PROFILE OF SECONDARY SCHOOL STUDENTS WITH HIGH MATHEMATICS ABILITY IN SOLVING SHAPE AND SPACE PROBLEM

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Abstract

This study aimed to describe the profile of secondary school students with high mathematics ability in solving shape and space problem in PISA (Program for International Student Assessment). It is a descriptive research with a qualitative approach, in which the subjects in this study were students of class VIII SMP N 1 Banda Aceh. The results show that in solving the problem PISA on shape and space, high mathematics ability students were able to identify the problem by making the information known from PISA issues related to the shape and space content.

Keyword: Profile, Problem Solving, Task of PISA

Abstrak

Studi ini bertujuan untuk mendeskripsikan profil siswa sekolah menengah dengan kemampuan matematika tinggi dalam menyelesaikan masalah bentuk dan ruang pada PISA. Studi ini merupakan suatu penelitian deskriptif dengan pendekatan kualitatif dengan subjek penelitian ini adalah seorang siswa kelas VII SMP Negeri 1 Banda Aceh. Hasil penelitian ini menunjukkan bahwa dalam menyelesaikan masalah PISA dengan kontek bentuk dan ruang, siswa yang berkemampuan tinggi mampu mengidentifikasikan masalah dengan menyebutkan informasi yang diketahui dari masalah PISA yang diberikan.

Kata Kunci: Profil, Pemecahan Masalah, Masalah PISA

In a developing country such as Indonesia (UNESCO, 2009) which has stability in politics and religion, education has become an important issue for the society. Even at the first time spaceship fly, the majority of people in the world not only saw the innovation, but also excited to think about education (Soemanto, 2006).

Indonesia is one country that has always tried to show its teeth to the world is also involved in this case Millions of teachers, thousands of lecturers have been recruited by the state in order to meet the educational needs of young people, although there are still many shortcomings that need to be fixed in times to come for a better education of Indonesia people in the future, a wide range of educational reform have been implemented.

Mathematics, as one of the pillars science of education, needs to be owned by every student as the future generation of a nation for going forward, so that awareness and mastery competency standards in mathematics will be among students. Problem solving ability is one of the five standard of mathematical competency which became the main destination in mathematics learning and was

stipulated by the National Council of Teacher of Mathematics (NCTM) (NCTM, 2000) as well as the math education curriculum branch of Indonesia (Depdiknas, 2006). The view that problem solving ability constitutes the main purpose of the teaching of mathematics contains an understanding that such capabilities are essential to learn mathematics (Usman in Novita, 2012). Besides, it is the researchers in the field of education who also place-solving problem as one of the important object in their research including among others Romberg and Schoenfeld (in Kesumawati, 2010) who stated that the solving problem is one aspect of ability which includes in the of higher order level thinking which must be mastered by students. Therefore, it is no surprise if problem solving ability getting priority more and emphasized in mathematics learning (Novita, 2012). Furthermore, problem-solving ability trains students learn to look for a different approach to a problem. Problem solving is needed in real life, as expressed previously as able to determine if there is an alternative way to achieve the answer (Saverin, 2007).

Unfortunately, and contrary to the desired expectations, The Third International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessments (PISA)as international indicators to see Indonesian student mathematics achievement (Zulkardi, 2005) both showed that the ability of Indonesian students is very weak in solving non-routine problems (math problems), but relatively better in resolving questions about the facts and procedures (Mulis et al, 2000). This situation is also supported by Stacey (2010) who explained that based on data from the Organization for Economic Cooperation and Development (OECD), in PISA 2009, 76.7% of students Indonesia were only able to solve math problems at level 2 or below. It is sign that education in Indonesia still have a lot a problem to solved related to PISA problem.

Therefore, beginning with this paradigm and problem some research must be held in order to identify the reason behind this and it is considered as ultimate needs to be fulfilled immediately. Otherwise, the problem will not have a solution. As the result considered this situation, the PISA question is selected to measure students' ability in problem solving.

Problem Solving

The term of problem solving is often used in various fields of knowledge which in principle is a process undertaken by the recipient of problem to be solved by him or her. However, according to Polya (1973) problem solving is that an effort to find a way out of difficulty, to achieve a goal which is not immediately achievable. Therefore, based on the Polya's definition the main characteristic of a problem is that to achieve the solution from the problem some difficulties will be faced in there or in this case it is not routine solution. In further, it is lead to a conclusion that the mean of problem in problem solving is nonroutine problems. Consequently, it can be concluded that math problem solving also related to nonroutine problem in mathematics

Malone, Douglas, Kissane and Mortlock (1980) stated that we are considering *nonroutine* mathematical problems only-nonroutine in sense that a student attempting such a problem possesses

neither a known answer nor a previously established (routine) procedure for finding one. since the nonroutine problems is not problem can be easily solved in problem solving, then we cannot assess students achievement only based on their answers toward the nonroutine problems rather than we should also concern to the process how students solve the problems and come up with some ideas. Furthermore, Novita (2012) also explained that related to mathematics which is one of the basic knowledge that is more concerned with the process than the end result, it means that the learners' solution in mathematical problem solving needed to be focused on where solution come from including using appropriate steps, rules, and concepts. The importance of using steps in solving a problem suggests that answers or solution is not easy to come with, but must go through the various procedural steps and be able to relate the concepts that have been there before.

Associated with efforts to improve problem-solving skills (problem solving), Lambertus (2010) noted that to develop problem-solving skills in students would be more interesting to start with raise issues related to everyday life, known and experienced by the students, because the using the experience and knowledge that have been held, students will try to find a solution of the problem. Furthermore, Polya (1973) asserts that the activities can be done in an effort to improve problem-solving skills in mathematics include the completion of a story matters, the completion of non-routine problems or solve a puzzle problem, the application of mathematics to the real world, creating and testing conjecture.

PISA (Programme International for Student Assessment)

The Programme for International Student Assessment is a project of the Organisation for Economic Co-operation and Development (OECD). PISA also involve the cooperative activities among the 30 OECD member countries and other partner countries, bringing together scientific expertise from the participating countries, and jointly directs them through a government council on the basis of shared values, and common interests. The project is implemented by the Australian Council for Educational Research (ACER) (OECD, 2003).

Furthermore OECD (2003) explained that the PISA tests ability including the ability to read (reading literacy), do mathematics (mathematic literacy), and do science (scientific literacy). In this study the sample involves children around the age of 15 years (or the equivalent of 8th or 9th grade junior high school students). The tests are designed to determine the extent to which students are able to make effective measures of what they have learned in school in terms of dealing with the various issues and challenges that they may face daily life. However, the questions that will be used is that mathemtics only.

Student Abilities in Math

Based on Kondalkar (in Widarti, 2013) ability is the capacity of an individual to perform multiple tasks in a activities. However, the ability of students here refers to the mathematical skills of

students (mathematical ability). Mathematical ability is itself an ability that is needed to perform a variety of mental activities: to think, to analyze, to solve the problem in solving math problems - in this case the problems involve PISA questions. Furthermore, in terms of students' mathematical ability Widarti (2013) says that in math skills, students are classified into three categories namely high, medium (middle) and low. Hence in order to assign students the correct category, it is necessary to reference the conversion value of the test results of students' ability. Ministry of Education (Depdiknas) (in Widarti 2013:4, Rofki 2012: 38) made a criterion level of student ability and its assessment scale into 3 categories, namely: high ability if the value is greater than or equal to 80 and less than or equal to 100; average ability if the value of the ability being that is greater than or equal to 65 and less than 80, and a low ability if the value is greater than or equal to 0 and less than 65.

In PISA the ability that will be assessed not only the content of math but also the mathematics process. In terms of mathematics process Hayat and Yusuf (2010) stated that PISA did it by observing the ability: to reason, to analyze, to communicate the idea, and to formulate and also problem solving. Furthermore, this ability later on must be followed by the ability to communicate the idea which can stimulate the problem solving competencies. This process already known as mathematisation process: beginning from the problem in the daily life, formulate the problem into math concept, to identify the relevant math concept, do assumption and generalization, find the problem conformity and patterns and finally acquire the model of problem solving based on math concepts. However, there are also competencies that essentially needed so that the process can be done they are: the ability to think and to reason, argued, communication, making model, formulate and problem solving, representation, and using math language. Therefore, it seems very complex to fulfill

Significance

By conducting this research hopefully we can determine and describe how far students in secondary school have ideas to solve shape and space problem in PISA. Therefore, at the future the educators can have some idea to teach a student with high mathematics ability in solving PISA problem especially shape and space content. Since the way how PISA assess students work is very complex, this condition can be considered as a chance for educators to assess students' performance toward problem solving with a high accuracy. Other advantages of doing this research is that guiding student to find some new ideas and creativity in problem solving since the majority of PISA question are contextual and related to daily life and this prost hold to all students with high, average and low ability. Moreover, this result of research also useful and helpful for all researcher who want to conduct others research related to students ability in problem solving.

METHOD

In this research in order to gain information and data related to profile of secondary school students with high mathematics ability in solving shape and space problem, one student from

Secondary Student of SMPN 1 Banda Aceh grade 8th is the respondent or subject. Moreover, it was decided that the design research to be used in this research is descriptive research by using qualitative approach since the aim of this research to describe secondary school student with high mathematics ability in solving shape and space problem. Furthermore, in terms of describing or exploring data, qualitative approach is considered as very suitable strategy or approach since qualitative design allows the researcher to focus on "insight, discovery, and interpretation rather than hypothesis testing (Merriam, 1998, p.10). In addition, in terms of data validation time triangulation is used for checking data credibility, hence data display and conclusion can be written properly. In this research, there are three instruments that have been used in order to gain data from the respondent. The first isntrument is MAT (Mathematical Ability Test), second is that MLP (Mathematical Literacy Problem) and the last one is interview guided.

Gathering the data which was consist of MLP (Mathematical Literacy Problem) and interview was given twice in a different time. The following table provides the information about schedule in conducting MLP and interview.

Tabel 1. Schedule of Conducting MLP and Interview

No	Conducting MLP and Interview	Day and Date	Place
1	I	Tuesday, 16th December 2014	SMP Negeri 1
2	II	Monday, 29 December 2014	Banda Aceh

RESULTS AND DISCUSSION

The subject with high mathematics ability was determined based on the data of Mathematical Ability Test (MAT). MAT is a test that aimed to measure at what level students understands mathematics whether in high level, average or the low one. The students with the final score more than 85 point was considered as the student which has high mathematics ability.

Based on data MAT, the mathematical ability students can be describe as follows

Table 2. the Description of Students' Mathematical Ability

Grade VIII-3	Students' mathematical ability			Total of Students
	High	Average	Low	
Number of students	2	8	27	37
Percentage	5.4%	21.6%	73%	100%

Based on Table 1, it can be found that from 37 students in grade VIII-3, there are 5.4% students with high mathematics ability (MA-H), 21.6% students with average mathematics ability (MA-A), and 73% with low mathematics ability (MA-L). Moreover, in determining or selecting research subject, the researcher also ask for teacher consideration in the class in order to chose the appropriate research subjects which was communicative since the way how researcher gathering data by using

interview based on task. Hence, based on considerations above, researcher took one (1) student with high mathematics ability as the subject in order to gather main data or information related to the profile of secondary school student with high mathematics ability in solving shape and space problem in PISA.

Related to the first step in solving shape and space problem in PISA which is understanding the problem, subject with high mathematics ability in understanding the first problem reads problem once only because by reading the problem once, she already understood the problem properly and she is not confuse about the what the problem asked for. Verbally, subject also told about her understanding toward the problem without writing all the information that has been told.

The following conversation shows the way how student with high mathematics ability understand the problem.

The conversation in first problem in understanding the problem

P *: alright, this is the last problem for today, please undrstand the problem first, if you have understand then tell me!*

R *: (she only nodding, means oke)*

After sometime

P *: Have you read the problem and understand it?*

R *: Yes, I have, but I just think whether the officer only saw the container that can be seen only or whole container which was under others containers?*

P *: What do you think?*

R *: I think, I should count up all of the containers, but in this case there are two possibilities whether the containers that can be known or can be seen only?*

P *: Then, how about you?*

R *: Emmmm ok! I should find out the sum all of the containers that can be known*.

The conversation in second problem in understanding step as the triangulation for validating the data

P *: Ok, this the last problem, please read and understand the problem, if you have understand it, tell me!*

R *: ok*

P *: have you understand the problem?*

R *: yes, I have*

P *: how many time do you read the problem until you understand it?*

R *: once only*

P *: wow, only once? Why do you read only once?*

R *: Yes, because I can understand the problem by read it once only*

P *: So, what do you think about the problem?*

R (S1M2S87) : based on the picture, I must find the remain match boxes after build the block,but empty inside.

To go further, in the second step which is devising a plan in order to solve shape and space problem in PISA, subject with high mathematics ability retentions about information related to the problem, where she move or react toward the problem standing by information including what the problem asked for. Even though, she still has confusion related to the problem. After that subject informs the strategy that she plan to be used in order to solve the problem that related to shape and space content in PISA. Moreover, subject with high mathematics ability uses calculating and counting up strategy directly based on the picture which provided in the problem. In addition, more information that reveals from data is that subject did not inform about other strategies that can help her to solve the problem.

The following conversation shows the way how student with high mathematics ability devising a plan.

The conversation in first problem in understanding the problem

P : How do you solve the problem then?

R : I still confuse about the problem whether the problem ask for all the containers or the containers that can be seen only?

P : So, you have two answer then? One answer for total containers that only can be seen the second one is the total containers that exist there?

R : Yes, like that

P : Soo, what plan do you have now in order to solve the problem?

R: I will count up the container directly from the picture!

The conversation in second problem in devising a plan as the triangulation for validating the data

P : ok then, what kind of plan do you have to solve the problem?

R : So he has 29 match boxes, he wants to make a block which look like this (by showing the picture), but the boxes is surplus, then he decides to make a block which empty inside but look like this. However, is the block that will be made only one?

P : Do you think more than that?

R : No, only one then, but empty inside P (S1M2S128) : So, how do you solve it?

R : emmm, I will count up the matches directly from the picture.

In the third step, subject with high mathematics ability carries out the plan based on the strategy that have been planned before, and the strategy that she used are that directly counting up the total boxes or match boxes from the picture or image that have been provided by the problem. Furthermore, based on the interview subject while carrying out the plan was influenced by her plan in devising step and it can be seen from her strategy to overcome the problem which is counting up the

boxes directly from the picture in the problem and this strategy have been mention in the second step as plan to counter the problem. As the result, subject with high mathematics ability in solving the problem with content shape and space in PISA write down the correct answer at the end and scratch the wrong answer to convince her toward the solution.

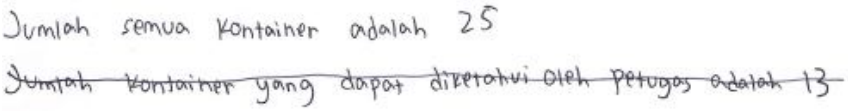
The following conversation shows the way how student with high mathematics ability carry out the plan.

The conversation in first problem in carry out the plan step

P: Ok, you can work on the problem now, based on the strategy that you have.

R: After I count it up directly I find the answer for containers that can be seen only is 13, but for all containers that can be count up is 25

The following image is subject's written answer



P: If so, are you sure with those answers then?

R: No, I am not sure, hehehehee

P: If you are not sure, which one is the correct one then?

She try to reunderstand the problem and after some time

R: 25, the answer is 25

P: So, you count it up directly and the answer is 25 containers?

R: yes, It is

P: are sure now?

R: Yes, I am

After that she scratches the wrong answer.

The conversation in second problem in carry out the plan step as the triangulation for validating the data

P: you can work on the problem now!

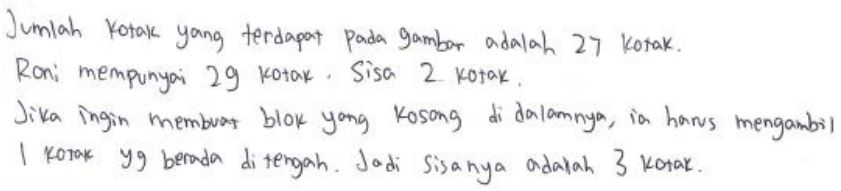
R: This is the block right. If the block is not empty inside the total match boxes that we are 27.

P: Twenty seven, how you know that?

She count up directly from the picture

R: Every line there are 9 boxes, because there are three lines to make a block, thus by mulplying with three, the total boxes are 27. Furthermore, because the block is empty inside then the total boxes that we need to make a block are those 26. Hence to find out residue boxes 29 – 26, and the result 3

The following image is written answer from subject


Jumlah kotak yang terdapat pada gambar adalah 27 kotak.
Roni mempunyai 29 kotak. Sisa 2 kotak.
Jika ingin membuat blok yang kosong di dalamnya, ia harus mengambil
1 kotak yg berada di tengah. Jadi sisanya adalah 3 kotak.

P: Ok then, are sure with this answer

R: Yes, I am pretty sure.

At the last step which is looking back toward the solution, subject with high mathematics ability did some correction as the reason to check and convince her that her solution is correct. It means that in this step, subject did the last process correctly.

The conversation in first problem in looking back the solution

P : Are your sure with your answer?

She directly see the problem and queit silent for some time

R : Yes, I am sure

P : Have you check the answer that you so sure?

R : Actually, I did the calculation twice. The first one as the way to get the answer and secondly as the checking process.

The conversation in second problem in looking back the solution as the triangulation for validating the data

P : Ok then, are you sure about the answer?

R : Yes, I am sure

P : do you check your answer after you get the answer?

R : Yes, I do

P : How do you check your answer?

R : I directly calculate the block with empty box inside, which are 26 so that the result is that 29 – 26 equal to 3. So the remaining boxes are 3. Therefore, the remaining boxes are 3

CONCLUSION AND SUGGESTION

As a conclusion it can be stated that the respondent in the secondary school SMP Negeri 1 Banda Aceh to solve shape and space problem in PISA, she was able to demonstrate a good understanding in analyzing problems PISA particularly content shape and space. At the final stage, in order to ensure the answer, respondent checking back every step solution that had been conducted until she was sure to about the answer, although she has not yet known if the answer is right or wrong. Behind it all, based on this description, it is expected that teachers can choose teaching strategies appropriate problem solving later to facilitate students in solving Mathematics problems especially Mathematical Literacy Problem in PISA with shape and space content. For other researchers, this

description of their hopes very helpful in researching other problems associated with problem solving, mathematical problem solving, and problem PISA.

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