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HOW MATHEMATICALLY LITERATE ARE SECONDARY TEACHERS IN PERFORMING CONTEXT-BASED PROBLEM SOLVING TASK? : A CASE OF INDONESIA

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This study aims to look into Indonesian secondary teachers' performance on context-based problem solving task based on perspective of PISA view on mathematical literacy. Results of this study point out that transformation error appeared as the most frequently found in teacher's performance. This is reinforced by data of their less activation of a set of fundamental mathematical capabilities mentioned in PISA framework 2012, such as mathematising and representation. Clarifying with questionnaire result, teachers admitted to most frequently fail in determining a precise mathematical model or strategies when carrying out context-based problem solving. The consequences of these results regarding both teacher education on mathematical literacy and further researchs are then discussed related to reflection on teachers' own formal conception of what it means to be mathematically literate.

Keywords: mathematical literacy, context-based task, problem solving, mathematics teacher

INTRODUCTION

It is highlighted that success story of students' mathematical literacy performance for some countries as reported by PISA (Programme for International Student Assessment) is inevitably influenced by the success story of developing teachers' quality on this issue. In particular, Stacey (2011) argued that countries such as Finland, Singapore, and Japan each of which scored highly in PISA survey consistently from the beginning survey in 2000, are often attributed to their great emphasis on concerning teacher's quality improvement. Considering this emphasis, Brown and Schafer (2006) has broadly structured their teacher education program on developing teachers' own, more formal, conception of what it means to be mathematically literate.

Being mathematically literate, students as well as teachers should be able to identify and use relevant mathematics to a variety of context (OECD,2013a). In performing this competence, they need to complete mathematical process as mentioned by PISA framework (OECD,2013a) well, i.e from formulating problem mathematically, employing mathematical procedures and facts, to interpreting the mathematical results back to initial problem. Moreover, a set of mathematical competencies, namely Fundamental Mathematical Capabilities (FMC) developed by PISA team are also needed to be activated into each of the mathematical processes with a variety of degrees of complexity.

In Indonesia, mathematical literacy has been becoming important issue, particularly, because of results on students' insignificant improvement in PISA survey since 2003. A great number of researches regarding students' performance on this issue, actually, has been conducted with a variety of purposes such as developing context-based task and investigating students' difficulties (see for example, Kohar and Zulkardi (2015), Wijaya, van den Heuvel-Panhuizen, Doorman, and Robitzsch (2014). However, research on how Indonesian teacher bring out idea of mathematical literacy as understanding context-based problem solving task are limited to be found. Therefore, this fact give rise question on how secondary teachers emerge idea of mathematical literacy within their content knowledge. As preliminary study, we investigated their performance in solving context-based task as well as their difficulties regarding this issue to get them reach common sense conception of mathematical literacy. Therefore, the following research questions were addressed: (1) How do secondary teachers perform context-based problem solving task based on PISA's mathematical literacy process? (2) What are secondary teachers' difficulties in (a) viewing context-based problem solving task, and (b) performing context-based problem solving task regarding PISA's fundamental mathematical capabilities?

THEORITICAL FRAMEWORK

PISA view on Mathematical Literacy

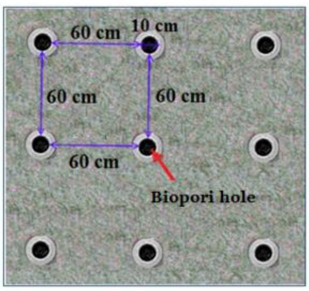
Mathematical literacy is formally defined by OECD (2013a) as an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. In the process of 'formulate', 'employ', and 'interpret', FMC are activated successively and simultaneously in varying degrees depends on the related mathematics topics to obtain a solution. FMC consist of (1) communication, (2) reasoning and argumentation, (3) mathematising, (4) representation, (5) devising problem solving strategies, (6) using symbolic, formal and technical language and operations.

Context-based Problem Solving Task

Context-based task refers to problem solving task situated in realworld settings which provide elements or information that need to be organized and modeled mathematically.

METHOD

Participants were teachers from four cities in East Java province comprising 70 junior high school teachers and 55 senior high school teachers. Data were obtained through context-based task and questionnaire. Teachers' work on the task was analyzed using framework on mathematical literacy performance error (adapted from Newman analysis (Clements, 1980), OECD, 2013a, and Wijaya, et, 2014) while their response on questionnaire was analyzed using percentage. Some of tasks were taken and then modified from Kohar and Zulkardi (2015), while others were developed by authors.The unit context for junior high school teacher are 'Futsal score' (1 item) and 'World Online Mathematics Contest' (1 item), while unit context for senior high school teacher is 'Biopori' (3 items). The following is an example of task of 'Biopori'



Zaki wants to make a number of biopori holes having a hole diameter of 10 cm in the lawn behind his house. He plans to make the arrangement of the biopori hole with a square pattern as shown in the following figure.

Using this design, what is the maximum number of holes that can be made by Zaki if the size of the field is 10 m x 10 m? Explain your strategy

RESULTS

Teachers' Error in Performing Context-based Problem Solving Task

In total, we had 305 possible responses (number of tasks done by all teachers in total) which included 109 correct responses (35.73%), 109 incorrect responses (35.73%), i.e., no credit or partial credit, and 87 missing responses (28.54%). Each incorrect response had an opportunity to be coded by more than one sub-type code since its different errors found from this response. For instance, an incorrect response was possibly coded as T-1 and P-2 simultaneously. Thus, we had 498 coded responses, excluding both correct and missing responses.

Type of responses	Sub-type	**Code**	N	%
Comprehension error	Misunderstanding the instruction	C-1	59	11,85%
	Error in selecting information	C-2	94	18,88%
Transformation error	Procedural tendency	T-1	153	30,72%
	Taking too much account of the context	T-2	6	1,20%
	Wrong mathematical operation/concept	T-3	30	6,02%
	Treating a graph as a picture	T-4	8	1,61%
Mathematical Processing error	Algebraic error	P-1	6	1,20%
	Arithmetical error	P-2	15	3,01%
	Error in mathematical interpretation of graph	P-3	18	3,61%
	Measurement error	P-4	15	3,01%
	Unfinished answer	P-5	8	1,61%
Interpretation error		I	86	17,27%

Table 1. Frequency of teacher's error on context-based problem solving task

An example of response showing error C-2 is shown, for example, by teacher who divided the length of one side of the field size by the distance between two biopori hole (1000cm/60cm=16.66 or 17) and then calculate the number of biopori from 17x17=289 holes. Here, the teacher select wrong information related to the number of biopori in one side of the field. Meanwhile, another error, T-3, is performed by teacher who used mathematical procedure/concepts which are not relevant to the tasks such as incorrect formula of n-series of arithmetical sequence or other algebraic form/equation which does not precisely represent the situation of the task.

Teachers' Difficulties in Viewing Context-based Problem Solving Task

Teachers' view on mathematical process in a questionnaire result show that the process of determining precise mathematical model and strategies is admitted as most difficult step (70 out of 172 chosen options) compared to the other three processes such as understanding problem (47 out of

172 chosen options), employing mathematical procedures and facts (9 out of 172 chosen options), and interpreting result back to initial problem (29 out of 172 chosen options).

Teachers' Activation of FMC within Mathematical Process

From teachers' work, we found difficulties in activating almost all components of FMC, particularly, in *mathematising* and *representation*. For instance, we found teachers using mathematical model which is not supported by a good understanding of related concepts to find the maximum number of biopori hole. Regarding representation, they seemed were unable to make a mathematical relationship between diameter of circular base of a biopori hole and the maximum volume of waste that can be loaded by the hole as understanding to sketch a precise graph.

DISCUSSION AND CONCLUSION

From table 1 we can say that teachers had most errors in transformation, i.e. providing mathematical structure to the problem presented in some contextualised form. Regarding teacher's difficulties in a questionnaire result, teachers admitted to most frequently failed in determining a precise mathematical model or strategies when carrying out mathematical literacy processes: formulate. These results seemed support a study of Siswono, Rosyidi, Kurniasari, and Astuti (2015) on Indonesian elementary teachers' problem solving which revealed that teachers had likely problem with their content knowledge such as finding strategies/mathematical model as early stages of solving mathematical problem. The implication of this study suggest to provide a professional program to develop teacher's performance on context-based task as part of strengthening concept of being mathematically literate as well as applying idea of mathematical literacy in practical teaching.

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