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USING TASK LIKE PISA'S PROBLEM TO SUPPORT STUDENT'S CREATIVITY IN MATHEMATICS

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Abstract

Creativity is one of the keys to success in the evolving global economy and also be a fundamental skill that is necessary for the 21st century. Also In mathematics, creativity or thinking creatively is important to be developed because creativity is an integral part of mathematics. However, limiting the use of creativity in the classroom reduces mathematics to a set of skills to master and rules to memorize. Doing so causes many children's natural curiosity and enthusiasm for mathematics to disappear as they get older, creating a tremendous problem for mathematics educators who are trying to instill these very qualities. To investigate the increase in awareness of elementary school students' creativity in solving math' problems by using the task like PISA's Question, a qualitative research emphasizing on the holistic description was conducted. We used a formative evaluation type of development research as a mean to develop mathematical tasks like PISA's question that have the potential effect to support students' creativity in mathematics. Ten elementary school students of grade 6 in Palembang were involved in this research. They judged the task given to them is very challenging and provokes their curiosity. The result showed that work like PISA's question can encourage students to more creatively in mathematics.

Key Words: PISA, problem solving, creativity in mathematics

Abstrak

Kreativitas merupakan salah satu kunci keberhasilan dalam perkembangan ekonomi global serta keterampilan dasar yang mutlak diperlukan pada abad ke-21. Dalam Matematika sendiri, kreativitas atau berpikir kreatif sangat penting untuk dikembangkan karena kreativitas merupakan bagian integral dari matematika. Namun, terbatasnya penerapan/penggunaan kreativitas di dalam kelas menjadikan matematika sebagai sebuah pelajaran menghafal atau mengingat sekumpulan rumus-rumus. Hal ini menyebabkan rasa ingin tahu dan antusiasme anak-anak terhadap matematika akan menghilang seiring usia mereka bertambah. Selain itu, keadaan ini juga menciptakan masalah besar bagi pendidik matematika yang selalu mencoba untuk menanamkan konsep matematika yang berkualitas. Dalam rangka menyelidiki peningkatan kesadaran kreativitas siswa sekolah dasar dalam memecahkan masalah matematika seperti masalah-masalah dalam soal PISA, sebuah penelitian kualitatif yang menekankan pada pemaparan secara menyeluruh telah dilaksanakan. Penelitian ini menggunakan formatif evaluation yang merupakan jenis atau tehnik dari penelitian pengembangan untuk mengembangkan soal-soal matematika seperti soal PISA yang mempunya potensial efek untuk mendukung kreativitas siswa dalam matematika. Sepuluh siswa SD kelas 6 di Palembang dilibatkan dalam penelitian ini. Hasil penelitian menunjukkan bahwa soal-soal seperti soal PISA yang diberikan dapat mendorong perkembangan kreativitas siswa dalam matematika.

Keywords : PISA, problem solving, kreativitas dalam matematika

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Have you wondered, "Can mathematics be creative?" or "How can engage the students' creative thinking in mathematics?" That is not simple question to answer, because we know that mathematics is commonly identified as one of the most difficult subjects encountered by pupils in schools and adults alike (UK Essays, 2013). A significant majority of students hate math class and find it a tedious and boring drudgery. Therefore, how can we make mathematics be interesting, so the students can

greatly enjoy investigating and, curious exploring their creativity in mathematics? For this reason, we need efforts to present mathematics in interesting and meaningful ways. Finally, the active role of the teacher in teaching learning process is an important factor in determining the success of a strategic learning (Usman, 2007).

Creativity or creativities thinking is one of keys to success in the evolving global economy and also be a fundamental skill that is absolutely necessary in the 21st century (Career Center Maine Department of Labour USA, 2004; Cropley, 1997). In Mathematics itself, creativities thinking is essential thing to support the mathematical thinking and communicate it clearly and precisely (Barody, 1993). In other hand, creativity in the mathematics classroom is not just about what pupils do but also what we do as teachers (Piggott, 2007). As teacher, we can offer our students with mathematical experience that give them opportunities to be creative.

The examples of mathematical experiences that can teacher conduct are trying to hold interesting and meaningful learning or providing the challenging problems for students. In this article we try to explain about awareness of elementary school students' creativity in solving mathematics' problems. We belief that mathematics is about problem solving and problem solving is a creative process (Piggott, 2007). Most students' classroom experiences of mathematics involve studying materials and working through tasks set by their teachers, or being passive observers of mathematics leaving little room for the entrepreneur or creative thinker. Students do not generally expect to be challenged by an unfamiliar situation. When students are placed in problem-solving situations it is nearly always within a context that is very familiar, for example, a problem involving the application of a mathematical concept the students have just been taught. In such situations learners are aware of boundaries, and have been given some clear leads about what knowledge to apply. Such problems often seem closed with very little room to explore and be creative. However, when students are given the problem that are not familiar or have not been taught, they will confuse and sometimes give up.

Therefore, students need often trained with problem or task that are not familiar or non-routine problem in learning, so that they are be more creative. One of the questions that can be given to support students' creative is a matter of the type of problem solving PISA (Programme for International Student Assessment) (Hayat & Yusuf, 2010).

In this research, we try to focus the explanation about how teacher can engage the student's creativity by giving them the set of problem solving tasks like PISA's question. In order to explain it, then we conducted a research which aimed to investigate the increase in awareness of elementary school students' creativity in solving mathematics' problem by using task like PISA's Question. The central issue of this research is formulated into a research question: How can the problems solving task like PISA's question support students 'creativity? We use a formative evaluation type of development research as a mean to create and develop the problem solving tasks like PISA's question (Novita, Zulkardi, & Hartono, 2012).

Problem Solving and Creativity

Using mathematical problem solving in learning mathematics can support students' creativity in mathematics. Mathematical problems that are truly problematic and involve significant mathematics have the potential to provide the intellectual contexts for students' mathematical development (Novita,

Zulkardi, & Hartono, 2012). Then, using “real world” problems, where neither the knowledge of rules or algorithms or procedures nor a specific knowledge of facts, of data, of relations, of properties, etc. is sufficient to get a solution, to solve these problems we need a new idea or a “cognitive jump”, "a divergent or creative thinking is necessary" (Kienel in Meissner (2003); Aisyah, 2007). Therefore, in this study we use the task like PISA’s question to support and explore the students’ creativity.

Creativity in Mathematics

How can we describe or define "creativity or creative thinking"? Many experts from different disciplines give various descriptions about it. "Creativity" is a highly complex phenomenon, and for some people it seems to be somehow incompatible with mathematics teaching. The traditional style of working in the mathematics classroom seems not to allow many creative ideas (Meissner, 2003).

Creativity enters mathematics in many different ways. Three important ways are abstraction, connection, and research. The creativity of abstraction concerns the creation of models that reflect the real world and can be solved with mathematical tools known to the individual. The creativity of connection is the realization that known mathematical tools can be applied to new problems, allowing problems to be viewed in a new way. Connections are also made when mathematical and other knowledge come together to understand and solve problems from a variety of areas. Finally, the creativity of researching is the discovery of new mathematical tools that fit unsolved problems and add to the available tools for other users of mathematics.

The research into creativity is, on the other hand, very voluminous. A good overview of mathematics and creativity can be found in Treffinger et al. (Treffinger, Young, Shelby & Shepardson, 2002). Most research is centered on children from Pre-Kindergarten through grade nine. Few publications deal with creativity in highly accomplished mathematicians. Moreover, there is a curious lack of research in the area of creativity in college mathematics (Brunkalla, 2009). The most basic problem is that there is no universally accepted definition of mathematical creativity (Haylock, 1997) and no single test or assessment of it. Many researchers agree on certain qualities of creativity but show some divergence on others. Significantly, most researchers link mathematical creativity to mathematical ability. Another focal point of mathematical creativity is the ability to solve problems (Silver, 1997). In this research, we try to describe creativity as a student’s ability to solve the challenging problem, how can the students create of models that reflect the real world and solve the mathematical problem with mathematical tools, how can the students connect mathematical and other knowledge when they solve the mathematical problem, and how can the students identify and understand the role that mathematics play in the world.

Programme for International Student Assessment (PISA)

PISA is a project of the Organisation for Economy Co-operation and Development (OECD, 2003). PISA involve testing of literacy in reading, mathematics, and science in samples of 15-year-olds draw from each participating country. The aim in focusing on students of this age is the generation of a summative, comparative, international report on mathematical literacy for students

nearing the end of their period of compulsory schooling. The tests are designed to generate measures of the extent to which students can make effective use of what they have learned in school to deal with various problems and challenges they are likely to experience in everyday life (OECD, 2009).

Test formulated in PISA are always based on real situations that contain problems that must be solved because the PISA assessment focuses on the mastery of processes, understanding of concepts and ability to apply it. So that the assessment conducted by PISA is more oriented to what students can do based on what they have learned in school, than just pay attention to whether students have mastered certain material. A student considered to have high levels of mathematical literacy if he is capable of analysing, reasoning and communicating mathematical knowledge and skills effectively, and able to solve and interpret mathematical problems in various situations.

METHOD

In this study, we use the qualitative research approach as the research method to describe the research process. Then, we use the formative evaluation type of development research to create and develop the problem solving tasks like PISA's question. This type of research is conducted in two steps, first is preliminary stage and second is formative evaluation stage that covering self-evaluation, prototyping (expert reviews, one-to-one, and small group), and field test (Tessmer, 1993)

Qualitative research is research studies that investigate the quality of relationships, activities, situations, or materials. This type of research is a greater emphasize on holistic description—that is, on describing in detail all of what goes on in a particular activity or situation rather than on comparing the effect of a particular treatment or on describing the attitudes or behaviours of people. In other hand,

There are five steps in qualitative research (Fraenkel & Wallen, 2010): (1) identification of the phenomenon to be studied/discus - students' creativity in solving mathematical problem solving like PISA's Question; (2) identification of the participants in the study –ten sixth grade elementary students in Palembang (namely S1-S10); (3) generation of hypotheses – mathematical problem solving like PISA's question can support students' creativity ini mathematics; (4) data collection – used students answer sheets and interviewed some students to get deeper information of their thinking process; data analysis – data will be analysed by holistic descriptive; and (5) interpretation and conclusion – using assessment rubric as a guideline to interpret and to make a conclusion.

RESULTS AND DISCUSSION

The mathematical problem that was used in this research was developed by using formative evaluation type of development. This type of research is conducted in two steps, namely preliminary stage and formative evaluation stage covering self-evaluation, prototyping expert reviews, one-to-one, small group, and field test. In self-evaluation stage, the initial steps undertaken by the researchers are analysing the students characteristic, analysing the curriculum and conducting cooperate with the

school. Then, researcher tries to design mathematics tasks according to PISA's characteristics of mathematical problem-solving. Product in this stage is called prototype I.

In the second stage, namely prototyping, prototype I have been evaluated by giving it to the expert (expert reviews) and to three students who have different mathematics ability. Experts are required to validate the product qualitatively. The result from this revision called prototype II. Then, this prototype II was tested in small group consisting of 5-6 students to observe the practicality of the product. Quantitatively validation process was also performed to determine validity of item tests (task) on prototype II. Finding or suggestions and result of validity item tests from students in this stage used to revise the prototype II becomes prototype III. The last stage, field tests, the tasks given in field test are in prototype III that has been qualified. The task like PISA's question used in this research consist of 4 challenging tasks (or problems).

Task 1: ***Car from Lemon Skin***

Context : Personal

Content : *Quantity*

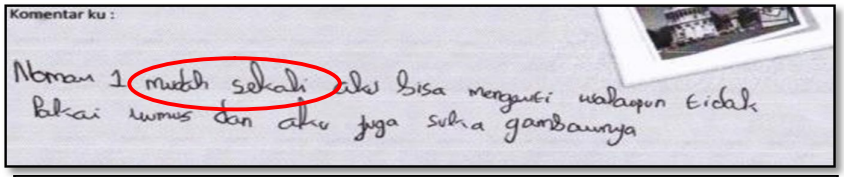
Competency Cluster : Connection

Car from lemon skin is one of traditional toy of Indonesian children. Mr. Saleh would like to make some of cars for children around of his house. To make this car, he needs some material and certain number of material as mentioned in the table below:

The Material	sticks 	for car bodies 	for car tires 
The amount of material needed to make a car	3	2	4
The amount of material available	52	27	60

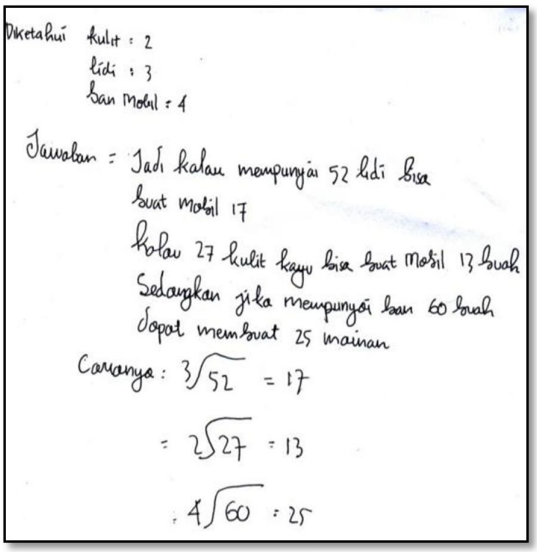
How many cars can be made by Mr. Saleh from the materials are available in the table? Prove your answer and give your reasons!

In fact, this problem is very interesting and challenging for students. They can answer this problem directly using their way, but they not release that they need deep understanding to answer this problem. For example the S1' answer in Figure1, we can see that in order to answer that task (problem), students have to really understand the situation in the problems and the need to involve the contextual situation in solving problems.



S1' comment:
This problem is very easy, I can understand even if I don't use the formula, then I also really like the picture there.

Figure 1. the S1' comment



S1' answer:

So, if you have 52 sticks, you can make 17 cars
If there are 27 orange peels (material for car body), you can make 13 cars.
then, I f you have 60 car tires, you can make 25 cars

The way is as follows:

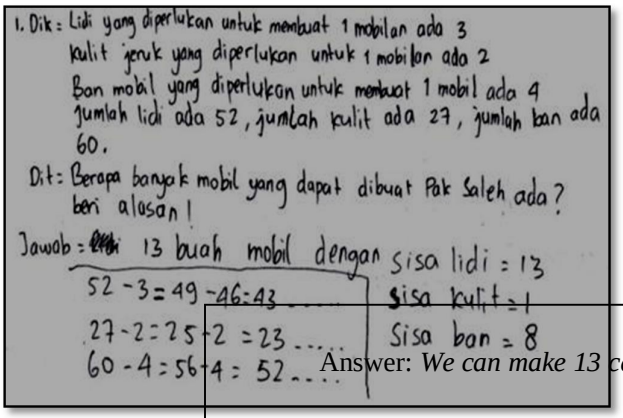
3/52 = 17

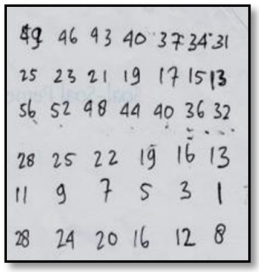
2/27 = 13

4/60 = 25

Figure 2. the S1' answer

Then, we will see the other students' creativity in answering and solving this problem like in Figure 3 and 4.



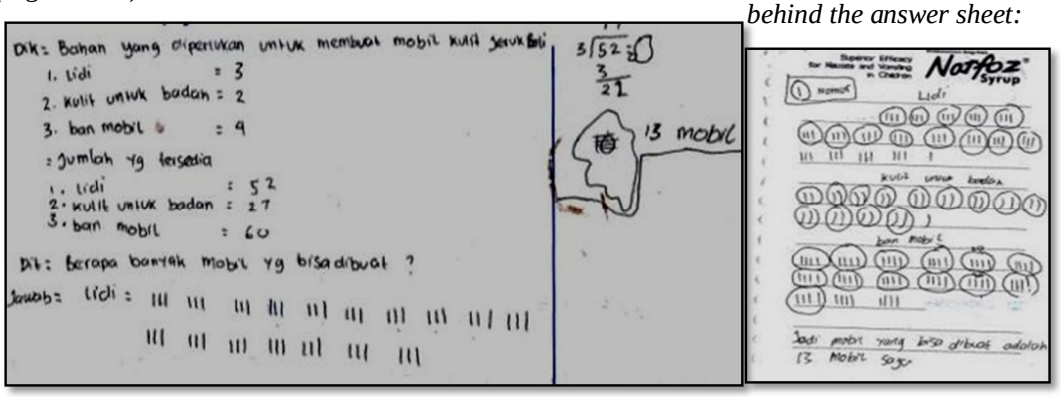


S2' answer:
Answer: *We can make 13 cars from the available materials with*
the rest of sticks are 13
the rest of lemon skin is 1
the rest of car tires are 8
52-3=49-3=46,43,40...
27-2=25-2=23,21,19..
60-4=56-4=52,48,44...

Figure 3. the S2' answer

In solving this task, we can see many strategies used by students. They use and apply some mathematics concepts for examples multiplication and division or repeated addition and subtraction (Figure 2&3).

behind the answer sheet:



So the cars that can be made are 13 cars

Figure 4. the S3' answer

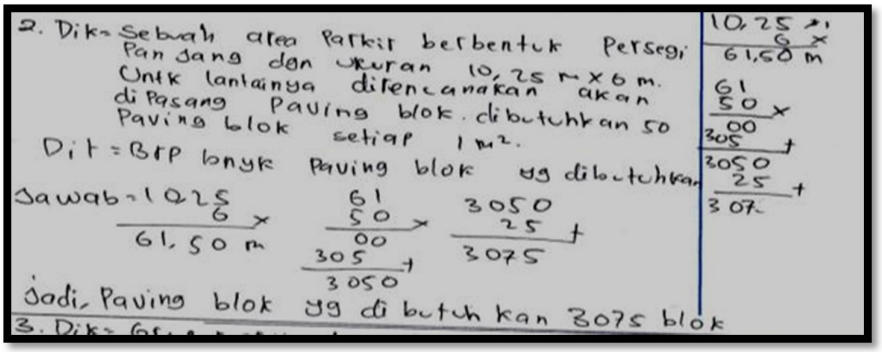
Especially for Task 1, the other creative answer (more than five strategies) that students use to solve it can be seen in Novita (2012). Now, let we discuss the Task 2.

Task 2: ***Parking Area***

Context	: Publics
Content	: *Quantity*
Competency Cluster	: Connection

A rectangular-shaped parking area will be built in front of the shopping centre. The size of parking area is 10,25m x 6m. In the floor of that parking is planned to be fitted with array of paving \block like shown in the picture in the right side. It takes 50 paving blocs for each 1m^2. How many paving blocks required to make that parking area?

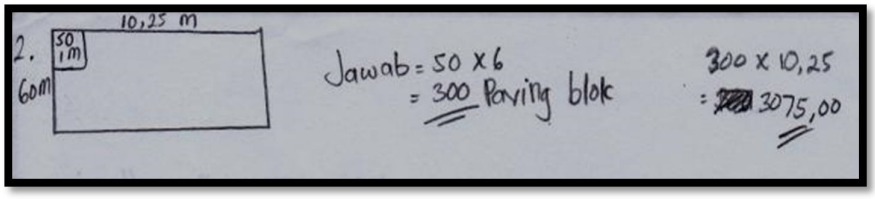
In solving this Task, we found some of the difficulties faced by the students including a lack of understanding the area and decimal number concepts (Novita, 2012). But like Task 1, students also showed their creativity with a variety of different strategies. Figures 5 to 8 below show the students answer and contribution to the Task 2.



So the paving block required are 3075 pieces

Figure 5. the S4' answer

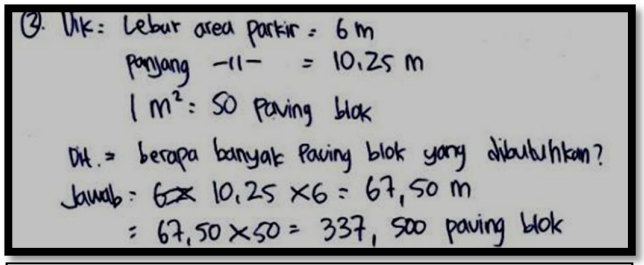
The Figure 5 shows that the students have deep understanding about the area concept, so that he try to determine the number of paving blocks for 61 m^2 in area then the number of paving blocks for 0,50 m^2.



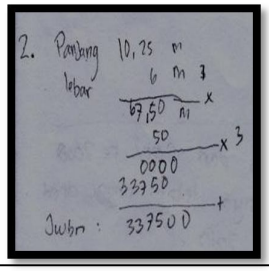
Answer:	*5 x 6 = 300 paving bloks*	*300 x 10,25 =3075,00*

Figure 6. the S5' answer

Initially, the student (S5)determine the number of paving blocks for 6m x 1m by multiplying 50 of paving blocks with 6m^2, furthemore determining the total paving blocks in the area.



Answer:
10,25 x 6 = 67,50 m
67,50 x 50 = 337,500 paving blok



Answer:
337500 paving blok

Figure 7. the S3' answer Figure 8. the S6' answer

Basically, students who have a good understanding on the concept of area and decimal numbers will be very easy to resolve the Task 2. This situation can be seen in Figure 5 and 6. Overall, Strategies raised by students in solving this problem are 5 strategies.

Task 3: Pizza

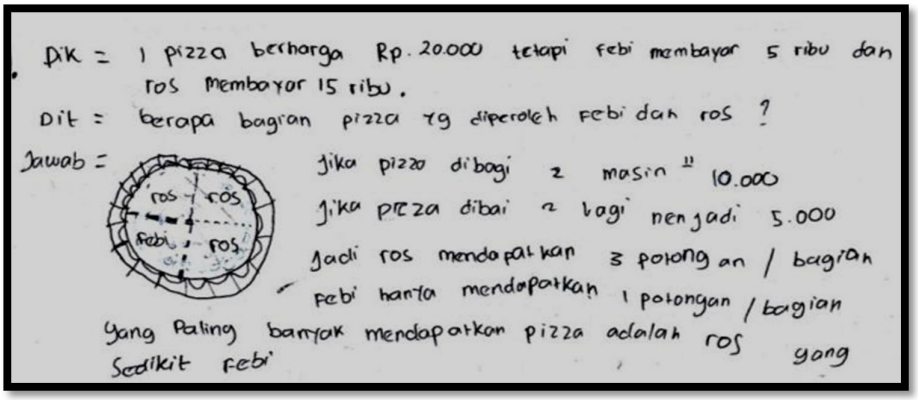
Context : Personal

Content : *Quantity*

Competency Cluster : Connection

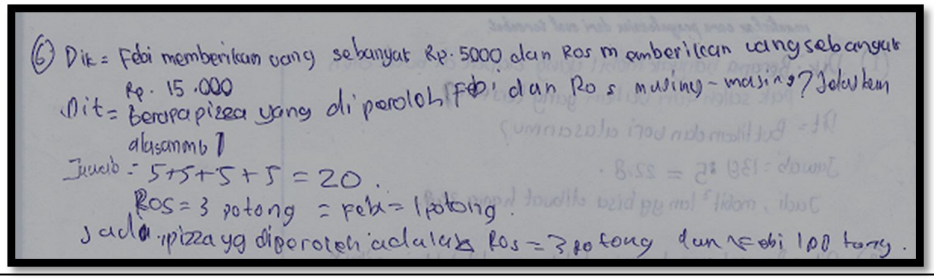
> *When the study group is finished, Febi and Ros want to buy pizza. From the list of menus, they ordered a pizza with a price of Rp 20,000. However, because of the money they have is limited, so they decide to pay Pizza together and will share equitably in accordance with the money given. If Febi gives Rp. 5000 of money and Ros gives 15,000, then how much of pizza given to Febi and Ros? Explain your reasoning!*

This problem requires a deep understanding of students about the concept of fractions. Student creativity in solving this task is evident from more than 6 different strategies. We can see this strategy in Figure 8 to 14 below.



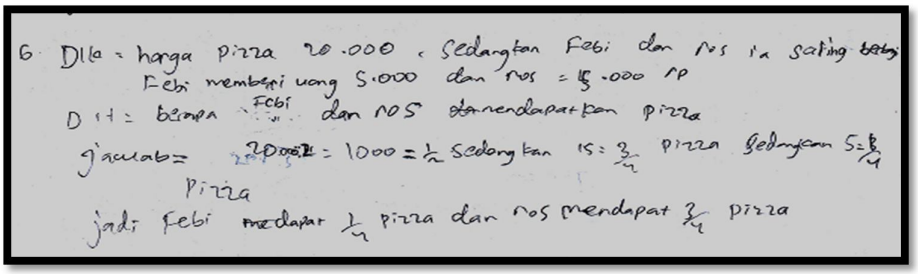
> *The S7's answer:*
> *If pizza is divided by 2, then each pizza is 10,000*
> *If pizza is divided by 2 again then each pizza is 5,000*
> *So Ros gets 3 pieces / parts*
> *And Febi only get 1 piece / part*

Figure 8. the S7' answer



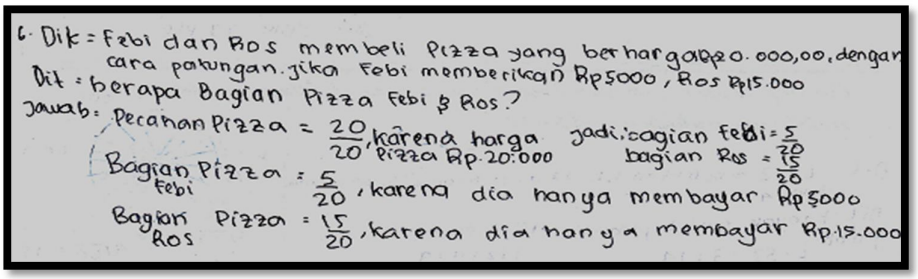
> *The S8's answer:*
> *5+5+5+5 = 20, Because Ros gives 5.000, so that she get 3 piecess of pizza, While Febi get 1 piece*

Figure 9. the S8' answer



The S9's answer:
20.000 : 1000 = ½ while 15 = 3/2 pizza while 5 = ¼ pizaa
So, febbi gets ¼ pizza and ros gets ¾ pizza

Figure 10. the S9' answer



The S10's answer:
The fraction of pizza = 20/20, because the price of pizza is Rp 20.000
Piece of pizza given to Febi is= 5/20, because he just pay as much as 5.000.
Piece of pizza given to Ros is= 15/20, because he just pay as much as 15.000.

Figure 11. the S10' answer

Task 4

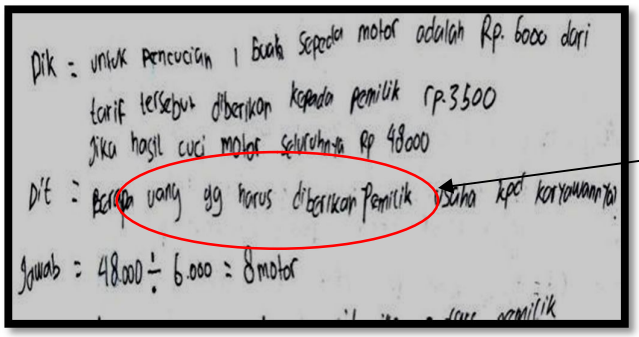
Context : Personal

Content : *Quantity*

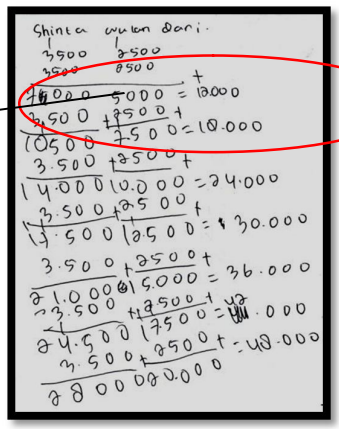
Competency Cluster : Connection

A motorbike washing business (Doorsmeer) that just opened only has one employe. These businesses determine the distribution of the results as follows: The rate charged for laundering a motorbike is Rp.6000, from this rate will be given to the owner for Rp. 3.500 and to the employe for Rp. 2.500.
If the total tarif colected today is Rp. 48.000. How much money should be given to each of them (owner and employe)?

The students strategies to solve the Task 4 are showed below! (Figure 12 & 13)

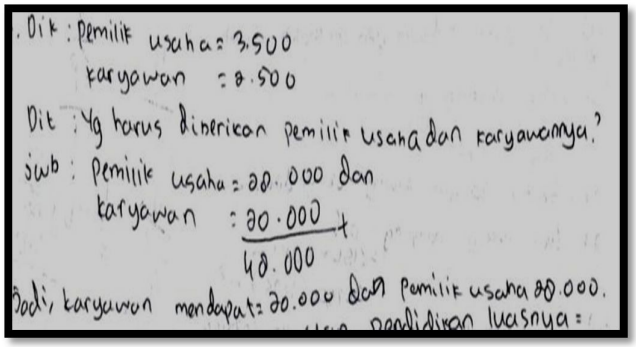


behind the answer sheet:



So, the money that was given to employe is Rp. 2.500 x 8 = Rp. 20.000
Then, the money for the owner is Rp. 28.000

Figure 12. the S9' answer



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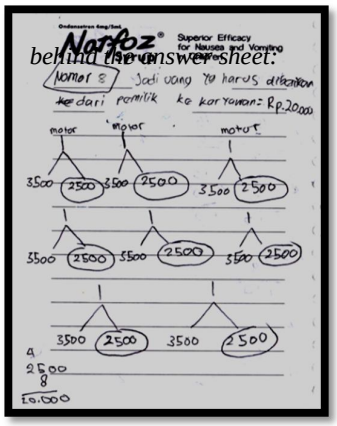

Owner : 28.000
Employe :20.000 +
48.000

Figure 13. the S9' answer

The concepts needed to solve this problem (Task 4) is very simple, students only need to apply on their understanding of the concept of multiplication and division. The most important of all is the understanding of matter itself (creativ ways). The results of research showed that students have failed in solving this problem because they do not understand the problems and less conscientious in performing the calculations. There are more than 5 different student strategies in solving this task.

CONCLUSION

Using mathematical problem solving in learning mathematics can support students' creativity in mathematics. It can be seen through their strategies and also explanation in solving PISA's Question.

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