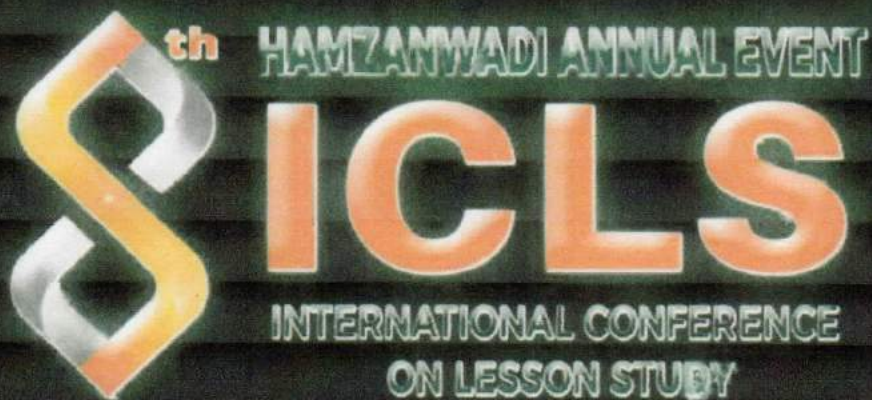# 5th HAMZANWADI ANNUAL EVENT
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" Professional Learning Community through
Lesson Study for Promoting Student Learning"

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"Professional Learning Community Trough Lesson Study for Promoting Student Learning"

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Implementation of Lesson Study on Integral Calculus Course

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Abstract

This paper presents the application of Lesson Study in the Integral Calculus course with the material of Definite Integral as an effort to improve the quality of learning to make the students comprehend towards the understanding of the integral calculus. Lesson Study activities are held on the short semester lectures at 2017 in the Integral Calculus courses.

Keywords: lesson study, integral calculus, riemann sum, definite integral.

1. Introduction

Indonesia needs professional human resources in educating students as the nation's future candidates. Through the world of higher education, steps taken to manage educators to become more reliable, active, and creative. Thus, we need an activity that aims to build a community of learning among lecturers so that collaboration occurs in developing the quality of learning, which ultimately created the conditions of lecturers and students who collaborate with each other in science transfer activities in universities [1]. Lecturers are expected to be more creative and active to create professional, active, and creative students as well. For example, lecturers have to be able to create a model implemented by Mathematics theory [2, 3, 4, 5]. Therefore, conducted Lesson Study for Learning Community activities expected to be a bridge to the exchange of information in learning methods.

Integral Calculus is a basic course that must be followed by all students in the Mathematics course of Islamic University of Bandung (UNISBA). The problem in the learning process of integral calculus session is that students do not fully understand about the concept of integrals, especially on the concept of definite integral. Consequently, we need serious efforts in applying learning methods that fit with the course [6].

2. Lesson Study, *State of The Art*

Lesson study was developed in Japan since the early 1900s. Lesson Study is a direct translation of Japanese *jugyokenkyu*, derived from the word *jugyo* meaning lesson or learning, and *kenkyu* which means study. Thus, lesson study is a study of learning. Through these activities, teachers in Japan review the learning through planning and observation together with the aim to motivate students actively learn and self-derived. Lesson study for learning community is a model of professional education through a collaborative learning and continuous learning based on the principles of collegiality and mutual learning to build learning communities.

Lesson study is carried out in three stages: *Plan* (design), *Do* (implementation) and *See* (reflection) which is done continuously. The first stage of the plan means planning and designing, that is, a stage in which the lecturer and a team determined to collaborate to design the lesson design that matches the material to be discussed in a course.

The second stage is *Do* or implementation, where a model lecturer performs a planned learning model in an open class. While the other team members as observers who observe the activities that occur during the lecture, especially what is done by students.

The third stage is *See* or reflection, which is a discussion activity conducted after the open class. Model lecturers and observers jointly conduct discussions guided by a moderator. The observer provides input from observations during the course, providing an alternative solution for further learning improvement.

One of the subjects sampled in Lesson Study is Integral Calculus Course. This is based on the consideration that Integral Calculus is a basic course that must be followed by all students in the Mathematics Department UNISBA, and most students still lack understanding of the concept of integral course especially on the concept of definite integral.

3. Results and Discussions

Lesson study activity consists of three stages: the first stage is *Planning*, the second stage is *Implementation*, and third stage is *Reflection*. At the first stage, the

model lecturer and lecturers who are members of the lesson study community, develop the lesson design. At the preparation phase, the lesson design begins with determining the initial activities, core activities, and closing activities. In the initial activities, students are prepared the material to be studied and discussed, namely the concept of rectangular area, triangle area, and trapezoidal area. These three concepts are discussed as starting stage to calculate the area that is known as the *Riemann Sum*. Subsequently, to the core activities, students are asked to discuss about calculating the area under a given curve by determining the area of the rectangular area, starting from two partitions, four partitions, and eight partitions.

From the obtained results, students are asked to create a table lists of area with several different partitions. Furthermore, students are asked to discuss what happens when partitions are multiplied to infinity. From the discussion results, it is expected that students may understand the concept of integral through the *Riemann Sum* approach.

The second stage is the implementation stage which is carried out in open class, where one lecturer becomes model lecturer and some other lecturers become observers.

In the early stages of the lecture, the model lecturer asks the students about the concept of area of rectangle, the area of triangle, and trapezoidal. The students can easily answer the questions. Next, model lecturer direct students to form four groups that will address some problems.

 Next, the model lecturer gives the problems to all groups and ask each of groups to calculate the area under the curve $y = x^2, 0 \le x \le 4$ by dividing the area to be calculated into *n* rectangles of equal width ($n = 4, 8, 16$) [7]. The area of each rectangle is calculated then is summed to get the total result.
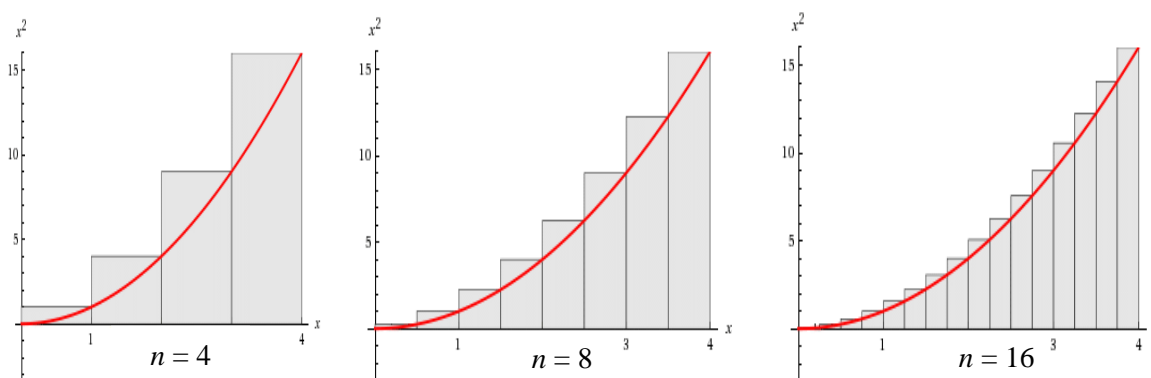

Figure 1. The area of rectangle with $n = 4$, 8, and 16.

The group with $n = 4$ calculates the area faster, but for group with $n = 16$ having difficulty and require quite long time to calculate. Furthermore, students are asked to discuss how if n is propagated to infinity. Students have difficulty understanding this propagation. To overcome this problem, the model lecturer provides help by using an application of *Riemann Sum* from Wolfram Mathworld for a larger n.
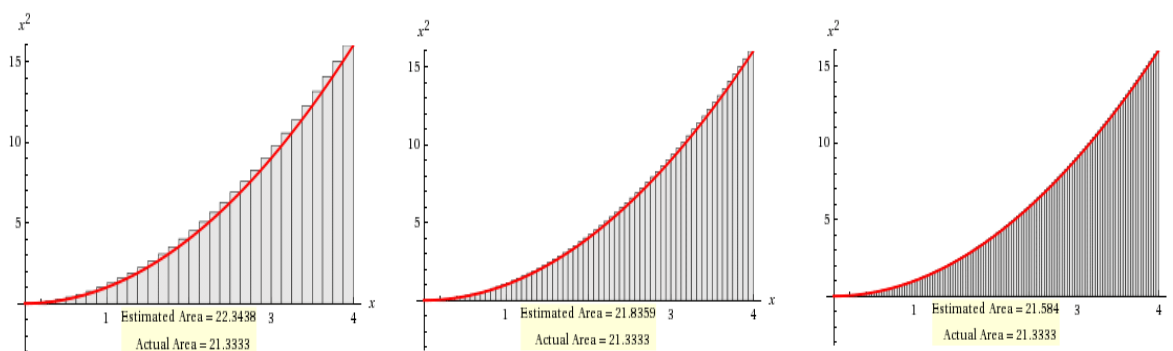

Figure 2. : The area of rectangle with $n = 32$, 64, and 128.

Furthermore, the obtained areas are shown in table 1:

Table 1. : The area for different n

No.	n	Area
1.	4	30
2.	8	25.5
3.	16	23.375
4.	32	22.344
5.	64	21.836
6.	126	21.584

From figure 2 it can be seen that the bigger the value of n, the wide area obtained is almost wide area under the curve $y = x^2, 0 \leq x \leq 4$. Furthermore, in the same way will be calculated the area under the curve $y = f(x), a \leq x \leq b$, by dividing the interval $[a,b]$ into 4 partitions with $a = x_0, x_1, x_2, x_3, x_4 = b, \quad \Delta x = \dfrac{b-a}{4}$.
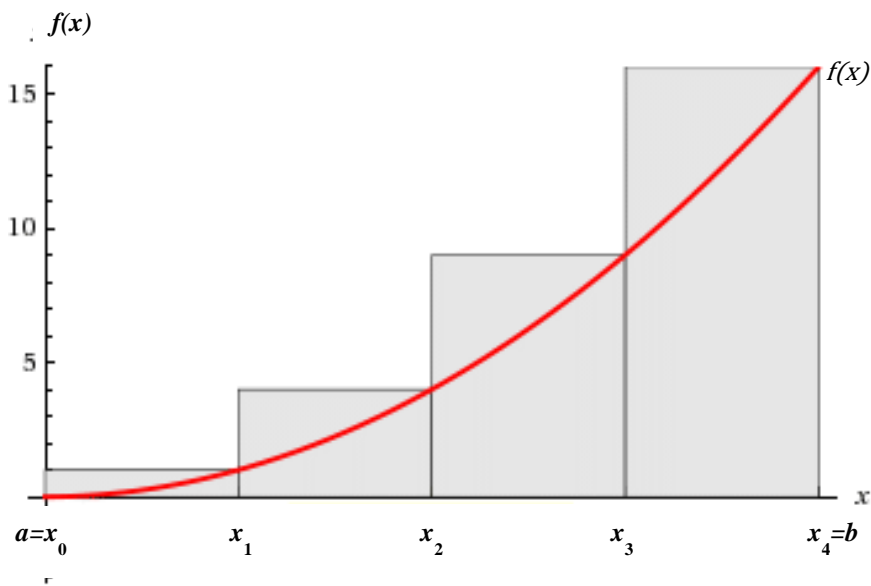
Students are asked to discuss the calculation of area and obtain a wide area formulation as follows:

$$Area = f(x_1)\Delta x + f(x_2)\Delta x + f(x_3)\Delta x + f(x_4)\Delta x.$$

In the same way, the formulation can be declared for any n.

$$Area = f(x_1)\Delta x + f(x_2)\Delta x + f(x_3)\Delta x + ... + f(x_{n-1})\Delta x + f(x_n)\Delta x$$

or it can be written in the form of sigma notation as follows:

$$Area = \sum_{i=1}^{n} f(x_i)\Delta x$$

Next, if n is propagated in to infinity, it will be obtained:

$$Area = \lim_{n \to \infty} \sum_{i=1}^{n} f(x_i)\Delta x = \int_{a}^{b} f(x)\,dx$$

The obtained formulation is a definite integral concept with the lower limit a and the upper limit b. Furthermore, by using the basic theorem of calculus, the area obtained under the curve is:

$$Area = \lim_{n \to \infty} \sum_{i=1}^{n} f(x_i) \Delta x = \int_a^b f(x)\,dx = F(x)\Big|_a^b = F(b) - F(a).$$

After students understand how to calculate the area under a curve at a closed interval using a definite integral concept, students are asked to discuss a problem as follows:

The Gardening Agency of Bandung City will make the existing garden pond with the following form:
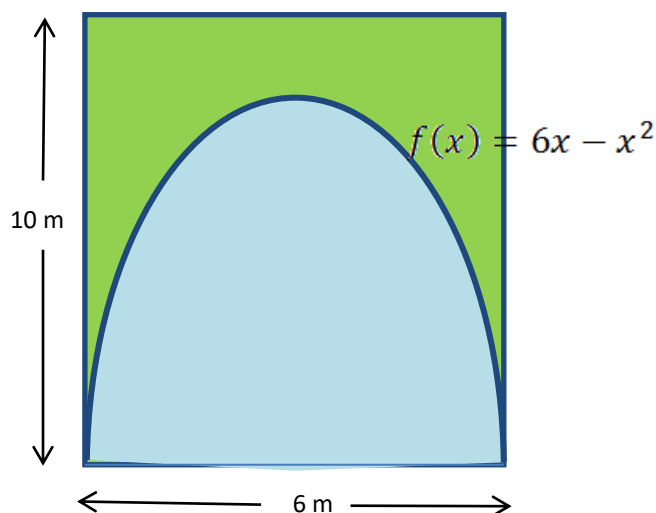
The Poolside will be planted with grass. Calculate how much area will be planted by the grass.

The third stage is reflection where implemented after the open class activities take place. One moderator leads the reflection activity to discuss some of the findings that submitted by the observer, as follows:

1. At the beginning of the group discussion, the observer found students who have difficulty in completing the given worksheet. The difficulties encountered are in

determining the value of a given function especially in groups with large partitions ($n = 16$)

2. For large partitions ($n = 8$ and $n = 16$), students do not need to calculate the area because it will take a long time. Model lecturer must find an appropriate strategy so that the learning process runs effectively. Simply use the *Riemann Sum* application to discuss if the *n* partition is enlarged to infinity.

3. There are found groups that are less able to communicate with their friends within the group, as well as communication between groups are still lacking. Therefore, the model lecturer should facilitate communication between students in groups and communication between groups. If needed, the model lecturers are required to move students from one group to another to make the group discussion work better.

4. Conclusion and Future Works

From the description above, it can be summed up as follows:

1. Implementation of Lesson Study in Mathematics Department of UNISBA in Integral Calculus course at academic year 2016/2017 has been done in accordance with the stages of Lesson Study, with some improvements for the next lecture.

2. Lecturers can plan lesson design collaboratively, to obtain a more innovative lesson design.

3. Lecturers get input from the observer about the learning that has been done for the improvement of learning in the future.

4. The change of teaching method from the lecture method becomes lesson study where the active lecturer teaches becomes a learning oriented approach to the active student learning.

As for future works, we have suggestions for further research as follows:

1. Lesson Study is suggested to apply to all subjects in department of Mathematics UNISBA, as an effort to improve the quality of learning.

2. Each lecturer conducts research from the Lesson Study activities that the lecturer has performed.
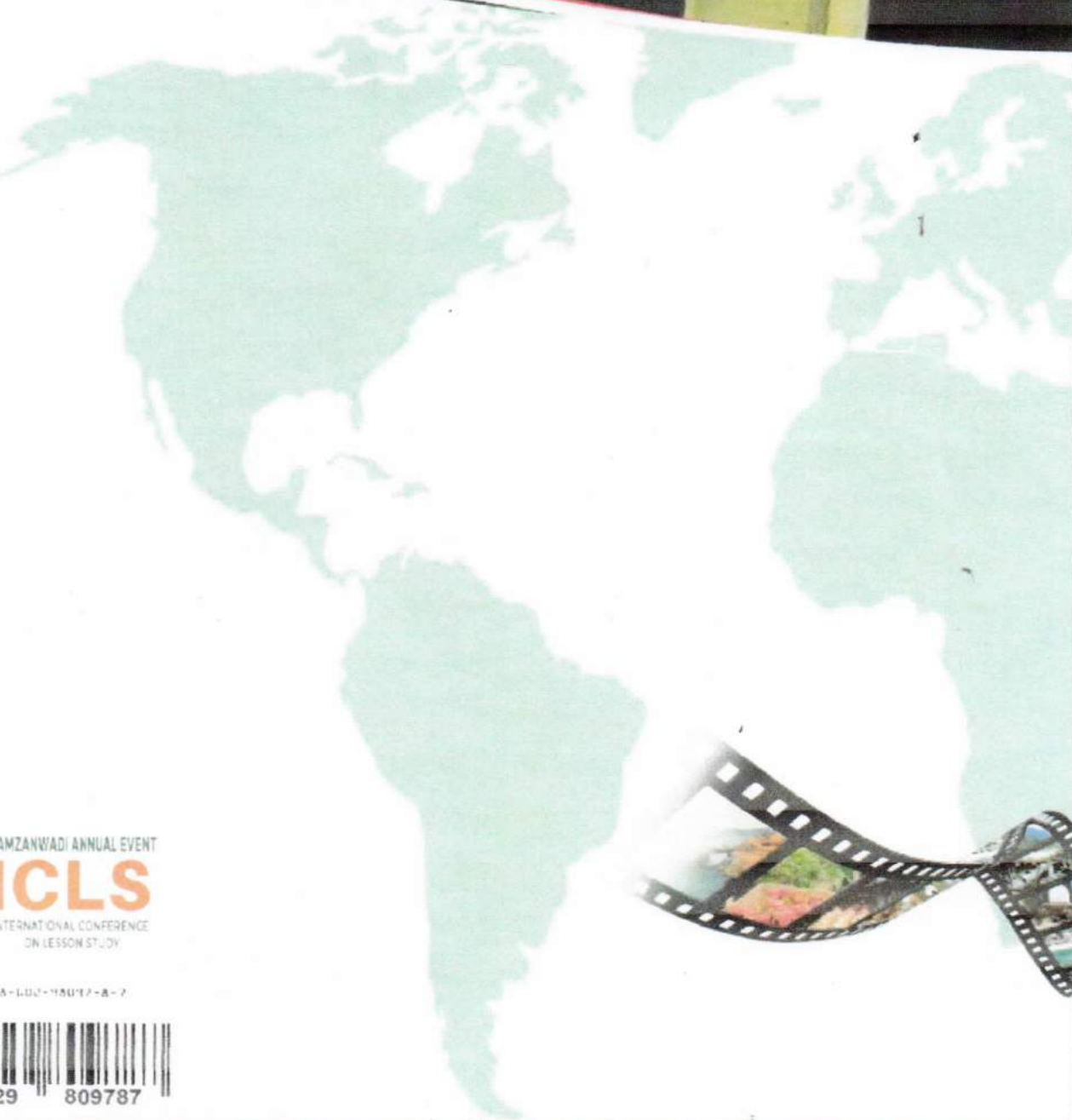
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