The effect of counting method and learning style on students' counting learning outcome in the mathematics lesson

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Abstract. This study was conducted to determine the effect on counting methods namely Jatimatika counting method (JCM) and Abacus counting method (ACM) and learning styles on the counting learning outcome of mathematics lesson. This type of research was quasi-experimental with research subject as many as 60 students were selected classes that have the same categories. The data collection technique used essay test. Two-way ANOVA analysed the obtained data. The results of this study revealed that: (1) there were significant differences in counting learning outcome of mathematics between JCM with ACM, (2) there were significant differences in counting learning outcome of mathematics between students with visual and auditory, (3) there was interaction between counting method and learning style to counting learning outcome of mathematics, (4) counting learning outcomes between JCM with visual learning style greater than ACM with visual learning style, (5) counting learning outcomes between JCM with auditory learning style greater than ACM with auditory learning style, (6) counting learning outcomes between JCM with visual learning style greater than ACM with auditory learning style, (7) counting learning outcomes between ACM with visual learning style greater than ACM with auditory learning style.

1. Introduction

One of the essential roles of mathematics in life is to prepare individuals and society through exercises acting on logical, rational, critical, accurate, honest, effective and efficient thinking. This preparation begins with the teaching of mathematics in elementary schools that gives every student the opportunity to have the ability to acquire, manage and utilize information in an increasingly dynamic life. For that, we need a way so that math lessons can be easily understood and used by students in the future [1].

Elementary math lessons that are important in mathematics such as addition, subtraction, multiplication and the division of counting skills are still one of the most challenging experiences [2] faced by low-grade students. Though the addition and subtraction operations are the primary stages that must be mastered by students so that students can continue higher counting operations. Various studies show that the difficulties of students mastering addition and subtraction operations are less variation of the methods used by teachers in teaching counting or teaching style, so the students' counting ability is still low [3]. Some teachers even ask students to memorize the sum, or imaginary, so that students have difficulty performing counting operations. In addition to counting methods that are still difficult to do
by students [4], the method of calculating is less in line with student learning styles consisting of various characteristics.

Most teachers do not give students the opportunity to use counting methods by following student learning styles. Students are forced to follow methods that are in accordance with the will of the teacher. Though the suitability of teaching methods with student learning styles can increase student learning outcomes [5-7] although it is not easy to do. Learning style as the technique in which persons start to focus on, practice, internalize and maintain new and hard information [8]. Learning styles which describe a person’s choice for how to receive, process and definite information [9], with auditory, visual and tactile-kinesthetic and each practices a different part of the brain [10].

Various difficulties in counting lead to various innovations in counting methods such as Jarimatika counting method (JCM), Abacus counting method (ACM). Both methods are proven to improve students' numeracy skills. JCM is one of the counting methods of using the fingers and finger knuckles for the operation of the multiplication, division, addition, and subtraction. Use ten fingers, with the right-hand fingers as ones and thousands, while the left-hand fingers for tens and hundreds. The JCM begins with the introduction of concepts--with concrete objects-- followed by the introduction of symbols in the finger, as well as addition, subtraction, multiplication, and division. The use of the JCM is done in a fun and interesting ways, such as games and songs. So expect counting lessons do not burden the memory of the brain, and not a frightening lesson for children [11].

![Figure 1. Symbol of jarimatika counting method [11]](image)

The ACM is a counting method that uses a rectangular tool consisting of beads and is divided into upper and lower parts. The top bead is worth five and the bottom is worth one. Each row of the abacus in pole units has one’s value and the more to the left is for tens, hundreds, thousands and so on. ACM can also be used for addition, subtraction, multiplication, division [12]. ACM is used to understand the process of counting operations in mathematics and can improve students' arithmetic abilities [13].

![Figure 2. The position of reading the abacus [14]](image)
On the basis of the review of studies and objectives of the study, the following hypotheses were formulated:

- There were significant differences in counting learning outcome of mathematics between JCM with ACM.
- There were significant differences in counting learning outcome of mathematics between students with visual and auditory.
- There was an interaction between counting method and learning style to counting learning outcome of mathematics.
- Counting learning outcomes between JCM with visual learning style greater than ACM with visual learning style.
- Counting learning outcomes between JCM with auditory learning style smaller than ACM with auditory learning style.
- Counting learning outcomes between ACM with visual learning style smaller than ACM with auditory learning style.
- Counting learning outcomes between JCM with visual learning style greater than JCM with auditory learning style.

2. Methods

2.1 Research Design

This study is quasi-experimental research by applying Jarimatika counting method (JCM) and Abacus counting method (ACM) in counting lesson in learning mathematics. Research design carried out by using factorial design 2 x 2 in order to compare two types of counting methods and two types of students' learning styles (visual and auditory). The research design was presented in Table 1.

| Counting Methods (A) | JCM (A₁) | ACM (A₂) |
|---------------------|----------|----------|
| Students’ Learning Styles (B) |          |          |
| Visual (B₁)        | A₁B₁     | A₂B₁     |
| Auditory (B₂)      | A₁B₂     | A₂B₂     |

Note:
A₁B₁ : Students who have visual are taught by using JCM
A₂B₁ : Students who have visual are taught by using ACM
A₁B₂ : Students who have auditory are taught by using JCM
A₂B₂ : Students who have auditory are taught by using ACM

2.2 Sampling Procedure

2.2.1 Population and Sample. The research was conducted at two private elementary schools in Depok, West Java. The population of this study was all the students in the second-grade academic year 2016/2017 in the first semester. The total number of populations was 100 students in four classes. Then from each school were selected two sample classes, namely the experimental class and comparison class. The experimental class, taught by using JCM. Meanwhile, the comparison class taught by using ACM.

Selection of this classes is not done randomly, but selected classes that have the same categories. The experimental class consists of 30 students, selected based on both visual and auditory learning styles. Similarly, the comparison class, consisting of 30 students. Selection of learning styles of each class based on the results of psychological tests conducted by schools in the second grade. Each class consists of 15 students who have visual learning styles, and 15 students with an auditory learning style.
2.2.2 Instruments of Research. The validated instruments used in this study were used essay test category. The objective test was used to test the students’ counting score. The number of test questions consists of 10 essay questions, which contain two-digit addition and subtraction. Previously the test has been validated using expert judgment so that the matter is valid and can be used to test the hypothesis.

2.2.3 Procedure of The Treatment. The experiment was conducted in both experimental and comparison classes with having the similar scope of teaching. There are two teachers have the same experience in teaching, same degree, and sex. The difference is on the use of teaching of counting methods. The first teacher applied JCM in experimental class, and the second teacher applied ACM in comparison class. The students of two classes have the same characteristics, although in the different school but they were in the same grade and range of age. The process of the treatment was carried out twice a week and it took 60 minutes for each treatment. It was four weeks to accomplish the treatment in the two classes, and it ends up giving the test to them.

2.2.4. Data analysis. The analysis of data had been used in this study was Two-Way Analysis of Variance (ANOVA) at level of significance $\alpha = 0.05$. It was used to test three hypotheses at first, if it meets the requirement that there is interaction, will proceed with further test with next four research hypothesis.

3. Results and Discussion

3.1. Result

The data were analyzed with the help of SPSS-20 program. The results of the study are as follows. Table 2 is result of hypothesis test of two-way ANOVA.

| Source                   | Type III Sum of Squares | df | Mean Square | F      | Sig   |
|--------------------------|-------------------------|----|-------------|--------|-------|
| Corrected Model          | 1115.533*               | 3  | 371.844     | 20.691 | .000  |
| Intercept                | 370992.067              | 1  | 370992.067  | 20643.438 | .000 |
| Counting method          | 792.067                 | 1  | 792.067     | 44.074 | .000  |
| Learning Style           | 129.067                 | 1  | 129.067     | 7.182  | 0.010 |
| Counting method*Learning Style | 194.400               | 1  | 194.400     | 10.817 | 0.002 |
| Error                    | 1006.400                | 56 | 17.971      |        |       |
| Total                    | 373114.000              | 50 |             |        |       |
| Corrected Total          | 2121.933                | 59 |             |        |       |

Dependent Variable: Counting_Learning_Outcome

First hypothesis accepted (sig p = 0.000 < $\alpha = 0.05$). There were significant differences in counting learning outcome between Jarimatika counting method and Abacus counting method. Second hypothesis accepted (sig p = 0.010 < $\alpha = 0.05$). There were significant differences in counting learning outcome between visual learning style and auditory learning style. Third hypothesis accepted (sig p = 0.002 < $\alpha = 0.05$). There was an interaction between counting method and learning style toward counting learning outcome of mathematics.

Figure 3 is the interaction between counting method and learning style done using ANOVA two lines (summarized in Table 2).
Figure 3. Interaction between Counting Method and Learning Style

The result of the third hypothesis states that there is an interaction between counting methods and learning styles, so that further tests using the Scheffe Test, with the results in Table 3.

Table 3. Result of scheffe test

| (I) Interaction | (J) Interaction | Mean Difference (I-J) | Std. Error | Sig | 95% Confidence Interval | Confidence | Lower Bound | Upper Bound |
|-----------------|-----------------|-----------------------|------------|-----|------------------------|------------|-------------|-------------|
| A₁B₁            | A₁B₂            | 6.53*                 | 1.548      | .001| 2.07                   | 11.00      |             |             |
| A₂B₁            | A₁B₂            | 10.87*                | 1.548      | .000| 6.40                   | 15.33      |             |             |
| A₂B₂            | A₁B₂            | 10.20*                | 1.548      | .000| 5.74                   | 14.66      |             |             |
| A₁B₁            | A₂B₂            | -6.53*                | 1.548      | .001| -11.00                 | -2.07      |             |             |
| A₁B₂            | A₂B₁            | 4.33*                 | 1.548      | .060| -.13                   | 8.80       |             |             |
| A₂B₂            | A₂B₁            | 3.67*                 | 1.548      | .145| -.80                   | 8.13       |             |             |
| A₁B₁            | A₁B₂            | -10.87*               | 1.548      | .000| -15.33                 | -6.40      |             |             |
| A₂B₁            | A²B₂            | -4.33                 | 1.548      | .060| -8.80                  | .13        |             |             |
| A₂B₂            | A₁B₂            | -.67                  | 1.548      | .098| -5.13                  | 3.80       |             |             |
| A₁B₁            | A₂B₁            | 10.20*                | 1.548      | .000| -14.66                 | -5.74      |             |             |
| A₁B₂            | A₂B₁            | -3.67                 | 1.548      | .145| -8.13                  | .80        |             |             |
| A₂B₂            | A₂B₁            | .67                   | 1.548      | .980| -3.80                  | 5.13       |             |             |

Dependent Variable: Counting_Learning_Outcome

The fourth hypothesis accepted namely A₁B₁ greater than A₂B₁ or JCM with visual learning style greater than ACM with visual learning style (sig. 0.000 < 0.05). The fifth hypothesis rejected namely A₁B₂ smaller than A₂B₂ or JCM with auditory learning style smaller than ACM with auditory learning style (sig. 0.145 > 0.05). The sixth hypothesis accepted, namely A₁B₁ greater than A₁B₂ or JCM with visual learning style greater than JCM with auditory learning style (sig.0.001 < 0.05). The seventh hypothesis rejected namely A₂B₁ smaller than A₂B₂ or ACM with visual learning style smaller than ACM with auditory learning style (sig. 0.98 > 0.05).

3.2. Discussion

The first hypothesis states that there are differences in counting learning outcomes on JCM and ACM. The difference in learning outcomes counting is determined by the counting tool that influences the learning outcomes counting. At JCM the finger-counting tool, always available and usable at all times,
makes students more effective and quicker to use. In contrast to JCM, ACM uses a counting tool in the form of beads on a board. Students must move the beads in accordance with the counting operation, in a stable position so as not to mix with unused beads. This condition causes less effective [15] use of abacus.

The second hypothesis states that there are differences in learning outcomes counting on visual learning styles with auditory learning styles. In JCM, learning outcomes counting of visual learning style has a greater average than the auditory learning style. Students can see and perform counting operations directly by moving their fingers, making it easier to perform calculations. For an auditory learning style, students should have high listening concentrations to make no mistakes in calculations even if the fingers can be moved. In contrast, in ACM the average learning outcomes counting on the auditory learning style greater than the visual learning style. Students more easily use the imagery of beads in their minds instead of using beads on the board directly [16].

The third hypothesis states that there is an interaction between counting methods with student learning styles. This statement concludes that the counting learning outcomes are strongly influenced by counting methods and student learning styles. Counting methods –JCM and ACM-- provide an opportunity for students to be able to choose the most appropriate and effective method that aims to facilitate and assist students in counting [17,18]. The ease of counting method is also highly determined by the learning style that the students have. Students who have visual learning styles are well-suited to methods that use easy-to-see tools, while auditory learning styles rely more on imagination and high concentration to make counting operations easier.

The fourth hypothesis states that the counting learning outcomes of JCM with visual learning style is greater than ACM with visual learning style. These results relate to the ease of using the fingers, can be seen the results of addition and subtraction operation directly. Compared with ACM with visual learning style, the difficulties often faced by students are the frequent changes or movements of beads on the abacus boards, so students have to repeat the calculations, and tend to experience the final error of calculation.

The fifth hypothesis was rejected because the counting learning outcomes of JCM with the auditory learning style was greater than counting learning outcomes of ACM with the auditory learning style. This condition is influenced by the learning style of auditory on JCM, still assisted by the movement of fingers. Students tend to have a habit of working on the problem by asking the teacher for help reading it while moving fingers to complete the calculation. Students can see their fingers and do not look their fingers directly but can move them by themselves without doing any imagination in mind. In contrast to ACM, the difficulties faced by some students with the auditory style is a matter of high concentration, so as not to be wrong in the calculations. Actually, this can train students' concentration to be better [19]. When the concentration is disturbed, the students have to repeat again, so it takes a quiet classroom atmosphere.

The sixth hypothesis states accepted that the counting learning outcomes of JCM with visual learning styles greater than the auditory learning style. Students with visual learning styles more easily perform calculations by looking at questions, opening and closing their fingers directly with ease compared to students who move their hands without seeing the operation open and close his fingers directly. Calculation errors are usually more common in students with an auditory learning style on JCM.

The seventh hypothesis states rejected because the counting learning outcomes of ACM with visual learning style is greater than the auditory learning style. Visual learning style on ACM will be more effective and easier for students, because the calculation plus and minus directly using the beads of the abacus, can be seen, although must keep the tool is in a stable or silent position. Instead, students who have an auditory learning style must move the abacus beads into his mind [20]. This condition requires a very high concentration, so the calculation is not wrong. The difficulty that often happens is that students have to listen to the problems of the teacher repeatedly and at the same time have to move the abacus beads in his mind.
4. Conclusion
Based on the discussion on the result of the research it can be concluded that (1) there were significant differences in counting learning outcome of mathematics between JCM with ACM, (2) there were significant differences in counting learning outcome of mathematics between students with visual and auditory, (3) there was interaction between counting method and learning style to counting learning outcome of mathematics, (4) counting learning outcomes between JCM with visual learning style greater than ACM with visual learning style, (5) counting learning outcomes between JCM with auditory learning style greater than ACM with auditory learning style, (6) counting learning outcomes between JCM with visual learning style greater than JCM with auditory learning style, (7) counting learning outcomes between ACM with visual learning style greater than ACM with auditory learning style.

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