MENTAL COMPUTATION PERFORMANCE: AN INTERVENTION STUDY WITH YEAR 5 STUDENTS

Marzuki

Department of Elementary Teacher Education, Faculty of Education,
Almuslim University, Bireuen, Aceh, INDONESIA.

zmarzuki.48@yahoo.co.id

ABSTRACT

This paper presents the prepared and results of intervention using instructional materials on the development of mental computation of a sample of 51 year 5 students. It comprises 25 students for experimental group and 26 students for control group. The performance of mental computation among students was not satisfied before the intervention was enacted as it was shown in the result of pre-test. Mental computation was quite a new topic for all of students in this study, they all never found such the problem in their previous experience of learning mathematics both formally and informally. However, they found that the instructional materials were not only challenging their mind but also very interesting. After the instructional intervention, experimental students' achievement was significantly higher than that of the control group. The data showed that mental computation can be developed through appropriate intervention. The findings in this study can benefit teachers who teach mathematics at elementary school in considering materials the will teach beyond the routine procedure.

Keyword: Mental computation, Number sense, Realistic Mathematics Education

INTRODUCTON

As a dynamic subject, mathematics at school needs to reform in term of materials as well as instructional approach. In term of materials, the mathematics the students need today, particularly in arithmetic section, is the mathematics that can differentiate them from calculating machines which have been programmed to follow certain algorithms (Munirah Ghazali et al, 2010). Being able to understand properly the result of a calculation provided by calculators or computers will not come by itself. It needs a serious effort to introduce students the kind of mathematics they need in this digital era. Introducing number sense can be considered as an answer or solution to this necessity.

Number sense is a topic that is currently being discussed and seriously considered by many mathematics educators and researchers around the world (Sengul, 2013). Almost all parts of the world, students and teachers feel that number sense is a new way of approaching mathematics, particularly in the topic of numbers and operations (Yang et al., 2009; Munirah et al., 2010; Greeno, 1991; McIntosh, 1997; Sengul, 2013).

Number sense will give in-depth mathematical insight to students besides the routine computation procedures. Even though many researchers argue that number sense cannot be defined in a unanimous way, it can easily be recognized through its natural characteristics. It gives students the way to estimate, to compute mentally, to decide if an answer is logic or not, and any other intuitive strategies that are not common in current curriculum.

Mental computation encourages students to perform their skills in computation that is quite different from those of in standard written algorithm. Mental computation gives them

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spacious space of the meaningful and creative thinking rather than static, rigid, and meaningless rote learning.

An in-depth thinking of number sense, particularly mental computation, in term of materials and the approach of mathematics teaching learning give clues that there are something in common between the materials and the way the mathematics that is realistically taught, the approach of realistic mathematics education (RME).

In this study the researcher would like to introduce the students mental computation with new teaching and learning approach of RME.

LITERATURE REVIEW

Many calls for reform in school mathematics regarding the important of number sense require teacher to provide a relevant instructions and materials that enable students to develop conceptual understanding along with procedural understanding (NCTM, 2000; Reys&Yang, 1998, Ma, 1999). They must swift the mode of teaching from traditional approach to the approach that enable the student to understand mathematics more flexibly. The wave of calling for reform in teaching and learning mathematics in the past few decades has been responded by the emerging the contextual teaching and learning (Widjaja et al., 2010). This calls are in line with the spirit of RME and number sense.

The urgency of number sense development has received many concerns among mathematics researchers and educators around the world (McIntosh, et al., 1997; NCTM, 2000; Anghileri, 2000; Yang, 2003; Yang & Wu, 2010). As an important component of number sense, mental computation contributes much to the development of number sense (Kaminski, 1997; Greeno, 1991; Yang, 2003).

Owens (1993) stated that mental computation is one of the two ways of approaching number sense besides computational estimation. If we look in depth on these three terminologies (mental computation, computational estimation, and number sense), Owens (1993) furthermore noted that mental computation lied at the lowest level, computational estimation in the middle, and number sense at the highest. This means that to achieve a higher level of number sense proficiency, a students must start to strengthen the foundation of it (mental computation followed by computational estimation).

As an important part of number sense, mental computation gives a wide range of mental activities to compute in any flexible ways apart from merely using standard written algorithm. Bennett & Nelson (2001) contents that mental computation has three techniques: compatible numbers (e.g., 27 - 15 + 13 = 27 + 13 – 15 = 40 -15), substitutions (e.g., 138 + 29 = 138 + (2 + 27) = 140 + 27, equal differences (e.g., 27 – 19 = 28 – 20 = 8).

Today, in Indonesia mathematics is considered as a big burden by majority of students at almost all schools, and even it is received a stamp of negative image. This image also affect people around the students who are not directly involve in the teaching and learning process of mathematics (Makkink, 2010). What they all know is that mathematics is a static, difficult, and boring subject. Many mathematics educators have worked intensively hard to find alternative solutions that can contribute to minimize this unwanted image. The instructional approach that may change this view point is the instructional approach that is flexible, student-centered, and meaningful. That kind of approach is the approach of what the reformist of mathematics education call *Pendidikan Matematika Realistik Indonesia* (Indonesian version of RME).

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In line with contextual teaching and learning, Realistic Mathematics Education (RME) is an approach in mathematics education which focuses on the meaningfulness of the mathematics contents learnt by students (Freudenthal, 1991). The approach is the opposite of the traditional approach which focus on the ready-made mathematics to be learnt by students through memorizing and retrieving the facts, symbols, procedures, etc.

Treffers (1987) gave five principles of RME: use of contexts, use of model, students' contribution, interactivity, and intertwining of various topics. Intertwining is one of the principles of RME that emphasize on the interconnected either among topics within mathematics itself or across the other subjects. In response to RME call, number sense (in this case mental computation) contributes as a main role to make mathematics, particularly the arithmetic section, more meaningful and interesting.

This study was conducted with the materials of mental computation and RME as a framework in conducting the processes of instructional. The RME framework is used to prepare, conduct, and evaluate the teaching and learning of the intended materials.

METHODS

Participants

The participants of this study were primary school students of *Sekolah Dasar Negeri 3 Peusangan* of in Bireuen Regency, Aceh Province, Indonesia. Two grade 5 classrooms of this school were randomly selected to participate in this study as an experimental group and a control group. Experimental group comprised 25 students and control group 26 students. Most of the students come from families of farmer and a little percentage of them from families of civil servant. According to the mathematics teacher all students were considered of having the same mathematical ability based on their achievement background in the previous grade. Table 1 below shows the composition of students for both experimental and control groups.

Table 1. The composition of students in experimental and control group

Group	*Boys*	*Girls*	*Total*
Experimental	12	13	25
Control	13	13	26
Total	25	26	51

Instruments

The instruments that was used in this study was the test that included 10 items of mental computation problems. The test consisted of three categories of mental computation, i.e. substitutions (items number 1 to 4), equal differences (items number 5 to 6), and compatible number (items number 7 to 10). Before applying, the reliability of the instrument had been measured with the result of test-retest reliability is 0.79. The same test was used for the purpose of pre-test and post-test.

Besides the instrument of pre-test and post-test, this study was equipped by additional instrument that was used as instructional materials. The contents of instructional materials were different between experimental and control group.

The instructional materials for experimental group were prepared based on the RME framework and the instructional materials for control group were prepared as the students

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were normally taught previously. For short, both groups were taught using the same materials but the materials were enacted with different teaching approaches.

Data Collection Procedures

Both experimental and control group were assigned pre-test containing mental computation materials. To answer the test, the students were told to do so without using standard algorithm as they usually did when performing calculation. They were also told that they had to think in different ways from the common practice of using paper-pencil computation.

The test results were used as a starting point and initial reflection and as a basis for constructing instructional materials, particularly for the experimental group. The experimental group was then directed to participate in classroom with the prepared RME-approach materials taught by the researchers. while the control group was also taught by the researcher with conventional approach.

Upon the completion of the instructional processes, both groups were then asked to sit for the post-test with the same contents as those of in the pre-test. This is intended to see the actual students' achievement before and after intervention, particularly for experimental group.

INSTRUCTIONAL ACTIVITIES

Both experimental and control group were taught by the researcher. All classroom activities were based on the prepared instructional materials with he amount of time allocated for both experimental and control group are the same (40 minutes for each instructional unit of materials) and they were video-recorded for the purpose of data analyzing. There were three instructional units that were prepared for enacting in the classrooms. These units were (a) additions (b) subtractions, and (c) combination of additions and subtractions. The topics of the materials that were prepared for each unit were as the following.

Additions

In this section the students are encouraged to perform mental computation by substitution. The substitution means to reconstruct the number to make the operation easier to compute. The addition 57 + 49 can be changed into (57 + 3) + 46 = 60 + 46 = 104. The reformation of addition expression from 57 + 49 to 60 + 46 changes the sum and easy to handle.

Subtractions

The students are also encouraged to perform mental computation in subtraction by substitution together with equal differences method. The subtraction likes 164 – 47 can be changed into (164 – 40) – (47 – 7) = 124 – 7 = 117. The equal differences mean that the two numbers in the subtraction are added or subtracted with the same unique number to make the subtraction easy to calculate.

Combination of Additions and Subtractions

In this session the students are required to solve one problem with two operation involved. The operations are limited to addition and subtraction. The mental technique that can be applied here is the compatible number strategy. This technique is performed by finding pairs of numbers that look easy to compute. The operation problem like 108 + 15 – 20 + 35 can be solved by changing the position of number into a new arrangement. The problem can be changed to be (108 - 20) + (35 + 15) which gives the simple expression addition 88 + 50 and the final result is 135.The last addition expression of the problem looks like more easier to answer than the original one.

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RESULTS

The results of the data obtained in this study are to be summarized in the following tables and graph.

Table 2. Mean and standard deviation of pre-test, post-test, t-test and *p*-value of post-test for high, middle, and low sub-groups from the experimental and control groups.

Level	*Groups*	*N*	*Pre-test*		*Post-test*		*t-value*	*p-value*
			Mean	*SD*	*Mean*	*SD*		
Low	Experimental	7	37.14	12.54	67.14	9.51	3.97	.002
	Control	7	35.71	5.35	44.29	11.34		
Middle	Experimental	11	56.36	5.05	86.36	5.05	4.08	.001
	Control	12	52.50	9.65	69.17	13.11		
High	Experimental	7	68.57	10.69	98.57	3.78	6.14	.000
	Control	7	68.57	6.90	82.86	4.88		

Table 2 shows that the performance of students in experimental group was statistically higher than that of the control groups in all sub-groups of achievement level (low, middle, and high).

Table 3. The mean scores and standard deviations of gain scores for high, middle, and low sub-groups from the experimental and control groups.

Level	*Groups*	*Mean*	*SD*	*N*
Low	Experimental	.48	.073	7
	Control	.13	.18	7
Middle	Experimental	.69	.09	11
	Control	.33	.33	12
High	Experimental	.73	.016	7
	Control	.54	.16	7
Overall	Experimental	.64	.13	25
	Control	.33	.29	26

Table 3 shows that the mean of gain scores is higher for all categories (low, middle, high, and overall) of experimental group compared to that of the control group. This means that students' performances of experimental group were better compared to the students' performances in control group.

Figure 1 shows the position of all mean of gain scores for high, middle, and low sub-groups from the experimental and control groups. From the picture, it can be seen that the gain score of experimental group is higher than that of the control group.

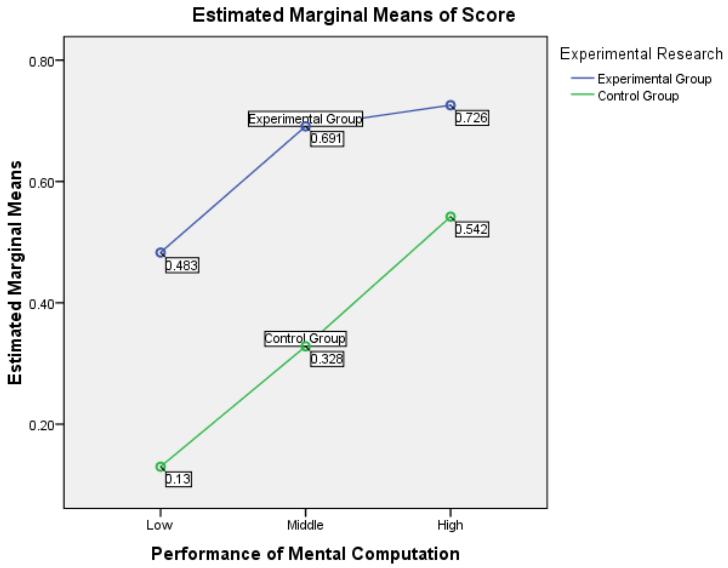

Figure 1. Mean of gain scores for high, middle, and low sub-groups from the experimental and control groups

DISCUSSION

This study was designed to find out students' performance on mental computation as a starting point to enhance their skills into a higher position. The result of pre-test showed that the students had no background knowledge of mental computation. All they knew are how to compute an arithmetic operation using the standard procedure usually called algorithm This finding is consistent with what have been found by McIntosh, et al. (1997). The instructional activities were design based on this initial finding. This was done to follow the guideline of the RME principles who suggest that the learning should be begun with what students have known or understood.

The results of the post-test show that the students' performance in experimental group is better than that of in control group. This is in line with the result found by many other researchers that confirmed intervention can enhance students achievement in number sense generally and mental computation particularly (Yang; Kaminski, 1997; Veloo, 2012)

The following are the sample of students' answers on their answer sheets.

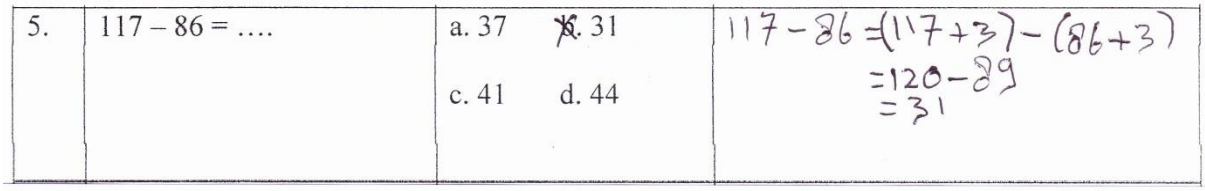

Figure 2. Answer of item number 5 submitted by FM

The answer as shown in Figure 2 above is the answer of a high-level student (FM) who tried to use a strategy of mental computation. The strategy that he used was called "equal difference".

Another student (RP) who are in the middle-level also tried to use one of the strategy but she could not perform it properly (Figure 3). She could not perform the way to answer with the easier way, she only changed the number but she could not find the easy expression problem.

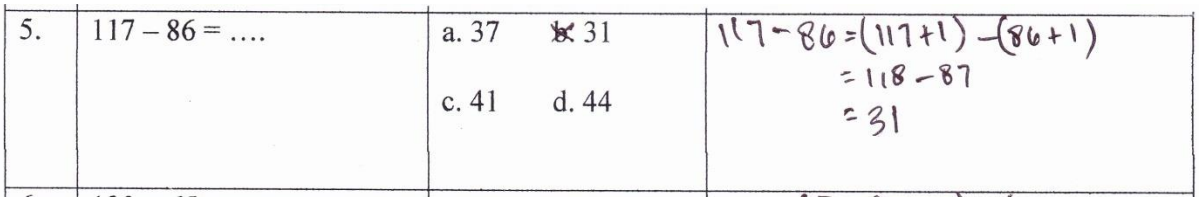

Figure 3. Answer of item number 5 submitted by RP

The third student (NS) who fall in the category of low-level students perform the calculation in the standard procedure. She did not recognize the strategy of mental computation (Figure 4).

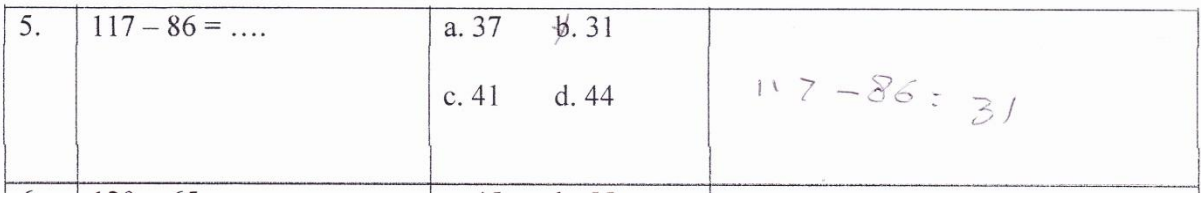

Figure 4. Answer of item number 5 submitted by NS

CONCLUSION

This study was conducted to discover the current mathematics teaching and learning at primary school and its contribution to the development of mental computation. Besides that, it also conducted to see the effect of intervention on the mental computation improvement of students.

Initially, the students' performances of mental computation are too low. It is because they had never found in the previous mathematics lesson about the topic. This topic is totally new for all students, even for the mathematics teacher who teach them.

Fortunately, all students show their high eagerness and seriousness to participate in this new approach of understanding additions and subtractions and they also show the significant improvement on it. These indicators imply that mental computation in particular and number sense in general can be enhanced through appropriate intervention.

The mathematics teacher confessed that she first knew the topic and the contents of topic on the days the researcher explained to her because these type materials are not found in the current mathematics textbooks. She was very grateful to know something new about the materials and way mathematics should be taught.

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