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Identifying Pre-Service Primary School Teachers' Division Strategies

Puri Pramudiani¹, Yoppy Wahyu Purnomo², & Tian Abdul Aziz³, ✉

^{1, 2, 3} Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia

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Abstract

This study focuses on identifying pre-service primary school teachers' works with division problem using a mathematical approach called Realistic Mathematics Education (RME). A case study was conducted to thirty-six pre-service primary school teachers in one private university in Jakarta who took RME course. The result of analysis of the participants written responses indicates that the approach led the participants to develop mathematical meaning to deal with division problems by means of various strategies. In compliance with the tenets of RME, to wit, the use of model and symbol for progressive mathematization, the study shows that the participants could acquire orientation for developing their mathematical ideas and strategies. Implications of the findings are discussed.

Keywords: Pre-Service Primary School Teachers, Division, Realistic Mathematics Education, Classroom Mathematical Activities

Mengidentifikasi Strategi Pembagian dari Calon Guru Sekolah Dasar

Abstrak

Penelitian ini fokus untuk mengidentifikasi karya calon guru sekolah dasar terhadap masalah pembagian menggunakan pendekatan matematis yang disebut Realistic Mathematics Education (RME). Sebuah studi kasus dilakukan untuk 36 calon guru di salah satu universitas swasta di Jakarta yang mengambil mata kuliah RME. Hasil analisis dari jawaban tertulis partisipan menunjukkan bahwa pendekatan mengarahkan partisipan untuk mengembangkan makna matematika untuk menangani masalah pembagian melalui berbagai strategi. Sesuai dengan prinsip RME, yakni, penggunaan model dan simbol untuk matematisasi progresif, penelitian ini menunjukkan bahwa partisipan dapat memperoleh orientasi untuk mengembangkan ide-ide matematika dan strategi. Implikasi dari temuan ini dapat ditemukan dalam pembahasan.

Kata kunci: Calon Guru Sekolah Dasar, Pembagian, Realistic Mathematics Education, Aktivitas Matematika di kelas

✉ Corresponding Author:

E-mail: tian_aziz@uhamka.ac.id

INTRODUCTION

Inevitably, mathematics is an essential part in daily life as it is a form of human activity and each person has equal opportunity to be an inventor. In addition, mathematical objects philosophically are in the nature of human thought and as a product of human creation (**Ernest, 1991, 1998; Hersh, 1997**). This understanding should be taken into consideration by mathematics teachers in their practice. When learning mathematics, teachers should engage students in activities that encourage them to construct their own mathematical meaning and avoid memorizing mathematical procedures.

Literatures, however, showed that in most cases in-service teachers and pre-service teachers tended to emphasize their mathematics teaching activity on memorization of facts and procedures (**Olanoff, Lo, & Tobias, 2014; Purnomo, Kowiyah, Alyani, & Assiti, 2014; Purnomo, Suryadi, & Darwis, 2016; Thanheiser, Whitacre, & Roy, 2014; Yang, Reys, & Reys, 2009**). Consequently, it might lead to mathematical errors, student's less conscientious, and difficulties in building connection among procedures, understanding and related context, and hinder development of mathematical competences (**Purnomo et al., 2014; Yang & Wu, 2010a**).

This emphasis also can be found when teachers presented the topics of numbers and operations (**Olanoff et al., 2014; Purnomo et al., 2014; Thanheiser et al., 2014**). Referring to what was stated by **Purnomo et al. (2014)**, understanding of numbers is not only focus on counting procedures, but also interpreting the number itself. In teaching arithmetics, numbers and operations cannot be separated. **van den Heuvel-Panhuizen (2008)** used the term of number relationship to express connection between them in which the relationships could clarify understanding of matters. They explained that a thorough understanding of whole numbers was invaluable for three reasons as follow.

1. It is important that children develop an understanding of numbers, so that they are capable of interpreting the meaning of numbers in all sorts of practical situations and recognizing the possible improper use of numbers.
2. With this knowledge numbers come to life, it is exploring how to operate with numbers has a good foundation and takes place naturally.
3. Analyzing numbers has a pure mathematical value, such as investigation in number theory.

Besides, **van den Heuvel-Panhuizen (2008)** stated that for whole numbers, calculation is interpreted broadly including number knowledge, number sense, mental arithmetic, estimation and algorithm.

Some researchers were in common argument that number sense played important role in basic education curriculum (**Courtney-Clarke & Wessels, 2014; Yang & Li, 2008; Yang & Wu, 2010b**). However, some researchers reported that most primary school students encountered difficulties in dealing with number sense (**Purnomo et al., 2014; Zanzali & Ghazali, 1999**). We need to consider this problem as an initial effort to improve students' ability in developing number sense. Therefore, based on this problem, investigation of pre-service primary school teachers in number sense is necessary to be conducted.

There are several mathematics activities to develop students' number sense, one of which is Realistic Mathematics Education (RME). The RME has various advantages as it has five powerful characteristics, to wit: phenomenological exploration, the use of models and symbols for progressive mathematization, students' own constructions and productions, interactivity, and intertwinement. RME was chosen in this study due to the scarcity in literatures.

In the wake of presenting RME within certain period, we evaluated pre-service primary school teachers' comprehension through investigating their approach in addressing mathematical problem. We focused heavily on their strategies to solve division problem. Therefore, in this study the researchers tried to answer the question: "To what extent does

Realistic Mathematics Education influence Pre-Service Primary School Teachers in solving division problem?"

METHODS

This research is case study on pre-service primary school teachers. The subjects were thirty-six pre-service primary school teachers who registered in the 2015/2016 academic year in a private university in Jakarta. The participants were in the fifth semester. The reason of researchers worked with them because they had taken Realistic Mathematics Education course.

The data was collected by administering test. The test was used to identify the division’s strategies conducted by pre-service primary school teachers. There was single item question about division with different indicators that could be seen in following table.

Table 1. The term of strategies

| Types | Indicators |
|------------------------------|---|
| Conceptual Strategies | Grouping, distributing one by one, using repeated subtraction |
| Procedural Strategies | Using formal procedures |

Besides, researchers used assessment guidelines to analyze participants' answers which were classified into two categories: conceptual strategies and procedural strategies. Data was obtained from all students’ answers which were classified based on indicators.

FINDINGS AND DISCUSSION

Generally, retrospective analysis toward teaching experiment conducted was taken from students’ answers in mid semester examination. Mathematical problem proposed was in the following:

Sebanyak 6.384 kelereng akan dibagikan kepada 12 orang anak. Berapa banyak kelereng yang harus dibagikan kepada setiap anak agar masing-masing anak mendapatkan jumlah kelereng yang sama?

Translate: 6384 marbles will be distributed equally to 12 children. How many marbles does each child have?

According to the five characteristics of RME, we expected the participants to develop their intuitive notions using the context given. By interpreting the problem that 6384 marbles would be distributed equally to 12 children, the idea of “fair sharing” might be considered. Here, the emergent of modeling played an important role in determining every stage of the marbles shared to each student. The model could be described by circle or the shape of marble itself. The use of model assisted students in developing intuition and bridging from informal level (contextual situation) into more formal mathematics (progressive mathematization). Every process in each step was done by pre-service primary school teachers as a part of their own constructions and productions. There were various strategies proposed which provoked into class discussion. At the final discussion, they made conclusion and related the topic of division into other topics such as mental arithmetic, estimation and algorithm (intertwinement stage).

From all participants, we analyzed of pre-service primary school teachers’ works. Overall, 61% students used conceptual strategies. There were 22% used grouping strategies which divided hundreds, tens, and ones such as in Figure 1 and 2.

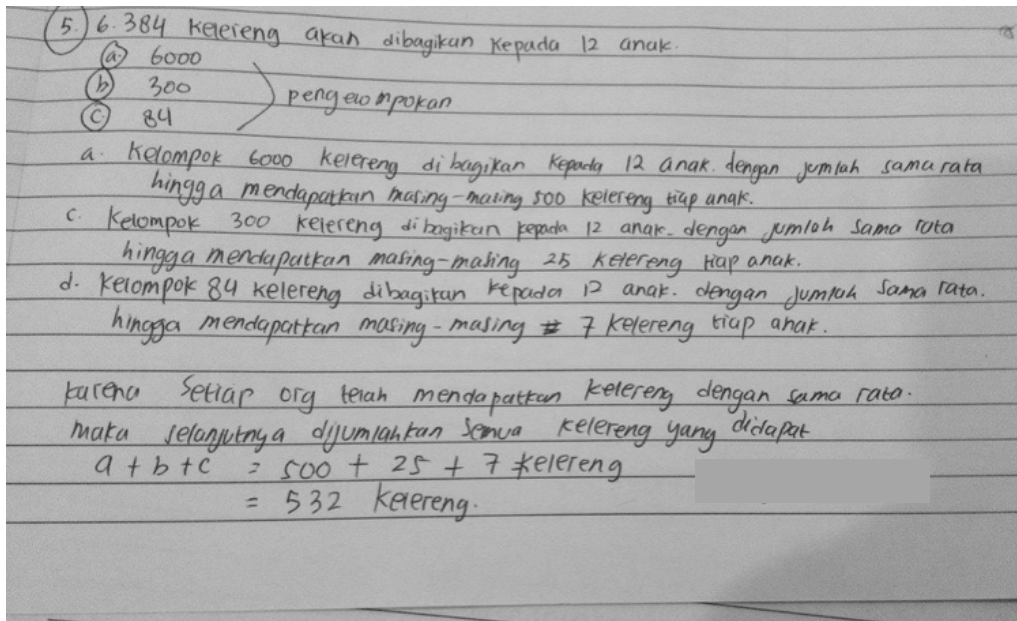


Figure 1. Grouping Strategy

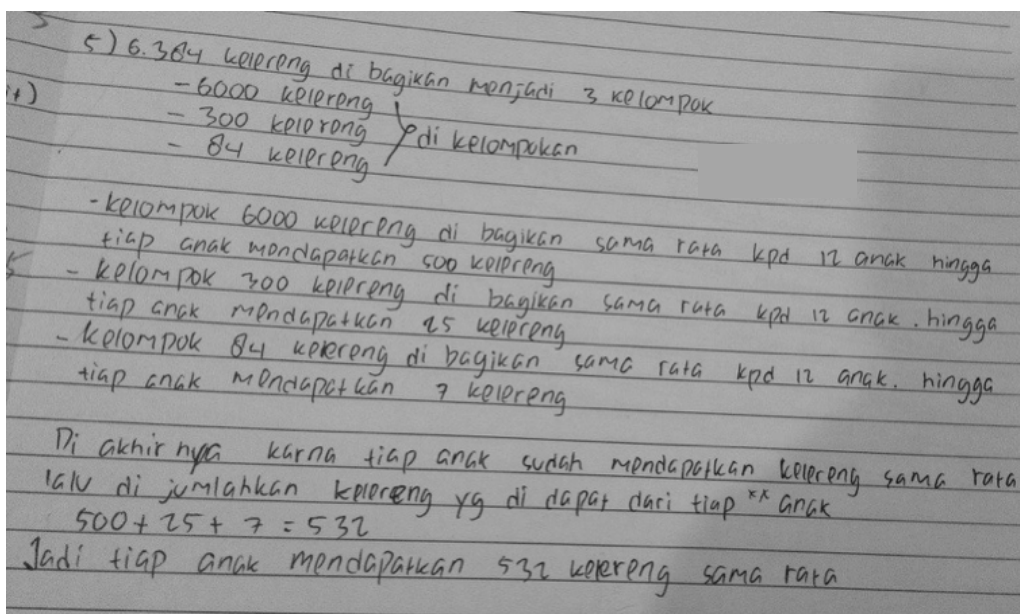


Figure 2. Grouping Strategy

When we asked students why they used this strategy, they explained that they initially interpreted the context which meant that they had to divide 6384 marbles into 12. Then, they thought that it would be easier for them to make a group in which 6384 was expressed as $6000+300+84$. Subsequently, 6000 divided by 12, 300 divided by 12, and 84 divided by 12. By doing this, they got the results 500, 25, and 7 respectively. After that, they added the results become 532. They concluded that in order to be fair, each student must have 532 marbles. 31% students used a strategy by distributing marbles one by one to each. They expressed that to distribute 6384 marbles, they would ask 12 students and distribute it to each student equally. From the answer, it was obvious that they thought that in order to distribute all marbles, they have to distribute each marble to each student one by one until there was no leftover (see Figure 3).

Sebanyak 6.384 kelereng akan dibagikan kepada 12 anak. Berapa banyak kelereng yang harus dibagikan agar masing-masing anak mendapatkan jumlah kelereng yang sama?
 Cara saya sebagai guru dalam membimbing siswa SD untuk memecahkan masalah tersebut adalah dengan cara pertama-tama saya akan meminta kepada 12 orang anak untuk maju kedepan kelas, kemudian berbaris. Selanjutnya saya akan meminta kepada anak yang duduk untuk bergantian maju kedepan kelas sambil mengambil kelereng yang tersedia dan memberikannya satu-satu kepada setiap anak (ke 12 anak) yang berbaris di depan kelas, begitu seterusnya bergantian oleh anak-anak yang duduk untuk maju dan membagikan kelereng dengan rata, sehingga lama-kelamaan kelereng tersebut habis. Setelah itu ke 12 anak tersebut yg telah menerima kelereng menghitung jumlah kelereng yang mereka dapat secara masing-masing. Maka jika ke 12 anak tersebut mendapatkan kelereng yang sama banyak maka itulah hasil pembagian dari kelereng yang diberikan kepada ke 12 anak tersebut. ($6.384 : 12 = 532$)
 Jadi masing-masing anak akan mendapatkan kelereng sejumlah 532 kelereng. Dengan begitu siswa akan mampu memecahkan masalah matematika dengan konkret, dengan konteks yang mudah dipahami, sebelum langsung menuju ke bentuk matematika kormal. Selain itu siswa diberi kesempatan untuk membangun dan menemukan pemecahan masalah dan konsep-konsep matematis.

Figure 3. Distributing One by One Strategy

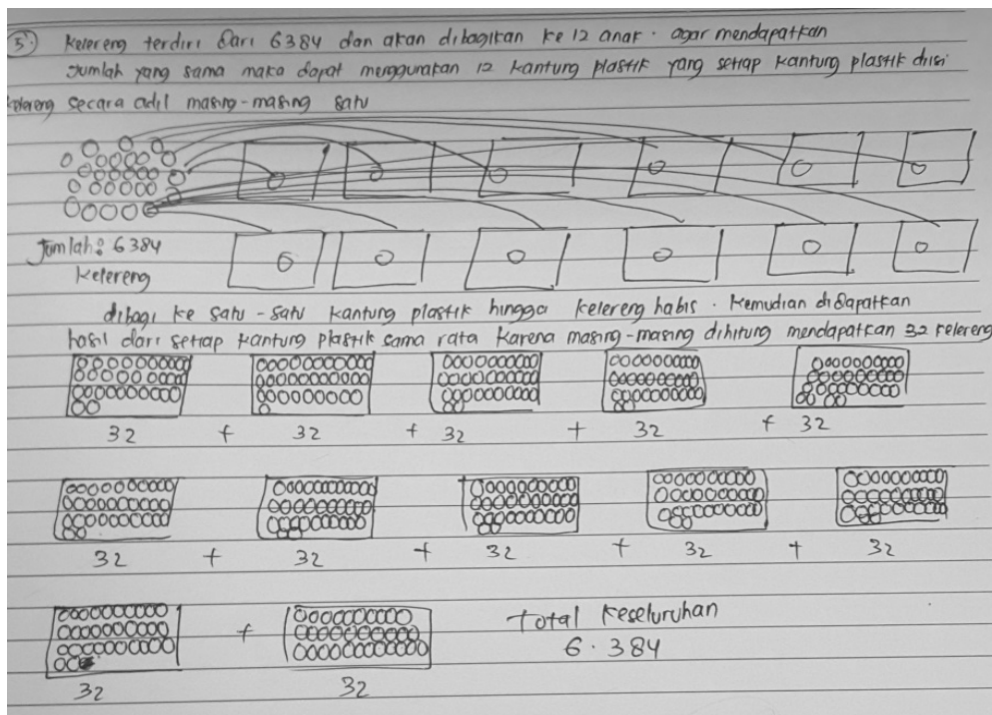


Figure 4. Distributing One by One Strategy using Model

Meanwhile, some students described the strategy of distributing one by one using model such in Figure 4. The students' strategy in Figure 4 actually was the same with Figure 3, yet in Figure 4 they used model to describe that each marble was distributed to 12

students until there were no leftover. This model could help the students to construct the strategy compared to only describing the strategies.

In addition, 6% students used the strategies that to distribute 6384 marbles into 12 students, they subtracted it with 532 continuously. When we asked them further, they got 532 because they divided it first. It means, before they come up to the strategy, they divided 6384 with 12. But there was no clear information with respect to the strategy of getting the result of 532. For these students, it seemed that they had already known the concept of division as repeated subtraction (see Figure 5).

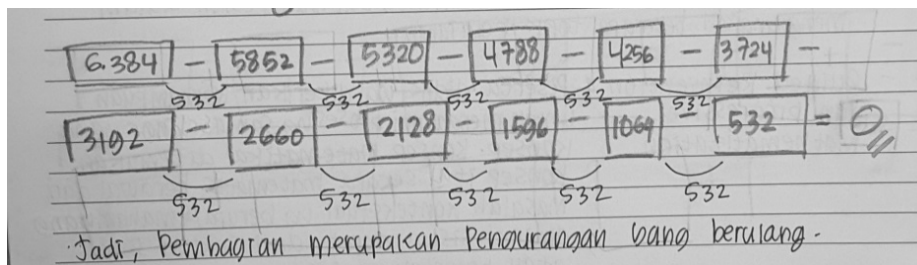


Figure 5. Repeated Subtraction' Strategy

Another strategy was proposed by one student who made the relationship between numbers and money. When we asked him why he used this strategy even though it was not mentioned in the question, then he explained that it was because young children were more familiar with money. So, he thought that when he had Rp6000.00, it means that he must have 12 pieces of Rp500.00. And then, he distributed the rest marbles (384) with 12 students. Finally, he got the result of 532 (see Figure 6).

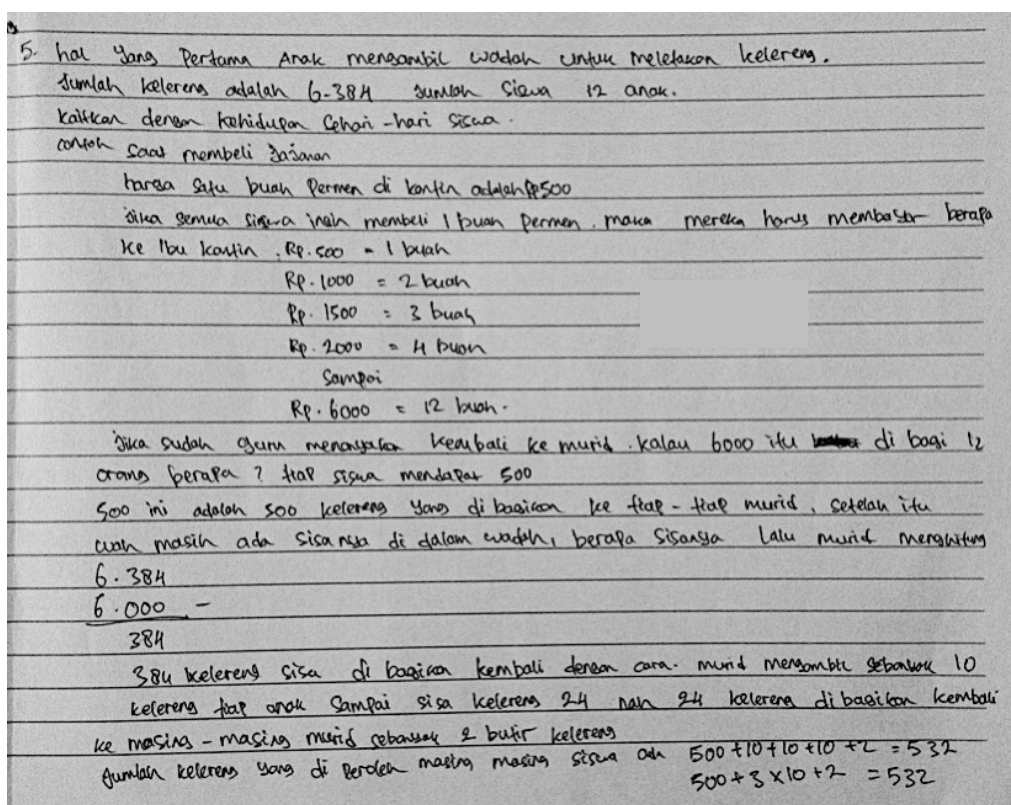


Figure 6. Money's Strategy

However, 36% students still used the formal procedures like in the Figure 7. The students who still used the formal procedures like in Figure 3 gave the reason that to divide 6384 marbles into 12 students need long time, therefore they decided to use the fastest solution using formal procedures. This strategy was more familiar since when they were students in primary school, their teacher taught division problem using that strategy. However, we need to investigate them whether they understood the concept of “fair sharing” in division or they just followed teacher’s instruction. In RME, we avoid using fastest solution or direct formal procedures because we have to build context, and from that context we will understand the mathematical goal including the emergent modeling as a bridging from informal level into more formal mathematics. Another reason expressed by students who used the formal procedures could be seen in Figure 8.

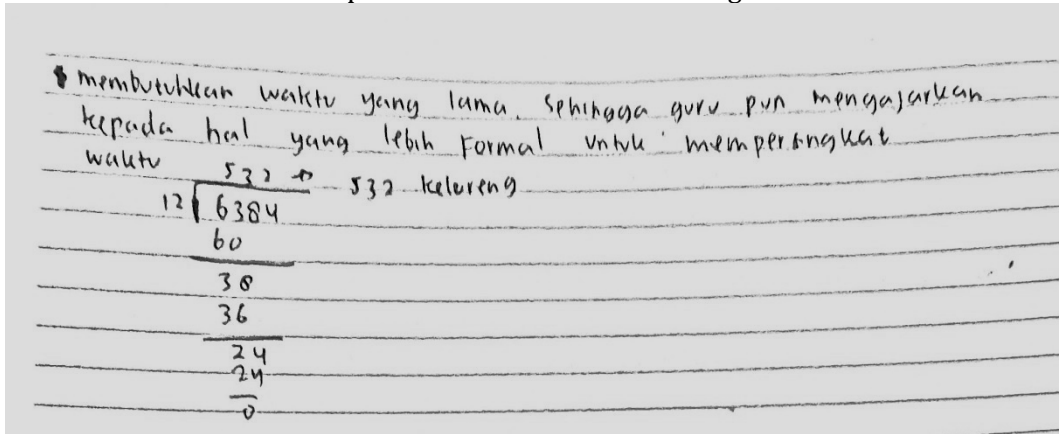


Figure 7. Formal Procedure Strategy

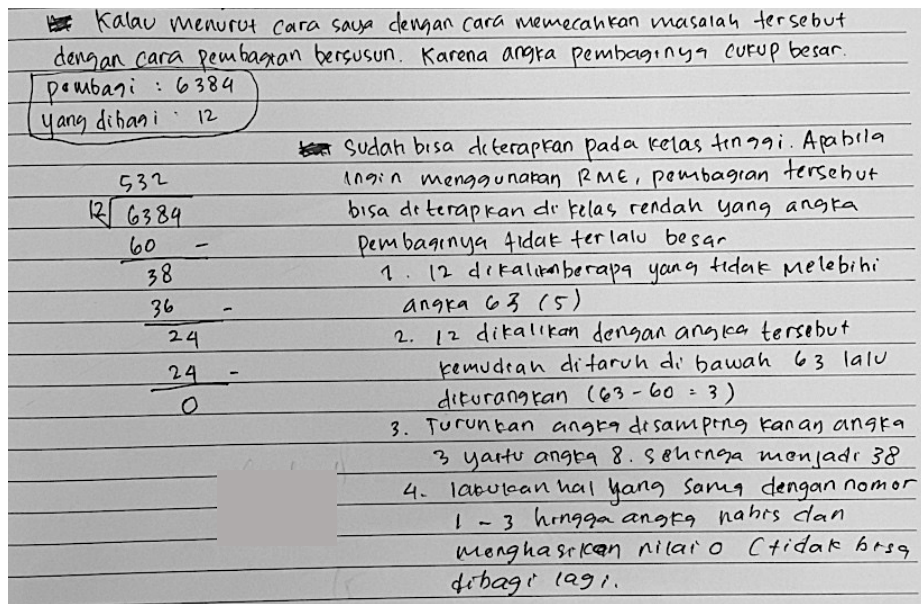


Figure 8. Formal Procedure strategy

In Figure 8, this student expressed that as the numbers divided was very large, then the easiest way to deal with it is by using formal procedures. In addition, she also mentioned that Realistic Mathematics Education was only could be applied in earlier primary school students (grade 1-3). However, according to her, for higher level students (grade 4-6) the formal procedures could be applied.

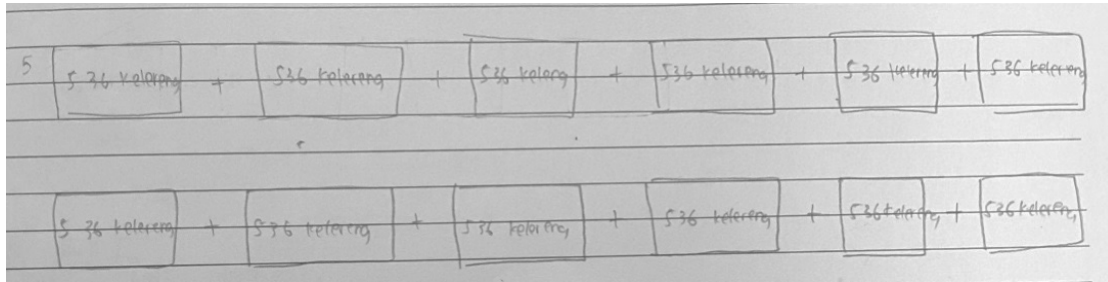


Figure 9. Repeated Addition Strategy

Finally, there was only one student who misunderstood the question. She thought that division was repeated addition (Figure 9). She also did wrong calculation as it were 536 marbles added twelve times, and she did not mention what the result was.

According to the findings, most of students used their strategies based on the context. They tend to apply their conceptual knowledge in solving the problem. Even though there were some students who still used procedural knowledge, but when they raised class discussion held after mid-semester, they realized that solving the problem without understanding the context and using the model was more difficult. It was suitable with what was stated by **van den Heuvel-Panhuizen (2008)** revealed that algorithm-based subtraction is postponed until the children can perform column subtraction skillfully and have completely mastered algorithm-based addition. It was also in accordance with what was stated by **Purnomo et al. (2014)** that understanding of numbers is not only focus on counting procedures, but also interpreting the number itself.

CONCLUSION

In the part of designed context and activities, Realistic Mathematics Education (RME) underlies this research, because most of participants used their progressive mathematization when dealing with the problem. This research shows that there were various strategies used by participants both in conceptual and procedural ways. The approach of RME could improve the students' comprehension in exploring the contextual situation and using model for progressive mathematization by constructing their own strategies.

In compliance with the fourth characteristic of RME, namely interactivity, the study shows that the pre-service primary school teachers could acquire orientation for development of mathematical ideas using their strategies. Even though there were some participants who still used formal procedures, but at the end when they come up into class discussion they realized that it such kind of memorizing and they did not know about the concept. Concerning the findings of this research, we recommend teachers and pre-service teachers in Indonesia to apply Realistic Mathematics Education (RME) or PMRI (Pendidikan Matematika Realistik Indonesia) as basic philosophy for teaching and learning mathematics which could become a bridge from informal level to pre-formal level mathematics, and also it could become a base for further studies to explore instructional design research.

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