

PROFILE OF MENTAL COMPUTATION OF ELEMENTARY PRE-SERVICE TEACHER ACCORDING TO REFLECTIVE-IMPULSIVE COGNITIVE STYLE

Chusnul Khotimah Galatea

University of Muhammadiyah Jember
liagatea@gmail.com

Abstract

The purpose of this study was to describe mental computation ability of elementary pre-service teacher with reflective-impulsive cognitive style. Twentyeight juniors in Jember University participated in this study. All of the juniors were tested on Matching Familiar Figure Test (MFFT). Two juniors were chosen, based the test result, as subjects of the research. They were classified as a junior with reflective cognitive style and a junior with impulsive cognitive style. The subjects were tested in an oral mental computation test. The test contains 4 items for additions, subtractions, multiplications, and divisions in whole numbers. Findings were analyzed with qualitative methods. At the end of the research, a subject with impulsive cognitive style showed a better result than reflective cognitive style. When computation strategies were analyzed, it was found that a subject with reflective cognitive style used standard method that were heavily influenced by written algorithm and only had one strategy to answer the problem, meanwhile impulsive subject used non standard method without reformulation and gave alternate strategy to answer the problem. Despite of that, the alternate strategy used by impulsive subject were influenced by written algorithm.

Keywords: *mental computation, computation strategies, juniors, cognitive styles.*

I. Introduction

Numeracy skill is an ability that cannot be separated in a person's daily life, from childhood to adulthood. This shows that the basic numeracy skill is the ability to possess someone. Moreover, with an increase in a person's numeracy, it will certainly affect the improvement of mathematics skills. In education; therefore, field numeracy emphasized since the students study in elementary school.

Cognitive development of students at the elementary level demanding role of the teacher that is quite dominant in the school. According to Mulyana (2007), the percentage of teacher mentoring for students in elementary school, both psychologically and pedagogic has been set at 80%, while the role of students 20%. The role of teachers is large enough, it must be balanced with the knowledge and mastery of concepts adequate teachers. Knowledge and adequate mathematicemathematical concepts; therefore, are appropriately held by students of Teacher Training of Elementary School who will be the teachers of Elementary Schools.

The knowledge and mastery of mathematical concepts that are owned by elementary pre-service teacher is one of the important roles in the teaching of mathematics because it will affect them in lesson plan and teaching instruction when they become a teacher. In addition, the knowledge and mastery of mathematical concepts of a teacher will also affect the knowledge obtained by the students. The knowledge of a teacher will influence the actions of a teacher in the classroom that will also affect what students are learning in the classroom. Therefore, the choice of elementary pre-service teacher as a research subject cannot be separated from the need of mental computation teaching at the elementary level. Thus, to improve mental computation of pre-service teachers, they should know the description of mental computation beforehand.

According to McIntosh, Reys & Reys (1997) mental computation refers to computing an exact answer to a computation “in the head”. So, there is no aid tools, such as a calculator or pencil and paper, which are usually used in counting. Furthermore, McIntosh, Reys & Reys, Reys (1984) stated that there are two distinguishing characteristics of mental computation. It produces an exact answer, and the procedure performed mentally, without using external devices such as pencil and paper. Hazekamp (in Morgan, 1999) also stated mental computation refers to the process of producing an exact answer mentally without resort to calculators or any external recording device, usually with nontraditional mental procedures. Thus, it can be said that mental computation is the calculation process which performed mentally by using non-standard methods to obtain exact answer without the aid of any counting tools. Despite, McIntosh, Reys & Reys (1997) stated that the strategy for computing may be invented by the user or “borrowed” from standards paper and pencil techniques.

The benefits of mental computation are numerous and cover student’s thinking, creativity, and problem solving skills (Reys, 1985; Reys 1984). Furthermore, children who encouraged to formulate their own mental computation strategies, they learn how numbers work, gain a richer experience in dealing with numbers, develop number sense, and develop confidence in their ability to make sense of number operations (Reys, 1984; Kamii & Dominick, 1998). Mental

computation also emphasis as computational strategies that student should develop over the years of schooling (NCTM, 2000).

Nevertheless, research conducted by Herman (2001) shows that primary school students in Indonesia have a tendency to use traditional algorithms in mathematics. The use of traditional algorithm in mathematics more commonly given by teachers, so students also tend to use traditional algorithms in mathematics. Traditional algorithms make students tend to think in terms of numbers, not the basic concept of numbers. If the algorithm used for calculating, sometimes at a certain number in this way it is very inefficient in the calculation. For example, the sum of the following two: $335 + 626 + 260$ and 198 . Students who use traditional algorithms always add up numbers from right to left, such as $0 + 5$, $3 + 6$, then $3 + 5$. Similarly, the same way also used in the second question. Nonetheless, students will tend to make mistakes on the second question because the sum of the two numbers is done from right going to produce the sum is more than 10. Thus, it can be said that, the traditional algorithm will always use the same way to solve all the problems. Though there are other counting strategy that is simpler and can be used to produce an answer. Based on the use of these strategies, it can be said that the use of traditional algorithms in mental computation would make the calculations more complicated and inefficient. Therefore, the elementary school students in Indonesia have a lack ability of mental computation, thus teaching mental computation should be given at the elementary level.

In learning activities, in general, the students have a consistent behavior when working on a wide variety of different tasks. According to Saracho (1997) consistency in the use of cognitive processes called cognitive style. This cognitive style does not show a person's cognitive level, but the cognitive styles show the stability of attitudes, tendencies or habits in the use of strategies that differentiate the style of a person while observing, remembering, thinking, and problem solving. Cognitive style usually described as a stable personality dimension and persistent influence attitudes, values, and social interaction. Meanwhile, Riding and Rayner (in Kozhevnikov, 2007) states that cognitive style is a preferable approach a person and an individual habit to organize and represent information, which affects the way in which people sense and respond to events. Goldstein and Blackman (in

Kozhevnikov, 2007) defines it as a hypothetical construction which has been developed to explain the mediation process between stimulus and response.

Thornell (1976) states the cognitive styles may affect learning activities in the classroom. The sense of teachers to the individual differences can give a significant effect on the way of teachers in facilitating learning in the classroom. By knowing the cognitive styles of the students, the teacher can provide a wide range of techniques and learning strategies considered easier to use by students. Cognitive styles used as consideration for understanding individual differences in students and use them to improve learning activities (Saracho, 1997).

According to Stenberg (in Goldstein and Naglieri, 2011) cognitive style refers to the special characteristics and trends that one has to process information. It also covers how student teachers in information processing for counting. According to a research of Swartz and Perkins (Hassoubah, 2004) human tends to experience four patterns of thinking are ineffective or wrong. There are four tendencies to think: a) in a hurry, which is too quick to make a decision, without considering the idea or other alternatives; b) disheveled, namely the tendency to be disorganized thinking, jumping from one idea to another without analyzing in depth one of these ideas; c) do not focus, that is become blurred or vague in their thinking and not clear in giving opinions; d) narrow, i.e.the tendency of thinking is not deep so ignore other important information that may exist. Furthermore, cognitive style associated with the use of time used by student teachers and the number of errors made by student teachers in answering the question divided into two, namely reflective and impulsive cognitive style. Refer to the results of this study it appears that the pattern of thinking is not effective tend to be owned by the pre-service teachers who have impulsive cognitive style.

Impulsive and reflective cognitive style defined as a property of the cognitive system that combines the time to make decisions of individuals and their performance in problem solving situations involving a high degree of uncertainty. According to Kagan (in Saklofske & Zeidner, 1995) it is in operational reflectivity regarded as a long response some errors. Meanwhile, impulsivity considered as a short response with many errors.

Ancillotti (in Rozenwag & Corroyer, 2005) states that reflective juniors tend to use analytical processes in information processing, while the impulsive juniors tend to use a holistic process. Holistic process is one of the characteristics of students who use mental algorithms in counting (Plunkett, 1979). When pre-service teachers do mental computation, they will use mental algorithms in counting. It is interesting to observe that pre-service teachers with impulsive cognitive style have a tendency to answer the questions quickly but then, make many mistakes. Further, the researchers also wanted to observe how the image of mental computation of pre-service teachers to with a reflective cognitive style who have a tendency to use the analytic process in answering questions (Ancillotti in Rozenwajg & Corroyer: 2005); in which, according to Plunkett (1979) students who process information analytically is one of the characteristics of students who tend to use written algorithms in counting.

II. Method

This research uses qualitative research that describes the profile of mental computation of elementary pre-service teachers according to reflective and impulsive cognitive style. The researcher used Matching Familiar Figure Test (MFFT), mental computation test, and interview to investigate the description.

The participants of this study were twenty-nine juniors of Teacher Training of Elementary School of Department of Education at University of Jember chosen by snowball sampling. The test of reflective-impulsive cognitive styles used in this study adapted from the Matching Familiar Figure Test that developed by Warli (2010) and has been tested the validity, reliability, and fit for use. In the test consists of 13 items and 2 items to trial. Giving items trial aims to enable students to be measured cognitive styles understand the task that must be done. Data obtained from experiments item were not analyzed. While 13 such items, including pictures of trees, shape forming a human head, uniforms, sunflower, ruler, birds, boats, line charts, cashew fruit, student wear uniform, bows, pedicab drivers, and bar charts. Two juniors were chosen based on MFFT result, as the subjects of the research. They were classified as reflective and impulsive subjects.

Mental Computation Test consisted of 4 items for the four operations (addition, subtraction, multiplication, and division) in integers. The mental computation test individually administered by the researcher/instructors with twenty second intervals per item. The oral items read twice with a short pause (2-3 seconds) between readings followed by a 20 seconds waiting period between items to let students answer the questions (Reys, 1985). Test administered orally because it is expected that oral test can invite student to use invented mental algorithm than written test (McIntosh, Nohda, Reys, and Reys, 1995). The students were given an answer sheet and not allowed to record anything except the exact answer. The examiner read the general instructions loudly for the MCT and answered any questions from the subjects. The Subjects were advised to listen carefully because each oral question will be read aloud and repeated only once. Immediately after these instructions, a practice question provided.

Table 1. Mental Computation Test 1

| NO | MCT 1 | MCT 2 |
|----|---------------------|---------------------|
| 1. | $63 + 75 + 137$ | $42 + 63 + 158$ |
| 2. | $97 + 48 - 13 - 48$ | $95 + 26 - 17 - 26$ |
| 3. | 33×25 | 28×50 |
| 4. | $1300 : 50$ | $1800 : 30$ |

A semi-structured interview used in the study. The interview used to gain deeper insight into the method that they used in mental computation. Collecting data in this study conducted by using two techniques that were the written test and interview. The process of collecting data obtained from the written test that are Matching Familiar Figure Test (MFFT) and Mental Computation Test (MCT). The data collection started by giving Matching Familiar Figure Test (MFFT). Then the results used to determine the subject of research. The next process, given the subject matter of mental computation followed by interviews with the study subjects.

In this study, the test of the credibility of the data used was the triangulation of time, by comparing and checking the degree of confidence behind the information obtained based on time or a different situation (Sugiyono, 2013). Data from MCT 1 and interview of reflective subject on the first time compared with the second data (MCT 2 an interview). If there were a lot of inconsistent data, the researchers took a different time to triangulate back to the previous data. This

continued until the consistency of the data obtained. The data were consistent with the recent data, so they were valid data. Furthermore, valid data analyzed to describe the mental computation elementary pre-service teachers with reflective and impulsive cognitive style.

III. Result and Discussion

Profile of Mental Computation of Elementary Pre-Service Teachers According to Reflective Cognitive Style

Based on tests of mental computation and interviews on reflective subject, authors obtain mental computation profiles of juniors with reflective cognitive style according to indicators of mental computation. Here are profiles of mental computation of reflective subject juniors, they are:

- a. Reflective subject stated a strategy of mental image of traditional algorithm from right to left to solve the sum of the integers. It shows that the subject could not perform mental computation and inflexible in calculating the sum of the integers.
- b. Reflective subject stated a strategy of mental image of traditional algorithm from right to left to solve the subtraction of the integers. It shows that the subject could not perform mental computation and inflexible in calculating the subtraction of the integers.
- c. Reflective subjects stated two strategies that were a mix of mental image of traditional algorithm from right to left with factoring to solve the multiplication of the integers. It shows that the subject could not perform mental computation and inflexible in calculating the multiplication of the integers.
- d. Reflective subject stated a strategy of mental image of traditional algorithm to solve the division of the integers. It shows that the subject could not perform mental computation and inflexible in calculating the division of the integers.

Based on the information above can be seen that profile of mental computation elementary pre-service teachers with reflective cognitive style in operating integers. In general, it can be said that the subject with reflective cognitive

style tend to use standard methods when performing mental computation on integers. Reflective subject used standard methods that are traditional algorithm from right to left to sum integers. The subject also mentioned that her way was the only way that she knew in doing computation with the addition operation. As addition operation, subtraction operation was also used traditional algorithm from right to left. The subject also stated that to solve the problem in subtraction operation, subject had only one strategy, the strategy that she used. However, in multiplication, the subject used transition method that combined of traditional algorithm from right to left and factorisation. Subjects also mentioned other strategy, traditional algorithm from right to left.

Furthermore, in division the subject used standard method, traditional algorithm. The subject also stated that the subject simply knowing traditional algorithm to compute integers in division. Thus, it appeared that reflective subject could not do mental computation because the subject tended to use a standard method in calculating integers. In addition, the reflective subject also did not have the flexibility in counting because she tended to have a strategy to solve the problem in which the strategy still influenced by the traditional algorithms. This is consistent with the opinion of Ancillotti (in Rozencwajg and Corroyer, 2005) who says that a person with a reflective cognitive style tends to use the analytic process in answering the questions. Besides, Plunket (1979), states a person who tends to process information analytically is one of the characteristics of a person who has a tendency to use traditional algorithms in mathematics.

Profile of Mental Computation of Elementary Pre-Service Teachers According to Impulsive Cognitive Style

Based on tests of mental computation and interviews on the impulsive subject, the researcher obtained mental computation profiles of elementary pre-service teachers with reflective cognitive styles according to indicators of mental computation. Here are profiles of mental computation of impulsive subject, namely:

- a. Impulsive subject mentioned two strategies which were front-end (left to right) strategy and the mental image of traditional algorithm from left to

- right to solve the sum of the integers. It shows that the subject could perform mental computation, but less flexible in calculating the sum of the integers.
- b. Impulsive subject mentioned two strategies that were front-end strategy and a mental image of traditional algorithm from right to left to solve the subtraction of integers. It shows that the subject could perform mental computation, but less flexible in calculating the subtraction of integers.
 - c. Impulsive subject mentioned a strategy that combined both factoring and partitioning strategies to solve multiplication of integer. It shows that the subject could perform mental computation, but less flexible in calculating the multiplication of integers.
 - d. Impulsive subject mentioned one strategy that was broken down into parts strategy to solve the division of integers. It shows that the subject could perform mental computation, but less flexible in calculating the division of integers.

Thus, it can be seen that the image of mental computation of elementary pre-service teachers with impulsive cognitive style in operating integers. In general, it can be said that the impulsive subject tended to use non-standard methods to perform mental computation. Subject used non-standard methods that was front-end (left to right) strategy in addition of integers. Furthermore, subject mentioned another strategy to solve the problem using traditional algorithm from right to left. Thus, the subject mentioned two different strategies that he used to compute the sum of integers. The subject also thought that the front-end (left to right) strategy was more effective to perform mental computation than traditional algorithm for the use of traditional algorithms can compute calculations and lead to wrong answers.

In subtraction, the subject also used non-standard method to calculate the problem. Subject used front-end strategy to calculate integers without borrowing and took away a certain number to calculate the subtraction of integers with borrowing. Furthermore, the subject also mentioned that the method of subtraction from right to left could be used to solve the problem. Nevertheless, the subject said that the front-end strategy was more effective than traditional algorithms for the strategy to simplify the calculation.

In multiplication, the subject used non-standard methods that were factoring and partitioning strategies to calculate. Although using two strategies to solve one problem, the subject could not mention other strategies such as traditional algorithms or any other strategies that include the non-standard methods. Similarly, in division, subject used non-standard method that was breaking dividen into parts strategy to solve the problem, but could not cite other strategies. Subject thought that the strategy that she used to calculate integers in multiplication and division were effective strategy. She stated a reason that its strategy is a common strategy that she used in counting. Thus, it can be seen that the subject with impulsive cognitive style had a good performance in mental computation as the subject tended to use non-standard methods in counting. However, impulsive subject could be said to lack flexibility to perform mental computation because she had put forward an alternative strategy that was still influenced by the traditional algorithms.

This is consistent with the opinion of Ancillotti (in Rozencwajg & Corroyer: 2005) who says that a person with an impulsive cognitive styles tend to use a holistic process in answering the questions. Besides, Plunket (1979), states a person who tends to process information in a holistic manner is one of the characteristics of a person who has a tendency to use mental arithmetic algorithms. However, the tendency of the subject in using non-standard without reformulation indicate that the subject is still not fully process information holistically.

IV. Conclusion

Mental computation skills of impulsive subject were better than reflective subject. It is because a reflective subject tended to use standard methods to perform mental computation, while the impulsive subject tended to use non-standard methods without reformulation in performing mental computation. Differences in counting strategy of mental computation of both subjects affected its flexibility in counting. A reflective subject was less flexible in counting because she tended to have a strategy to complete the computation in which the strategy was still influenced by the traditional algorithms. Meanwhile, impulsive subject who tended to use non-standard methods without reformulation in performing mental computation could mention another strategy to answer the question. Nevertheless,

the alternative strategy of impulsive subject was still influenced by the traditional algorithms. Thus we can say that the impulsive subject was more flexible to count using mental computation than reflective subject.

Nonetheless, the traditional algorithm used by reflective subject in mental computation tends to make the subject produced the wrong answer when the form of the given problem long enough. Subjects tended to be difficult to count "inside the head" while listening to the problem. Meanwhile, impulsive subject stated that using standard algorithms to compute the problem could cause inaccuracy and ultimately produced the wrong answer.

As the results of this study, the researchers suggested that teachers also pay attention to individual differences in learning, in particular cognitive style in computing mentally, and if it is possible a teacher should give more attention to reflective students than the impulsive students, without neglecting the students with other cognitive style which are fast-accurate and slow not-accurate. Furthermore, researchers hope the results of this research can be developed more widely, i.e, the ability of mental computation subject in others such as fractions, percents, or decimal. It can be used to see the consistency of the subject in using the strategy of counting on different numbers with the same arithmetic operations.

V. References

- Mulyana, A. Z. (2007). *Rahasia menjadi guru hebat*. Jakarta: Grasindo.
- NCTM. (2000). *Principles and standards for school mathematics*. Reston: NCTM.
- Saklofske, Donald H. and Zeidner, Moshe. (1995). *International handbook of personality and intelligence*. New York: Plenum Press.
- Saracho, Olivia, N. (1997). *Teachers' and Students' Cognitive Styles in Early Childhood Education*. London: Bergin & Garvey.
- Sugiyono, (2013). *Metode penelitian pendidikan: pendidikan kuantitatif, kualitatif, dan R&D*. Bandung: Alfabeta.
- Kamii, C., & Dominick, A. (1998). The Harmful Effects Of Algorithms In Grades 1-4. In L. J. Morrow & M. J. Kenney (Eds.), *The Teaching And Learning Of Algorithms In School Mathematics* (pp. 130-140). Reston, VA: National Council of Teachers of Mathematics.

- Goldstein, S. and Naglieri, Jack A. (2011). *Encyclopedia of Child Behavior and Development*. Springer Reference, Vol. 1, A – D.
- Kozhevnikov, Maria. (2007). “Cognitive styles in the context of modern psychology: toward an integrated framework of cognitive style”. *Psychological bulletin*, Vol. 133 No. 3, pp. 464–481.
- McIntosh, A., Nohda, N., Reys, B. J., and Reys, R. E. (1995). “Mental computation performance in australia, japan and the united states”. *Educational studies in mathematicsematics*, Vol. 29 No. 3, pp. 237-258.
- McIntosh, A., Reys, R.E., & Reys, B.J. (1997). “Mental computation in the middle grades: the importance of thinking strategies”. *Mathematicsematics teaching in the middle school*, Vol. 2, pp. 322-327.
- Plunkett, Stuart. (1979). “Decomposition and All That Root”. *Mathematicsematics in school*, Vol. 8 No. 3, pp. 2-5.
- Reys, Robert E. (1984). Mental Computation and Estimation: Past, Present, and Future. *The Elementary School Journal, Special Issue: Mathematicsematics Education*, 84 (5), 546-557.
- Reys, Barbara J. (1985). Mental Computation. *Arithmetic Teacher*, 32 (6), 43-46.
- Rozenchwajg, Paulette & Corroyer, Denis. (2005). “Cognitive Processes in The Reflective–Impulsive Cognitive Style”. *The Journal of Genetic Psychology*, Vol. 166 No. 4, pp. 451–463.
- Hassoubah, Zaleha Izhah. (2004). Cara Berpikir Kreatif dan Kritis Alih Bahasa Bambang Suryadi. Bandung: Yayasan Nuansa Cendikia.
- Morgan, Geoffrey R. (1999). *An analysis of the nature and function of mental computation in primary mathematicsematics curricula*. Dissertation. Queensland University of Technology, Brisbane.
- Thornell, John G. (1976). “Research on Cognitive Styles: Implications for Teaching and Learning”. *Educational Leadership*, pp. 502-504.
- Warli. (2010). *Profil kreativitas siswa yang bergaya kognitif reflektif dan siswa yang bergaya kognitif impulsif dalam memecahkan masalah geometri*. (Disertasi doctor tidak dipublikasikan). Universitas Negeri Surabaya.
- Herman, Tatang. (2001). *Strategi Mental Yang Digunakan Siswa Sekolah Dasar dalam Berhitung*. Seminar Nasional Pendidikan Matematika di Universitas Negeri Yogyakarta.