Improving students’ understanding of mathematical concept using maple

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Abstract. This study aimed to improve students’ understanding of mathematical concept ability through implementation of using Maple in learning and expository learning. This study used a quasi-experimental research with pretest-posttest control group design. The sample on this study was 61 students in the second semester of Mathematics Education of Universitas PGRI Palembang, South Sumatera in academic year 2016/2017. The sample was divided into two classes, one class as the experiment class who using Maple in learning and the other class as a control class who received expository learning. Data were collective through the test of mathematical initial ability and mathematical concept understanding ability. Data were analyzed by t-test and two ways ANOVA. The results of this study showed (1) the improvement of students’ mathematical concept understanding ability who using Maple in learning is better than those who using expository learning; (2) there is no interaction between learning model and students’ mathematical initial ability to toward the improvement of students’ understanding of mathematical concept ability.

1. Introduction
The first goal of learning mathematics is students have the ability to understanding the mathematical concept. This statement was mentioned in the Regulation of the Minister of National Education of Indonesia, number 22 in year 2006 [1]. Having ability to understanding mathematical concept is very important to students when they learn mathematics, and when they solve their daily life problems. In learning mathematics, the ability to understanding the mathematical concept is the main thinking that can lead students to have other mathematical ability [2, 3].

The NCTM describes that the ability to understanding the mathematical concept is the ability to (1) define the concept, (2) identifying the examples and not examples, (3) using the models, diagrams, and symbols to present a concept, (4) changing one form into representation to another form, (5) recognize the various meanings and interpretations of the concept, (6) identifying the properties of the concept, and compare and contrast the concept (as cited in [2]).

Considering the importance of students’ understanding mathematical concept ability, the learning process of mathematics in the classroom should be conducted to support the development of this ability. But the fact, the mathematics ability of students in Indonesia at middle school is still low. It can be seen from the result of PISA (Programme for International Student Assessment) evaluation in year 2015. The mean score of mathematical ability of students in Indonesia is 386, meanwhile the mean score in PISA is 490 [4].
The lack of understanding the mathematical concept is not only happened to students at the middle level, but also for students at the higher level of education. For example, many of the students in undergraduate education whose learn mathematics got the low score in Calculus. Tall as cited in [5], stated that the lack is caused because of the learning process of Calculus is focusing on procedural not conceptual.

Based on the discussion, to develop the students’ understanding of mathematical concept ability, teachers should use the innovative approach to learning mathematics. NCTM [6] suggested the using of computer technology in the learning process, such as Computer Algebra Systems (CAS). The using of computer technology in learning mathematics supported students to explore and to identify the concepts in mathematics and its relation. One of a mathematical computer program which is used as assisted in learning mathematics is Maple.

Maple software gives many benefits for students in undergraduate education. When they learn Linear Algebra or Calculus, it is helping students to do the verifying computation and drawing the complicated graph [7]. In addition, students’ understanding of mathematical concept could improve by using Maple in the learning process [8, 9].

Another factor that can impact the improvement of students’ understanding of mathematical concept ability is the mathematical initial ability (MIA). According to [10] students’ prior knowledge before the learning process will influence the learning goal. The students’ MIA divided into three categories, high, medium and low.

The purposes of this study are: (1) to know if students’ mathematical concept understanding ability taught by using Maple in learning is higher than students taught by expository learning? (2) to know if students’ mathematical concept understanding ability taught by using Maple in learning is higher than students taught by expository learning based on the students’ mathematical initial ability (high, medium and low)? And (3) to know if there is an interaction between learning model and students’ mathematical initial ability to the improvement of students’ mathematical concept understanding ability?

2. Methods
This research is a quantitative research model of quasi-experimental design with pretest-posttest control group (pretest-posttest control group design). Research conducted at Mathematics Education of PGRI Palembang University, South Sumatera in the second semester of the Academic Year 2016/2017. The samples are two groups of classroom: the experiment class (E) in which learning with Maple was applied, and control class (C) that was treated with expository mathematics instruction. To know the improvement of students’ understanding of mathematical concept ability, the data of student’s n-gain for each level of students’ MIA was analyzed between those who received the Maple instructions and the expository instructions. Meanwhile, to know the interaction between the learning approach and the students’ MIA toward the improvement of students’ understanding of mathematical concept ability, the two ways ANOVA was conducted.

3. Results and Discussion

3.1. Description of students’ MIA
The MIA of students is divided into three categories levels (high, medium and low). The distribution of research sample based on MIA is shown in Table.1.

| Sample Research Group | Students’ MIA Category |
|-----------------------|-----------------------|
|                       | High  | Medium | Low  |
| Experiment Class      | 7     | 18     | 6    |
| Control Class         | 6     | 18     | 6    |
To see if there is any different of students’ MIA between the experiment and control class before the research conducted, the data of students’ MIA is tested. Before using the statistic test, the test of normality and homogeneity for students’ MIA is addressed.

### Table 2. Data Normality Test for Groups and Each Level of Students’ MIA.

| MIA Category | Class | Experiment | Control |
|--------------|-------|------------|---------|
|              | N     | K-S        | Sig.    | N     | K-S        | Sig.    |
| Overall      | 31    | 0.832      | 0.492   | 30    | 0.717      | 0.682   |
| High         | 6     | 0.701      | 0.710   | 6     | 0.547      | 0.926   |
| Medium       | 18    | 0.864      | 0.444   | 18    | 0.714      | 0.688   |
| Low          | 7     | 0.151      | 0.141   | 6     | 0.998      | 0.272   |

The result of data normality test on Table 2, shows that the probability value (sig.) for every level of students’ MIA on both of class is higher than 0.05. It means that the data distribution of students’ MIA for every level in every class is normal.

### Table 3. Variance Homogeneity Test for Both Groups and Each Level of Students’ MIA

| MIA Category | Statistic | Sig. |
|--------------|-----------|------|
| Overall      | 0.416     | 0.521|
| High         | 0.701     | 0.710|
| Medium       | 0.864     | 0.444|
| Low          | 0.151     | 0.141|

The result of variance homogeneity test on Table 3, shows that the significant value for every level of students’ MIA is higher than 0.05. It means that the variance data of students’ MIA for every level is homogenous. Because data is normal and homogenous, so to see if there is the different mathematical ability between both classes the testing is continuing by using the t-test.

### Table 4. Significant Different Test.

| MIA Category | t   | Sig. |
|--------------|-----|------|
| Overall      | -0.262 | 0.795|
| High         | 0.000 | 1.000|
| Medium       | -0.273 | 0.787|
| Low          | 0.171 | 0.867|

The significant value on Table 4 for every level of students’ MIA is higher than 0.05. It means that the students’ MIA of experiment class and control class are not different.

### 3.2. Description the improvement of students’ understanding of mathematical concept ability.

One of the aims of this study was to describe the difference of students’ improvement in understanding mathematical concept ability between those who got the Maple in learning and those in the expository instruction, based on the students’ initial mathematics ability. The study was also conducted to see the difference of the interaction between those approaches. The data analyzed were the n-gain score of understanding mathematical concept ability between students’ pretest and posttest score.

From the data analyzed, it could be concluded that there was an improvement of students’ understanding mathematical concept ability for every level of students’ MIA both in Maple-based
classroom and expository-based classroom. Descriptive result of the n-gain score of students’ understanding of mathematical concept ability on both groups is shown in Table 5.

Table 5. Description of Students’ Understanding of Mathematical Concept Ability Improvement (n-gain score).

| MIA Category | Class  | Experiment | Control |
|--------------|--------|------------|---------|
|              | N      | Mean       | SD      | n       | Mean   | SD      |
| Overall      | 31     | 0.68       | 0.13    | 30      | 0.47   | 0.14    |
| High         | 6      | 0.83       | 0.07    | 6       | 0.65   | 0.18    |
| Medium       | 18     | 0.66       | 0.12    | 18      | 0.42   | 0.94    |
| Low          | 7      | 0.62       | 0.12    | 6       | 0.42   | 0.08    |

Based on Table 5, known that the mean n-gain for every level of students’ MIA of experiment class is higher than control class. According to Hake (1999), the n-gain score of experiment class for high level of students’ MIA is in high category, and for medium and low level is in medium category. Meanwhile, the n-gain score of control class for every level of students’ MIA is medium.

Next step is testing the different of students’ understanding of mathematical concept ability based on students’ MIA level. The result of the data normality test n-gain of the students’ understanding of mathematical concept ability had shown that probability score (sig.) for every level of students’ MIA in each class is more than 0.05. From this result, it can be concluded that the sample in both groups is normally distributed. The result of data normality test is in Table 6.

Table 6. Data Normality Test N-gain of Students’ Understanding of Mathematical Concept Ability.

| MIA Category | Class  | Experiment | Control |
|--------------|--------|------------|---------|
|              | N      | K-S        | Sig     | N       | K-S      | Sig     |
| Overall      | 31     | 0.666      | 0.767   | 30      | 1.075    | 0.198   |
| High         | 6      | 0.454      | 0.986   | 6       | 0.489    | 0.971   |
| Medium       | 18     | 0.453      | 0.986   | 18      | 0.529    | 0.942   |
| Low          | 7      | 0.434      | 0.992   | 6       | 0.368    | 0.999   |

The result of the variance homogeneity test n-gain of the students’ understanding of mathematical concept ability had shown that probability score (sig.) for every level of students’ MIA in each class is more than 0.05. From this result, it can be concluded that the variance of both groups is homogenous. The result of variance homogeneity test is in Table 7.

Table 7. Variance Homogeneity Test N-gain for Each Level of Students’ MIA.

| MIA Category | Students’ MIA | Lavenve Statistic | Sig.   |
|--------------|--------------|-------------------|--------|
| Overall      |              | 0.346             | 0.559  |
| High         |              | 1.697             | 0.222  |
| Medium       |              | 1.732             | 0.197  |
| Low          |              | 0.537             | 0.479  |

From the test of normality and homogeneity, it is known that the data n-gain is normal and homogenous, so for the test of signification using the t-test. The null hypothesis of this test is there no differences between n-gain of understanding of mathematical concept ability of students learning with Maple and those learning with the expository. The criterion for this test is if the probability value (sig.) is more than 0.05, the null hypothesis will be accepted. The result of t-test can be seen in Table 8.
Table 8. Signification Different Test of Students’ Understanding Mathematical Concept Ability Improvement.

| MIA Category | T     | Sig.  |
|--------------|-------|-------|
| Overall      | 6.203 | 0.000 |
| High         | 2.314 | 0.043 |
| Medium       | 6.855 | 0.000 |
| Low          | 3.224 | 0.008 |

Based on Table 8, the probability value (sig.) for every level of students’ MIA is less than 0.05. It means that the null hypothesis is rejected. So the result of this test is there is the differences between the understanding mathematical concept ability of students learning with Maple and those who learning with the expository one.

3.3. Description the interaction of learning process and students’ MIA level toward the students’ understanding of mathematical concept ability improvement.

To find out if there is the interaction between learning process and level of students’ MIA toward the improvement of students’ understanding mathematical concept ability, the two ways ANOVA was conducted. The null hypothesis of this test is there is no interaction between learning process and level of students’ MIA toward the improvement of students’ understanding mathematical concept ability. The criteria of this test is accepted the null hypothesis if the probability value (sig.) between learning process and level of students’ MIA is more than 0.05. The result of two ways ANOVA test is can be seen in Table 9.

Table 9. Two Ways ANOVA Test of Students’ Understanding Mathematical Concept Ability Improvement.

| Variance Resource          | Type III Sum of Squares | df | Mean Square | F     | Sig.  |
|----------------------------|-------------------------|----|-------------|-------|-------|
| Learning Process           | .504                    | 1  | .504        | 39.952| .000  |
| Level of Students’ MIA     | .403                    | 2  | .202        | 15.987| .000  |
| Learning Process * Level of Students’ MIA | .011                | 2  | .006        | .449  | .641  |
| Error                      | .693                    | 55 | .013        |       |       |
| Total                      | 22.168                  | 61 |             |       |       |
| Corrected Total            | 1.833                   | 60 |             |       |       |

Based on Table 9, the probability value (sig.) is more than 0.05. It means that there is no interaction between the learning process and level of students’ MIA toward the improvement of students’ understanding mathematical concept ability. So, in another word, we can conclude that the improvement of students’ understanding mathematical concept ability is affected by the learning process only. This test result is also could be seen from the plot in Figure 1.
This result study shows that the improvement of students’ understanding mathematical concept ability students which is learning with Maple was higher than those who learning with the expository one, for every level of students’ MIA. It means that using Maple in learning support the improvement of students’ understanding mathematical concept ability [9].

The biggest achievement n-gain score of students’ understanding mathematical concept ability improvement is obtained in the high level of students’ MIA of experiment class. The n-gain score is 0, 83, high category. It means that students in high level of MIA could learn with Maple very well. They could understand how to operate the Maple Program, as well as they learn to understanding the mathematical concept. Besides that, students in high level of MIA felt that Maple was very useful for them in learn to understand the mathematical concept, such as when they wanted to draw the difficult graph, the drawing process become much easier and more attractive with Maple program. This statement is accordance to [7].

4. Conclusion
The results of this study show (1) students’ ability of understanding the mathematical concept taught by using Maple in learning is higher than students taught by expository learning, (2) students’ ability of understanding the mathematical concept taught by using Maple in learning for every level of students’ mathematical initial ability (high, medium and low) is higher than students taught by expository learning, and (3) there is no interaction between learning model and students’ mathematical initial ability to the improving of students’ understanding of mathematical concept ability.

Maple is very useful to development the students’ understanding of mathematical concept ability. From the result of this study known that the achievement of students’ understanding mathematical concept ability of students which is taught by using Maple is higher than the expository one. For the future, Maple can be used to development others mathematical ability, such as mathematical communication ability and mathematical problem solving ability.

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