastly, 14% of the made mistake is in comprehending PISA problem. In the other hand, the context of PISA problem which has the most error is scientific context with a percentage of 43%. While occupational context problem has the fewest mistake which is only 12%.

Keywords: *Analysis of Student's Error, PISA, Newman Analysis.*

I. INTRODUCTION

Program for International Student Assessment (PISA) is a program for assessing student's ability in International scope that was managed by Organisation for Economic Cooperation and Development (OECD). One aspect that assessed by PISA is the ability of students to apply mathematical context in variety situations in daily life. Therefore, PISA instruments is the real problems that require the ability in reasoning, spatial orientation and problem solving (OECD, 2013a).

In 2012, the result of OECD show that Indonesia was only places on 64 out of 65 participating countries in mathematics context which only gained 375 points. It suggest that Indonesian students ability in employing mathematics knowledge in their life is low. In the other hand, OECD stated that mathematics is strong predictor of a person's success in his youth. Moreover, it also affects the ability of class participation and the expectations of future earnings.

In fact, student's inability in solving PISA problem is caused by the lack of student skill in modelling daily life sentences into mathematics sentences. Moreover, this is also supported by the role of teachers in which they do not realize their mistakes in learning process that make student's errors in solving mathematics. The teachers tend to give the problems and the direct formulas without connecting the situations of daily life and mathematics concepts. As a result, students become confused and make mistakes in solving the next level of PISA problems.

To sum up, it is beneficial for Indonesia to improve PISA scores in subsequent years. For these improvements, we are interested in analyzing student's errors in solving PISA problems, especially in the matter of mathematics. These activities will provide an overview of student's thinking in solving PISA

based on their errors' analysis. Hence, these results can be used as the references to make improvement in mathematical student's ability of PISA level.

Regarding to the purpose of the study which is to describe the types and the location of errors in solving PISA problems, there are benefits of this research as follows: (a) For lecturers, this study can be used as consideration in determining topic of student's thesis or final projects in their lecture, and (b) For mathematics teachers, this study can be used to determine the action plan to overcome student's mistakes in solving mathematics PISA problems by developing a model or a method of mathematics learning.

II. RESEARCH METHODS

This study is an exploratory research by using qualitative approach hence it will generate descriptive data such as the description of the types and the location of student's errors in solving PISA problem, which is amounted 4 questions. In this study, researchers act as observers and interviewers to determine student's mistake in solving PISA problem.

This study was conducted in SMP Muhammadiyah 17 Plus Surabaya in the even semester of 2015/2016. The research subject is the selected students in 8th grade which is determined by their mistakes in solving PISA problem. The problems is adjusted to each content in PISA 2012, namely change and relationship, quantity, space and shape, and uncertainty.

There are three phases of a qualitative research approach, namely the preliminary phase, the core phase and the data analysis phase.

A. *The Preliminary Phase*

The researcher made an agreement with mathematics teacher of research's subjects and discussed about the mathematical content which has been obtained by the students who will be research subjects. The next activity is the preparation of research instruments. In this study, the main instrument is the researcher due to the fact that we are a determinant in research process and an observer in collecting data in the field, such as in-depth interviews on the subject to obtain the necessary information in data collection. Whilst, the other instruments that has been used in this study are PISA Test Problem and Interview Guidelines. PISA test problems is arranged to reveal student's error in solving PISA problem which is rarely gotten by the students. While interview guidelines instrument is prepared to identify the mistakes that was done by the students when they solved PISA problem and to probe their reason of their errors.

B. *The Core Phase*

This activity begins with the selection of research subjects based on the result of PISA test that was given earlier. Each subjects represents a type of error according to Newman analysis. In addition, the subjects is also based on the communication skill and the similarly mathematical ability. The communication skill meant that student had no difficulty when communicate orally and be able to express his opinion. The next activity is doing semi-structured interview with the selected subjects in more depth in order to verify the result of data recorded. As a result, both the interview data and PISA test data are the initial data to do the analysis of data.

C. *The Data Analysis Phase*

The purpose of this phase is arranged the data be structured systematically and easily interpreted. Actually, the data analysis will be done using descriptive analysis to disclose student's errors in solving PISA problem which is refer to Newman analysis. In addition, there three stages of analysis data process, namely data reduction stage, data exposure stage and drawing conclusion stage. The former refers to sharpening process, selecting, focusing and transforming the obtained raw data. Then, it will be selected, simplified and grouped with the corresponding data in order to answer the research question. The second stage is classifying and identifying the set of organized data in the form of narrative text, charts and others hence it is possible to draw a conclusion. As a result, the set of data that has been reduced, classified, identified is allowing the researcher to draw conclusions on the analysis of student's error in solving PISA problem which is refers to Newman Analysis.

III. RESULT AND DISCUSSION

There are 5 students that have been selected as research subjects. It can be clearly seen that their response in solving PISA problems have been analyzed and categorized into Newman's 5 types of errors. Then, the type of error made by the subject will be discussed further on the error's analysis which are made

by each of them. Here is a discussion of the error analysis of each subject when they solved PISA problem with different contexts.

TABEL 1. ERROR'S ANALYSIS OF SA-RESPONSES

Type of error	Test Item				Total
	1 (Social Context)	2 (Occupational Context)	3 (Personal Context)	4 (Scientific Context)	
Reading			√	√	2
Comprehension	√			√	2
Transformation			√	√	2
Process Skill	√		√	√	3
Encoding	√		√	√	3
The number					12

TABEL 2. ERROR'S ANALYSIS OF SB-RESPONSES

Type of error	Test Item				Total
	1 (Social Context)	2 (Occupational Context)	3 (Personal Context)	4 (Scientific Context)	
Reading					0
Comprehension	√			√	2
Transformation				√	1
Process Skill	√	√		√	3
Encoding		√		√	2
The number					8

TABEL 3. ERROR'S ANALYSIS OF SC-RESPONSES

Type of error	Test Item				Total
	1 (Social Context)	2 (Occupational Context)	3 (Personal Context)	4 (Scientific Context)	
Reading					
Comprehension	√				1
Transformation	√		√	√	3
Process Skill			√		1
Encoding			√		1
The number					6

TABEL 4. ERROR'S ANALYSIS OF SD-RESPONSES

Type of error	Test Item				Total
	1 (Social Context)	2 (Occupational Context)	3 (Personal Context)	4 (Scientific Context)	
Reading			√	√	2
Comprehension				√	1
Transformation	√	√			2
Process Skill		√			1
Encoding		√	√	√	3
The number					9

TABEL 5. ERROR'S ANALYSIS OF SE-RESPONSES

Type of error	Test Item				Total
	1 (Social Context)	2 (Occupational Context)	3 (Personal Context)	4 (Scientific Context)	
Reading				√	1
Comprehension				√	1
Transformation	√			√	2
Process Skill	√			√	2
Encoding	√			√	2
The number					8

TABEL 6. ERROR'S ANALYSIS OF ALL STUDENTS RESPONSES

Type of error	Test Item				Total
	1 (Social Context)	2 (Occupational Context)	3 (Personal Context)	4 (Scientific Context)	
Reading	0	0	2	3	5
Comprehension	2	0	0	4	6
Transformation	3	1	2	4	10
Process Skill	3	2	2	3	10
Encoding	2	2	3	4	11
The number of errors	10	5	9	18	42

Explanation:



: Uncorect Student's Response with Newman's Error Analysis



: Correct Student's Response



: No Response

Based on their general response in solving PISA problem with 5 different context, the most mistake that have been done by them is encoding error with percentage of 26%. Then, the another error that has the lowest percentage is reading error with 12%. While, 24% of mistakes are process skill error and transformation error. The remaining 14% of the made mistakes is comprehension error.

In the other hand, the PISA context which has the most error is scientific context with a percentage of 43%. Meanwhile, occupational context problem has the less mistake that is only 12%. Then, personal context problem and social context problem consecutive has an error percentage of 21% and 24%.

A. Reading Error

Reading error is a condition when subjects have difficulty with reading and hard to establish a context for a particular text, predict its grammatical structure and predict the meaning of the text. In this study, subjects do mistake in reading the main information of the problem hence they did not apply its information in solving problem. Moreover, reading error done by subjects in scientific and personal context of PISA problem.

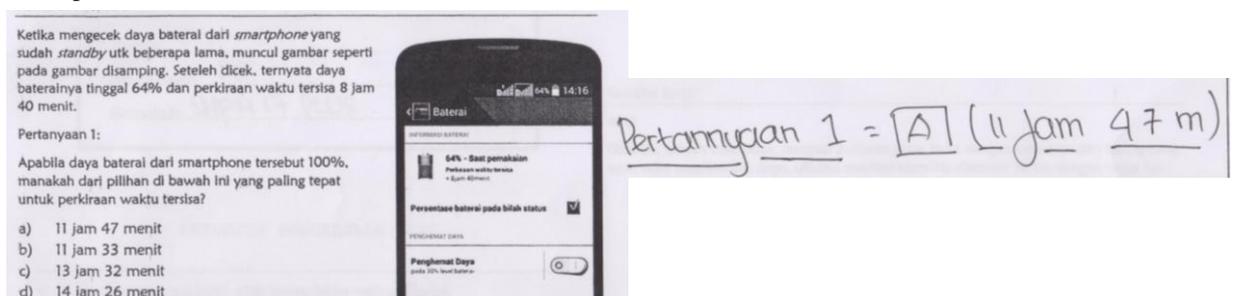


FIGURE 1. SD'S RESPONSE ON SCIENTIFIC CONTEXT OF PISA PROBLEM

Based on the result, SD did not apply the information on the question due to the fact that he did not read the main information. Moreover, based on the interview, he said that he didn't know the meaning of "standby" on the question hence he decided to choose option A.

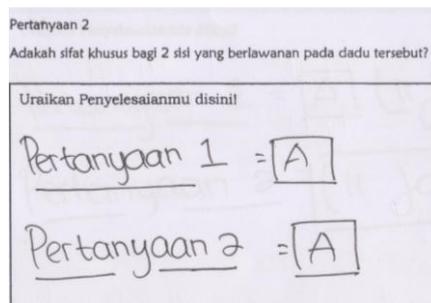


FIGURE 2. SD'S RESPONSE ON PERSONAL CONTEXT OF PISA PROBLEM

Based on SD's response on personal context of PISA problem, his response is not accordance with the question which he have to explain about the special characteristic of the opposite dices . Based on the interview, subject argued that the answer of question 2 is equal to the question 1, so he decided to choose option A as his answer.

B. Comprehension's Error

Comprehension error is a mistake when subject misunderstand what the problem ask and collect information from the problem insufficiently. In solving PISA problem, subject perform copenhension error on the saintific and social context of PISA problem. In the following is the subject's response on those context with the explanation. .

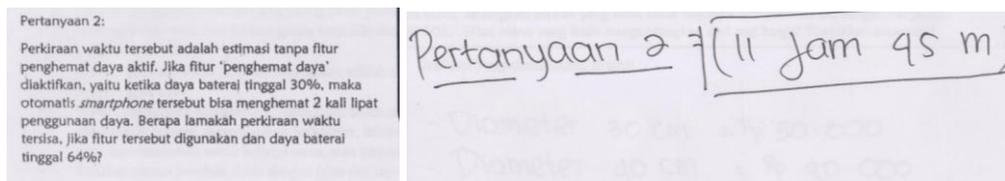


FIGURE 3. SD'S RESPONSE ON SCIENTIFIC CONTEXT OF PISA PROBLEM

Based on interview, SD does not comprehend the meaning of the question implicitly between "fitur baterai" and "penghemat daya" hence SD only write the answer based on alternative response provided in question 1.

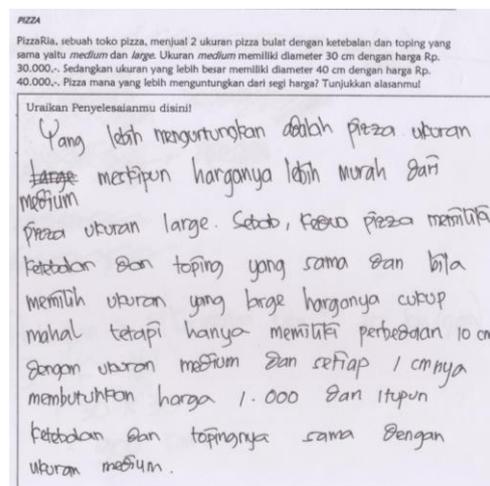


FIGURE 4. SC'S RESPONSE ON SOCIAL CONTEXT OF PISA PROBLEM

SC also make a mistake in comprehending PISA problem on social context. Based on the interview, SC misunderstand with what question ask about “menguntungkan”. Therefore, subject got confused in writing an appropriate solution.

C. Transformation's Error

Transformation error is a mistake when subject can not change the question into mathematics model correctly. This mistake occurs in all contexts of PISA problem where two questions which get the most error is on social and scientific context..

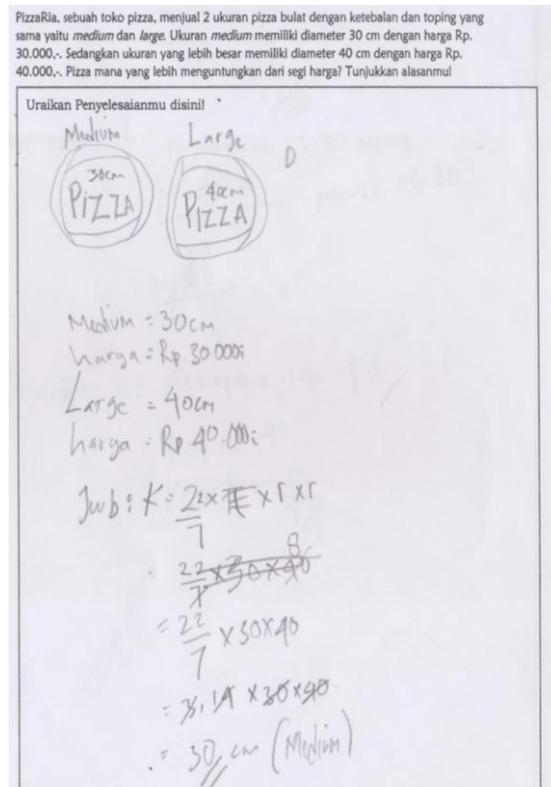


FIGURE 5. SE'S RESPONSE ON SOCIAL CONTEXT OF PISA PROBLEM

Subject make transformation error when he write the area of circle by “ $K = \frac{22}{7} r r r$ ” with $r_1 = 30$ cm and $r_2 = 40$ cm. In fact, the area of circle must be written in symbol “L” and the radius have the equal length.

D. Process Skill Error

Process skill error is a mistake occurring because subject does not master in calculating mathematically. Therefore, this mistake make the subject give the response uncorrectly. This study suggest that the most error in process skill occurs on social and scientific context of PISA problem.

In figure 5, SE do a mistake in multiplication process “ $3.14 \times 30 \times 40 = 30 \text{ cm}$ ”. In interview process, SE stated that subject cancel out the same number are 3 and 4 such that 30 obtained from the calculation. In addition, subject also stated that his teacher commonly used thus method in division process so subject consider that cancel out method can be used in multiplication process.

E. Encoding's Error

Encoding error is a mistake when the subject write the final answer which is not accordance with what question ask. In this study, PISA context problem which getting the most error in encoding answer are social and scientific context.

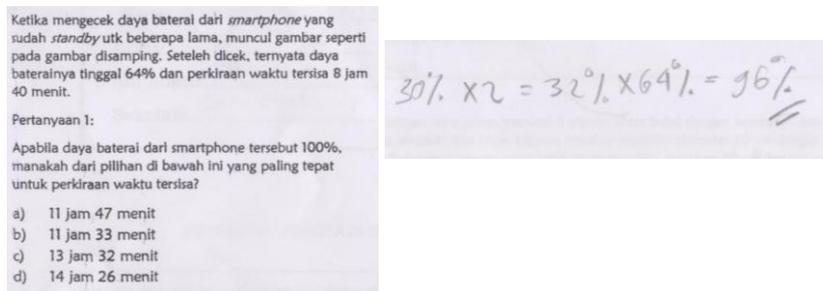


FIGURE 6. SE'S RESPONSE ON SOCIAL SCIENTIFIC OF PISA PROBLEM

Based on the subject work, the answer 96% is not accordance with what the problem ask about how long the remaining times in times unit. Based on the interview, subject consider that the answer of question 2 is about the percentage of the remaining time.

IV. CONCLUSION AND SUGGESTION

Based on the result, it is found that there are 5 types of mistakes made by the students namely reading error, comprehension error, transformation error, process skill error and encoding error. The most common mistake which are have been done by the subjects is encoding error with a percentage of 26%. While reading is the fewest errors made by a subject that is only 12%. Both transformation and process skill error possessed the same percentage of the number of errors is 24%. The last, 14% of the made mistakes is an error in understanding the problem of PISA.

In this study, PISA problem is adopted from PISA 2012 where the predominant domain is mathematics. Thus, there are 4 selected PISA problem that each question has a different context namely social, personal, occupational and scientific. PISA Problem with the most errors is scientific context with a percentage of 43%. Meanwhile, PISA with occupational context contains only 5 out of 42 errors. The rest, both personal and scientific context in succession problem has a percentage of error of 21% and 24%.

Based on the conclusions, the writer can provide input for other researchers, teachers, students and schools. For other researchers, they need to analyse further on-students error in solving PISA problems that have different content. As for teachers, it is required the learning of PISA types of problems in mathematics teaching so that students are familiar with the form of the question. In addition, students should also be open to their teachers if experiencing difficulty when doing on math problems.

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