Geogebra in integral areas to improve mathematical representation ability

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Abstract. Integral Calculus is material that must be understood by students as a basis for teaching in school. The ability of mathematical representation of an integral area is felt to be less comprehensively mastered. It is indicated by the large number of students having difficulty in making graphic visual displays. Several researchers make some approaches through technology-based media, including GeoGebra. The purpose of this study is to find out better improvement between the mathematical representation abilities of students who use GeoGebra in Integral Areas with conventional learning in terms of overall and prerequisite abilities. In this research, the sample is fourth semester students of the Mathematics Education Study Program at Universitas Suryakancana. The design of this study uses a nonequivalent control group design with purposive sampling technique. As a result, the improvement of Students' mathematical representation ability who use GeoGebra in integral area is better than students who use conventional learning and mathematical representation ability with the category of high and low prerequisite abilities using Geogebra in Integral Areas is better than those carrying out conventional learning in the category of high and low prerequisite abilities.

1. Introduction
Calculus is one of the fields of mathematics that is the basis of mathematical thinking. This course contains some mathematical concepts and their application in everyday life [1]. One of the courses is Integral Calculus which contains integral concepts, basic theorems of calculus, integration techniques, application of integrals in determining the integral areas [2].

The problems found when conducting research on S1 Mathematics Education Study Program University Suryakancana in 2017 that is (1) Students still experience difficulties and errors in solving integral calculus problems due to lack of mastery of concepts; (2) Students still make mistakes in drawing pictures/graphs of functions that explain integrals so they cannot determine the upper and lower limits of the functions that are integrated so that they are wrong in integrating to determine the area objects; and (3) Difficulties in solving mathematical problems relating to the application of integral calculus.

Mathematical concepts introduced to students use more formal definitions without paying attention to the concept of images/visuals [3–5]. Though there is a link between formal concepts with pictures / graphics in defining integrals [6]. Integral is introduced to estimate the outer regions between certain curves with the x-axis through images. So the concepts are understood according to imagination or graphic illustrations.
But students are still weak in their ability to illustrate images[7]. Students who have no visual ability rely more on memory/memorization skills so that they are low in algebraic, graphical representations, and their effects on analytical abilities [8,9]. Visual ability Skills is a serious problem in solving problems. Weaknesses in solving problems due to obstacles drawing graphics in calculus [10]. There are some similar difficulties in differential calculus, namely drawing graphs of differential functions that are not yet correct/difficulties [11]. Specifically explained that the error in determining the upper and lower limits of the integral if the problem is not known the integral limit, so it must draw a graph in determining the area of the integral. The majority of students make mistakes determining the integral upper and lower bounds [12].

The importance of mathematical representation ability can be seen from the standard of representation set by NCTM. Stipulates that learning programs from pre-kindergarten through grade 12 must enable students to: (1) create and use representations to organize, take notes, and communicate mathematical ideas; (2) selecting, applying, and translating mathematical representations to solve problems; and (3) using representations to model and interpret physical, social, and mathematical phenomena [13]. Thus, the ability of mathematical representation is needed by students to find and create a tool or way of thinking in communicating mathematical ideas from the abstract to the concrete, so that it is easier to understand.

GeoGebra is being used for mathematics teaching from the primary to the university level. Teachers and researchers all over the world have developed numerous worksheets and methods using the software at many levels[14]. The GeoGebra program is very beneficial for teachers and students. Unlike the use of commercial software that usually can only be used at school, GeoGebra can be installed on a personal computer and used anytime and anywhere by students and teachers. For teachers, GeoGebra offers an effective opportunity to create an interactive online learning environment that allows students to explore various mathematical concepts. Several studies have shown that GeoGebra can drive the process of student discovery and experimentation in class. Its visualization features can effectively assist students in proposing various mathematical conjectures [15].

The application of GeoGebra is expected to be an alternative solution to develop students' mathematical representation abilities. Based on the background of the problem above, the purpose of this study is to find out better improvement between the mathematical representation abilities of students who use GeoGebra in Integral Areas with conventional learning in terms of overall and prerequisite abilities.

2. Method
The research method used in this study was quasi experimental [16,17]. The quasi experimental research design used in this study took the form of nonequivalent control group design. The sampling technique uses purposive sampling, which is the method of taking samples whose selection is determined according to certain characteristics. The number of students in level two of the Mathematics Education Study Program at University of Suryakancana at level II-A was 24 people and level II-B was 26 people. The instruments in this study consisted of tests. The tests in this study used the pretest and posttest students' mathematical representation ability (MRA), while those included in the non-test instrument were a list of differential calculus courses and the scale of students' attitudes toward the use of GeoGebra in the Integral Areas.

After testing is done on the class then steps are taken to analyze the validity and reliability. By using Anates V. 4 software the test results obtained that questions 1 to 5 are said to be valid and reliable. The mathematical representation ability (MRA) test consists of questions in the form of descriptions. The total number of question details is 5 questions. Each question has a score interval between 0 - 5 and a maximum score of 5 so that the maximum total score is 25.

In this study there are two main stages of processing data for a problem, namely 1) testing all the statistical requirements needed as a basis for testing hypotheses. The statistical requirements tested first are the test of the normality of the data, then proceed with testing the homogeneity of the variance between groups according to the problem; 2) determine the type of statistics according to the problem...
to test the hypothesis. The relationship between the problems, hypotheses, groups of data processed and the types of statistical tests that will be used are presented in Table 1.

| Problems                             | Hypothesis                      | Group Data          | Types of Tests         |
|--------------------------------------|---------------------------------|---------------------|------------------------|
| Improvement of MRA (MRA)             | 1                               | Gain MRA – UG       | Mann Whitney U Test    |
| better students who use GeoGebra in  |                                 | Gain MRA – CL       |                        |
| the integral areas (UG) and          |                                 |                     |                        |
| conventional learning (CL)           |                                 |                     |                        |
| Improvement of MRA (MRA)             | 2                               | Gain MRA – UG High  | Kruskal Wallis Test    |
| better who use GeoGebra in the       |                                 | Gain MRA – UG Low   |                        |
| integral areas (UG) and              |                                 | Gain MRA – CL High  |                        |
| conventional learning (CL) in terms  |                                 | Gain MRA – CL Low   |                        |
| of the prerequisite ability (PA)     |                                 |                     |                        |

3. Result and Discussion

Based on data processing on the pretest, posttest, and improvement of students' mathematical representation ability (MRA), the mean score and standard deviation were obtained.

| Types of Learning | Prerequisite Abilities | Gain | Mean | Standard Deviation |
|-------------------|------------------------|------|------|--------------------|
| GU                | High                   | 0,70 | 0,19 |
|                   | Low                    | 0,67 | 0,23 |
|                   | Total                  | 0,69 | 0,21 |
| CL                | High                   | 0,45 | 0,14 |
|                   | Low                    | 0,37 | 0,11 |
|                   | Total                  | 0,41 | 0,13 |

From the description of the calculation results in Table 2, in UG obtained the mean score in the high PA category of 0.70 and mean score in the low PA category of 0.67. At UG, the mean score in the high and low PA categories is relatively similar. While in CL obtained mean score in the high PA category by 0.45 and mean score in the low PA category by 0.37.

In CL, MRA gain score in the high and low PA categories is relatively similar. MRA gain score, between students in each PA (high and low) in GU and each PA category (high and low) in CL, there is relatively no difference. This shows that MRA gain score as a whole as well as the student PA category before being given treatment has relatively no MRA.

From the description in Table 2, the obtained total mean score in the UG and the CL showed sufficient results. In the UG, the total mean score was obtained 0.69, and in the CL, the total mean score was obtained 0.41. Based on MRA gain score of students, the UG is better than MRA gain score of students in the CL.

Furthermore, Table 2 shows that learning factors tend to influence MRA, when viewed from MRA test gain. Based on the learning factor, MRA gain score of students UG tends to get better Gain compared to students who get CL. Likewise, based on the student PA category, MRA gain score of the high student PA category tends to get better Gain than the PA category of the low student category.
These results indicate that students involved in this study, both from UG and CL have relatively the same PA. This condition will certainly affect the readiness of students to receive advanced courses, namely integral calculus, especially on integral material delivered with an UG and CL.

To find out better MRA between UG and CL in terms of overall and better MRA between UG and CL in terms of students' prerequisite ability categories, will be analyzed statistically using SPSS version 22 software. Statistical analysis begins with a normality test. The normality test used is the Kolmogorov-Smirnov test, with the criteria: if sig > 0.05, then the distribution of data is normally distributed. The results of the normality test calculations are presented in Table 3.

| Table 3. Normality Test Mean Student MRA Gain Judging from Overall and PA Category Mahasiswa |
|------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| Types of Learning | PA | Kolmogorov-Smirnov | Conclusion |
| | | Statistic | Df | Sig. |
| UG | High | 0.264 | 12 | 0.020 | Normal Distribution |
| | Low | 0.175 | 12 | 0.200 | Not Normal Distribution |
| | Total | 0.190 | 24 | 0.025 | Normal Distribution |
| CL | High | 0.171 | 12 | 0.200 | Normal Distribution |
| | Low | 0.177 | 14 | 0.200 | Normal Distribution |
| | Total | 0.179 | 26 | 0.032 | Not Normal Distribution |

To see the presence or absence of Gain differences (improve in MRA scores from before being given treatment until after being given treatment) significantly, in terms of the overall and category of student PA, nonparametric statistical techniques used are the Mann Whitney-U Test and the Kruskal Wallis Test because there is data gain that is not normally distributed.

The hypothesis that will be tested is $H_{01}$: the population distribution of data on the improve in MRA of students who get an UG is not better or the same as those who obtain CL, $H_{02}$: the population distribution of data in the improve in student MRA with the PA category of students who get an UG is not better or the same as those who get a CL $H_{A1}$: the population distribution of data on the improve in MRA of students who received an UG is better than that of obtaining CL $H_{A2}$: the population distribution of data on the improve in MRA of students with the PA category of students who received an UG is better than those who received a CL. Test criteria: if half a significant value $> 0.05$ then $H_{0}$ is accepted, and if half a significant value $< 0.05$ then $H_{0}$ is rejected.

| Table 4. Mann Whitney U Test Improvement of Student’ MRA |
|------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| Gain | Mann Whitney U | 83,500 |
| | Wilcoxon W | 434,500 |
| | Z | -4,448 |
| | Symp. Sig (2–tailed) | 0,000 |

Based on the results of data processing presented in Table 4, it can be concluded that for learning has half a significant value of 0.000. Because the value of sig = 0.000 < 0.05, then $H_{01}$ is rejected. This means that the population distribution significantly from the data improves MRA between students who UG better than those who get CL. In other words, an improve in MRA between students who UG is better than those who obtain CL.

Based on the results of the Mann Whitney test in Table 4, it was found that the population distribution significantly improved the MRA between students who used GeoGebra in the Integral Areas better than those who obtained conventional learning (overall). In other words, an improve in the ability of mathematical representation between students who use GeoGebra in the Integral Areas is better than those who obtain conventional learning (as a whole). This is because students who use GeoGebra in
Integral Areas have an attractive appearance and can directly simulate spatial fields independently. Software that is easy to use by students also provides challenges and innovative new creations.

In line with the results of previous studies that the differences in activity and learning atmosphere in the experimental class and the control class. In-class learning experiments carried out by applying GeoGebra where more students get lots of questions, broader material, a learning atmosphere interesting. This will affect the ability of students to find and create solutions to the problems being faced [18]. For students doing conventional learning, students are fed up with the conditions and atmosphere of learning. While for students doing conventional learning, students are bored with the conditions and atmosphere of learning. Students think hard to make a broad graphic area of the integral image. They do it manually so that many students are still wrong in making graphic images of integral areas, so that it takes a long time to study.

Students' mathematical representation ability is divided into 3 indicators, namely students can represent in the form of images (visual), mathematical equations (symbolic), and in words (verbal). In terms of representing the use of GeoGebra in classroom learning, it gives a big change in improving students' ability to draw graphics from a given mathematical function.

GeoGebra can help students understand how to draw the area of an integral area with one curve or two curves. In terms of the ability to represent in the form of mathematical (symbolic) equations, students can represent graphic images of the area of an integral area to the form of mathematical equations or in the form of writing integral symbols with functions and upper and lower limits. In terms of the ability to represent words or verbal form, students can make questions about calculating integrals from the integral area graphic images.

Student prerequisite abilities has a significant value of 0.000, because half the value of sig = 0.000 < 0.05, then H02 is rejected. This means that the population distribution of the improve in student’ mathematical representation ability data using GeoGebra in the Integral Areas is better than that obtained by conventional learning in terms of the student prerequisite abilities category (high and low). So it can be concluded that the student's prerequisite ability factor has a significant influence on increasing students' mathematical representation ability.

| Group                  | N  | Mean Rank |
|------------------------|----|-----------|
| High Group (Experiment)| 12 | 36.75     |
| Low Group (Experiment) | 12 | 33.29     |
| High Group (Control)   | 12 | 20.58     |
| Low Group (Control)    | 14 | 13.39     |
| Total                  | 50 |           |

Based on the calculation of the Kruskal Wallis Test in table 5, the difference in the distribution of the population improve MRA data between students and the student PA category (high and low). In Table 5, it is seen that the highest mean rank value is the high category PA group in the UG, while the lowest mean rank is the low group in the CL.

Table 5 shows that the ability of mathematical representation with the category of high prerequisite abilities using Geogebra in Integral Areas is better than those carrying out conventional learning in the high and low prerequisite ability categories. Likewise, the ability of mathematical representation with the category of low prerequisite abilities using Geogebra in Integral Areas is better than those carrying out conventional learning in the category of high and low prerequisite abilities.

Student gave more attention on classroom as they were interested in visualization of object by using GeoGebra[19]. Besides the ease of using Geogebra makes students active[20]. In general, the weakness of students in drawing integral area charts can be resolved. In general the weaknesses of students in drawing integral areas graphs can be resolved.
4. Conclusion
From the results of the research and discussion that has been described, it can be concluded that improved the mathematical representation ability of students who use GeoGebra on the Integral Areas is better than students who use conventional learning, as a whole and in terms of the ability category of student prerequisites.

Mathematical representation ability with the category of high and low prerequisite abilities using Geogebra in Integral Areas is better than those carrying out conventional learning in the category of high and low prerequisite abilities.

The improved mathematical representation ability is due to the effectiveness of using GeoGebra in Integral Areas. Where students who used to not be able to draw graphics correctly, with the help of GeoGebra software, all difficulties faced by students can be resolved. Students' mathematical representation ability is divided into 3 indicators, namely students can represent in the form of images (visual), mathematical equations (symbolic), and in words (verbal). GeoGebra can help students understand how to draw the area of an integral area with one curve or two curves, students can represent graphic images of the area of an integral area to the form of mathematical equations or in the form of writing integral symbols with functions and upper and lower limits, and students can make questions about calculating integrals from the integral area graphic images.

GeoGebra is a mathematical software that can solve cases relating to visual, symbolic, and verbal forms. Learning using GeoGebra is effectively used to improve mathematical representation ability. Besides making it easy to present graphs of functions in calculus, it can also make students more interested and motivated to do the tasks given by the lecturer. Need to be developed in the making of teaching materials by using Geogebra for courses that measure mathematical representation ability such as calculus, geometry, and algebra.

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