**Understanding of Integral Calculus Concepts by Using Maple Software for Vocational Students in Kuningan**

**Abstract.** This study aims to examine the effectiveness of the use of Maple software in mathematics learning, especially in improving students' mathematical understanding skills in the concept of integral calculus. This study is based on student learning difficulties in understanding the concept of integral calculus, area and volume of rotating objects. Learning used is learning mathematics assisted by Maple software with a simulation method. The population in this study is SMK Negeri 2 Kuningan, with a sample of 2 classes, sampling using a purposive random sampling technique where the first class is the control and the second class is the experimental class. The experimental class is taught with Maple Software, while the control class is taught by classical learning. This research is a quasi experimental design. Sampling using a purposive random sampling technique. The sample subject is a class of study in the classroom, if the classroom arrangement is randomized, it is feared to interfere with learning activities. The data in this study collected through understanding ability tests, observations, questionnaires and interviews. Data relating to students' understanding abilities were collected through tests (pretes and postes) based on Holistic Scoring Rubrics presented. Observations were made to see student and teacher activity during the learning process taking place in the experimental class observed through the guidelines on the observation sheet. While the data relating to the attitude of students in the learning model based on learning assisted Maple software collected through a questionnaire scale student attitudes with Likert scale model. Meanwhile, the interview aims to find out the subject's answer about the problems in oral learning.This research design is Quasi Experimental with Non-Equivalent Control Group Design. Data analysis techniques use the normality and homogeneity test as a prerequisite test, because both data are normally distributed and homogeneous, followed by a comparative t-test. Based on the results of statistical analysis, obtained t count (4.962)> t table (2.39), so H1 accepted means there is a difference in the average ability of significant mathematical understanding between students who use maple software and those who do not use, conclusions that can taken is research is learning mathematics using maple software can improve students' mathematical understanding skills in the concept of integral calculus, besides that, learning mathematics with the help of maple software gets a positive response from students.

1. **Introduction**

Mathematics is one of the most important branches of science in the history of human civilization, many basic concepts of mathematics are applied and integrated into other branches of science, such as physics, civil engineering, aviation and others, Mathematics as a rapidly developing field of knowledge continuously applied in various employment and education fields (NCTM) [1]. The learning objectives of mathematics are to develop problem solving skills, creativity, critical thinking and others, this is a number of abilities needed in facing the demands of the industrial revolution 4.0. More details Grzybowska [2] conveyed some of the skills needed in facing the industrial revolution 4.0 are: creativity, entrepreneurship, problem solving, conflict solving, decision making, analitycal skills, research skills and efficiency oriented, all of these are capabilities that can be developed through learning mathematics.

The purpose of mathematics learning according to the 2013 Curriculum (Kemendikbud) [3] emphasizes the modern pedagogical dimension in learning, namely using the scientific (scientific) approach. In mathematics learning activities are carried out so that meaningful learning is observing, asking, trying, reasoning, presenting, and creating. All abilities that have been stated above are expected to be possessed by students. However, they cannot be realized if they only rely on the learning process that has been used to be in our school, such as teaching theory / definitions / theorems, then given examples and finally given practice questions (Soedjadi) [4]. Indonesia is one of the countries that consistently participates in TIMSS and PISA studies. But the measurements from the Program for International Student Assessment (PISA) and Trends in the Indonesian International Mathematics and Science Study (TIMSS) are at the bottom of the list. State in terms of quality of education. Indonesia's achievements have always been below international standards, Indonesia in the TIMSS study in 2015 was ranked 36 out of 39 countries that had the lowest score. Science scores for students in TIMSS 2015 grade 4, Indonesia obtained a score of 397. Students' IPA scores respectively from 1999, 2003,2007, 2011 to 2015 were 435, 420, 433, 386, and 397. Based on the acquisition of science scores they could It is seen that Indonesia in 2015 was still the lowest as in the previous year (Provasnik, et. Al.) [5].

Based on the results of observations that the author did in one of SMK Negeri 2 Kuningan, the ability of students' mathematical understanding has not shown maximum results. This can be seen from the daily test scores obtained by students, there are still many who have not met the Minimum Completion Criteria (KKM) that have been set in Mathematics, namely 78. The following is the table of results of Daily Examination of Mathematics Subjects in Kuningan 2 Vocational High School:

|  |
| --- |
| **Table 1.** the results of Daily Mathematics Tests at SMK 2 Kuningan |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Class | Total Students | KKM | Total Above KKM | | Total Under KKM | |
| n | % | n | % |
| XI AK 1 | 32 | 78 | 15 | 46,87% | 17 | 53.13% |
| XI AK 2 | 31 | 78 | 18 | 58,06% | 13 | 41.94% |

Based on observations, in general students often experience difficulties in learning mathematics, including difficulties in understanding the completion of questions that require understanding concepts and reasoning and mathematical connections. One of the subjects that the object of this research is made is the calculus chapter which consists of derivative and integral concepts. Calculus is one of the subjects that occupies an important role in mathematics education. Calculus is one of the subjects that must be mastered by students because the basic concepts of calculus are often used in understanding the concepts of physics, engineering and other scientific activities. One example is in mastering the concept of derivatives in calculus. Most students have not been able to understand correctly from the concept of a broad integral area that is limited to curves that exist in calculus.

According to Mulyasa [6] : "mathematical understanding is the ability possessed by someone to bring back the knowledge obtained both in the form of speech and writing to people so that other people really understand what is being conveyed". Skemp [7] revised definition of both understanding and include the type of understanding new ones, called formal understanding, namely: 1) Instrumental understanding is the ability to apply the right rules for settlement of a problem, without knowing why the rule works. 2) Understanding relational is the ability to draw conclusions rules or procedures certain of more mathematical relationships general. 3) Formal understanding is the ability to connect symbols and mathematical notation with relevant mathematical ideas, and combine these ideas into in a series of logical reasoning. Another opinion about indicators of understanding concepts, Sanjaya [8] suggests that indicators contained in mathematical understanding include: 1) Able to guess verbally about what he has achieved, 2) Able to present mathematical situations into various ways and know differences, 3) Able to classify objects based on whether or not the requirements that form the concept are met, 4) Able to apply the relationship between concepts and procedures, 5) Able to provide examples and counter examples of the concepts learned, 6) Able to apply concepts, 7) Able to develop learned concepts.

One learning model that can used to increase active roles at once understanding of students' mathematical concepts is a mathematical learning model assisted by maple software. Maple is a computer application program for mathematics produced by Waterloo Maple Inc., Ontario Canada. This program was originally developed by the University of Waterloo, Canada in 1988. Maple is a very strong symbolic computing system (Symbolic Computation System). This program has been widely used by students, educators, mathematicians, statisticians, scientists and engineers to work on numerical and symbolic computing (Kristayulita) [9]. The users can enter mathematics in traditional mathematical notation. Custom user interfaces can also be created. There is support for numeric computations, to arbitrary precision, as well as symbolic computation and visualization. (Carnia) [10]. In addition to facilities for conducting computations, Maple can be used in various fields including education. The use of Maple Software is mostly done in terms of determining a solution to the various mathematical problems that are asked. So it is possible to use it as an alternative in selecting learning media. To help students understand in terms of understanding derivative concepts in calculus subjects, they will be assisted by using Maple Software. Maple will give the results of the question being asked. In addition, Maple will show how the derivative process is carried out to get the results (Kristayulita) [11]. Maple is very suitable for visualizing the steps in solving questions about integral calculus, the following will be presented in the steps of Maple, to help students' mathematical understanding in solving the problem of the area of integral.

As for the application of this Maple software integration into learning by using the simulation method, the teacher explains the procedure by displaying equations, graphs and mathematical modeling using maple software, then students are invited to write the steps in the problem solution procedure using the prepared worksheet. Simulation-based learning models can attract interest in learning, make it easier for students to understand concepts and to stimulate high thinking, and be able to facilitate the achievement of goals to understand and remember information or messages contained in equations, images, and graphics (Finkelstein) [12].

For example, Calculate the area of ​​the integral area bounded by the curve *y=x2*dan *y=2x-x2*. To solve the above problem, the concept determines the area of ​​the integral area bounded by the curve. Completion using Maple software as follows:

1) Open maple worksheet, Type  ,then press enter, type and then press enter.

2) Type and then press enter.

3) The graph shows 2 points of intersection. To determine these points, by typing 

4) From the picture above, it is found that the two curves intersect at x = 0 and x = 1.

5) To determine the area bounded by a curve, namely by means of 

6) In the picture above, it shows that the area is limited by the curve y = and y = is 1/3 unit area or 0.33333333.

|  |
| --- |
|  |
| **Figure 1.** In this case simply justify the caption so that it is as the same width as the graphic. |

The difference in this research with several previous studies, namely (1) this study focuses on examining the differences in student work results in graph calculations and simulations resulting from differential (derivative) and integral (antiderivative) functions, and these have not been studied by researchers (Saparwadi [13]; Carnia [14] and Priatna [15] ) before; (2) The students' responses qualitatively related to the effects of the benefits arising from calculus learning using Maple software are still not examined by research (Qodariyah et.al [16]) before. This shows that the results of this study will provide new knowledge related to the effects of learning differential calculus and integral calculus by using Maple software on differences in the results given when compared to without using Maple software. In addition, this study will provide knowledge about student responses related to the benefits obtained from learning.

1. Methods

The method used in this research is quasi-experimental method (Quasi Experiment), considering learning achievement, mathematical comprehension ability, and student response can be influenced by many factors. In addition, it is not possible to take samples randomly or for reasons of practicality or ethical reasons (Sugiyono) [17].

The population in this study were all students of class XI of SMK Negeri 2 Kuningan in the academic year 2017/2018 which consisted of 6 classes. Sampling is done by selecting two classes randomly determined. Furthermore, from the two classes randomly chosen to determine the treatment given so that the chosen class is the sample in the study, namely students of class XI AK 1, amounting to 30 students as an experimental group and class XI AK.2 SMK Negeri 2 Kuningan, amounting to 30 students as a class control. The method used in this research is the experimental method. The experiment used in this study was "nonequivalent Group pretest-posttest design" or the control group did not receive treatment. The class used in this study consisted of two classes, namely classes that were treated with mathematics learning assisted by Maple software with simulation methods and control classes given conventional learning. Each class in the design of this study will be given a test before treatment and after treatment. The tests given are learning achievement tests, mathematical comprehension skills tests, and student response questionnaires to learning. Learning achievement data is obtained through measurement with a test instrument in the form of a description with 10 questions. The results obtained are converted so that the values ​​range from 0 to 100.

1. **Result and Discussion**

Data relating to students' reasoning abilities were collected through tests (pretes and postes) based on Holistic Scoring Rubrics presented by Cai, Lane and Jakabcsin [18]. Observations were made to see student and teacher activity during the learning process taking place in the experimental class observed through the guidelines on the observation sheet. While the data relating to the attitude of students in the mathematics learning assisted by Maple software with simulation methods collected through a questionnaire scale student attitudes with Likert scale model. Meanwhile, the interview aims to find out the subject's answer about the problems in oral learning. This research design is One Group Pretest-posttest Group Design by Sugiyono [19], where the research design is described as follows:

O1 X O2

Keterangan:

X : Treatment provided (Use of Maple Software)

O1 : Pretest Value (Before Treatment)

O2 : Posttest Value (After Treatment)

The research variables used are two independent variables and dependent variable. The independent variable in this research is learning assisted by Maple software and the dependent variable is students' understanding ability. Data collection methods used in this study there is a test method, the test used an instrument that can measure students' mathematical understanding abilities.

**Table 2.** Description of Results Data Tests of students' understanding ability

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Control Class** | | **Experiment Class** | |
| **Pre** | **Post** | **Pre** | **Post** |
| N | 30 | 30 | 30 | 30 |
| Ideal Maks Score | 100 | 100 | 100 | 100 |
| Maks Score | 72 | 88 | 74 | 94 |
| Min Score | 37 | 56 | 50 | 72 |
| Mean | 54.23 | 73.97 | 60.53 | 84.50 |

In Table 2, the average score of the pretest in the group Control class is 54,23, whereas in the experimental class was 60,53. The average posttest score in the control class is 73,97, while in the experimental class is 84,50. The maximum ideal value for the results of learning achievement is 100, Before the average difference test, then investigated in advance the normality and homogeneity of the sample as a test of basic assumptions of the study, based on the results of normality test results obtained.

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| **Table 3.** The results of Data Normality Test |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Kolmogorov-Smirnova** | | | **Shapiro-Wilk** | | |
| **Statistic** | **df** | **Sig.** | **Statistic** | **Df** | **Sig.** |
| Gain Kontrol | .115 | 30 | .200\* | .945 | 30 | .121 |
| Gain Eksperimen | .129 | 30 | .200\* | .953 | 30 | .197 |
| \*. This is a lower bound of the true significance. | | | | | | |
| a. Lilliefors Significance Correction | | | | | | |

Based on result of normality test known Sig value. 0.200 because of the value of sig. > 0,05 then 0,05 hence can be concluded that both data of student reasoning ability both experiment control class normal distribution. Further data are tested by using homogeneity test.

**Table 4.** Test of Homogeneity of Variances

|  |  |  |  |
| --- | --- | --- | --- |
| **Levene Statistics** | **df** | **df2** | **Sig.** |
| ,015 | 1 | 58 | .901 |

Based on homogeneity test results obtained sig value. The ability of mathematical reasoning is 0.901. Because of all the Sig values. > 0.05 then both data is homogeneous. Because all the data meet the basic assumption test that is normal and homogeneous, then the next test using parametric statistics test.

**Table 5**. Procedure of data analisys with Independent T-Test.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Learning Group** | **N** | Mean | **t** | ***Sig*. (*1-tailed*)** | **Ho** |
| Kontrol | 30 | .6160 | 4.962 | 0.000 | Rejected |
| Eksperimen | 30 | .4293 |

Based on the results of the test in Table 5 we get the probability or sig value. (one-tailed) of 0.000 is smaller than α = 0.05 so Ho is rejected, meaning that there is a difference in the ability of students' mathematical understanding of the concept of calculus in class XI Kuningan 2 State Vocational School between students with mathematics learning assisted by maple software using simulation method, the average students' experimental understanding ability is higher than the conventional class. The results show that students who learn by using Maple software have a higher average mathematical understanding ability than students who use conventional learning. The response of students of class XI of SMK Negeri 2 Kuningan to mathematics learning assisted by maple software is good, this is evidenced from the questionnaire score analysis of the experimental class students' responses after applying mathematics learning with the help of maple software has reached 78%, this includes high with an interval of 68% -100% interval. This is in line with Ricki [20] & Idris [21] who stated that learning mathematics using software can help students understand learning abstract concepts that require good visualization and reasoning from students.This result is possible because through learning Maple software, students are facilitated in draw graphic, calculate the solution, animation, and interactive activities so that students gain a better understanding of mathematical ability.

1. **Conclusion**

Based on the results of statistical analysis, obtained t count (4.962)> t table (2.39), so H1 accepted means there is a difference in the average ability of significant mathematical understanding between students who use maple software and those who do not use, conclusions that can taken is research is learning mathematics using maple software can improve students' mathematical understanding skills in the concept of integral calculus, besides that, learning mathematics with the help of maple software gets a positive response from students. It is expected that maple will become one of the teacher's mathematical software choices in teaching mathematics.

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