Eny Winaryati The Implementation of Maple Software to Echance the Ability of Students' Spaces in Multivariable Calculus Courses

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The implementation of Maple software to enhance the ability of students' spaces in multivariable calculus courses

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Abstract. The implementation of technology in learning becomes imperative and needs. Through learning, technology will be more meaningful and facilitate students in comprehending the materials. Based on the evaluation of the multivariable calculus courses can be concluded that the students had much difficulty in drawing materials graphic in dimensional space 3 (R3). Students had not been able to draw graphs of linear and quadratic equations well. To solve the problem, the researchers implemented the Maple software on the multivariable calculus courses. This study used a qualitative approach with a descriptive analysis method. The subject of research is the students' of Mathematics education of Muhammadiyah Semarang University in Multivariable calculus courses in the academic year 2019/2020. The stages of learning have six stages, such as; 1) Students are introduced Cartesian coordinates in R3; 2) Students are given student worksheets; 3) Students are required to draw graphics in the Maple software; 4) Students are asked to compare pictures in student worksheets and Maple; 5) Students present discussion results; 6) Lecturers give feedback and conclude learning. Based on the research results, it can be concluded that the implementation of Maple Software can improve the ability of students' spaces in Multivariable calculus courses.

1. Introduction

The development of technology has been increasingly rapid in education. The implementation of technology in learning becomes imperative and needed. Even the use of multimedia learning technology as a teaching base has increased [1] and curriculum changes that integrate the use of technology in teaching are being carried out in various countries [2]. Through learning technology, it will be more meaningful and more accessible for students to understand material. The rapid advancement of information and communication technology offers new facilities in learning that cause a shift in learning orientation from outside-guided to self-guided and from knowledge-as-possession to knowledge-construction [3].

Multivariable Calculus is a continuation of Differential Calculus and Integral Calculus. This course contains differential and integral material in many variables. Cartesian coordinate material in R3 is the first introduction to Cartesian coordinates, points and distances in R3, drawing graphs of linear equations, and drawing graphs of quadratic equations. The material to draw graphics in R3 will later be used when learning integral and variable material.

Based on the evaluation in the Multivariable Calculus course, it can be concluded that students had many difficulties in drawing graphics in R3. Students had not been able to draw linear and quadratic equation graphs well. Based on observations, the most challenging material for students to understand was drawing solid objects. Students had not been able to determine the intersection of solid objects that were limited by several linear or quadratic equations. So, the solid objects of some similarities could make different perceptions of each student. In short, it can be concluded that the ability of students' spaces is lacking. It is necessary to increase the ability of students' spaces in the Multivariable Calculus course. Through the mastery of drawing graphics in R3, the researchers hope that when determining the area of solid objects in the integral and variables do not experience difficulties.

Mathematical Software recently is being conducted to improve the learning quality of Bozic [4] & Hussain [5]. One of the software that can be used in learning Multivariable calculus is the Maple software. This software is complete in its features and can be in the application in a variety of courses. Some of the advantages include that Maple can be used to solve problems in mathematical areas such as algebra, calculus, differential equations and others [3]. In the use of multivariable calculus drugs, the features create both two-dimensional and three-dimensional graphics. Through this maple software, students will be helped in determining the actual point and can be seen from all areas. Various studies have been conducted and most of the results state that technology has a positive effect on learning.

Many types of research have been implemented using Maple software. As a result, the help of Maple software contributes to the mathematical creative thinking skills of 82.81% [3], increasing student's motivation [6], Improving communication [7] and enhancing learning ability [8]. [9] and [10] concluded that students'work using Maple is better than the student's work without the use of Maple. Maple can be used for all materials both in essential calculus and in Advanced Calculus [11]. Based on the research results, it is necessary to implement the implementation of Maple software.

2. Method

This study used a qualitative approach, precisely a descriptive analysis method. To define the descriptive method of analysis as a method that attempted to illustrate and interpret what the object is. In this case, the researchers conducted analysis only to the extent of the description, namely analyzing and presenting a fact systematically [12]. The subject of the research is Math of the course of Multivariable calculus in the academic year 2019/2020.

3. Result and Discussion

The process of learning Maple application on the course of multivariable calculus is to draw at the coordinates of Cartesian R3. By using the Maple, the software can be clearly described and detail a point, graph and shape of a solid object. We can see at it from various angles so that it will get a figure of a model clearly and precisely its size. At the coordinates of the point in the figure on the paper, we can only see from the front. Using maple, we can see as needed, and it can be seen from the side (x, z and y, z), from the front (x.y field). So that the students can distinguish those points if viewed from all directions. The stages of learning implementation are described below.

3.1. Introduce cartesian coordinates in R3

At differential calculus and integral calculus courses, the students only get 2-dimensional graphic material. In the course of multivariable calculus students, in the beginning, introduced a 3-dimensional graphic (R3). So that the ability of the students will increase. This is because on the 3-dimensional chart, students should be able to make a thought three axis coordinates. This stage students introduced

Cartesian coordinates that have three-axis coordinates i.e. x, Y and Z. Image of Cartesian coordinates in R3 can be seen in Figure 1.

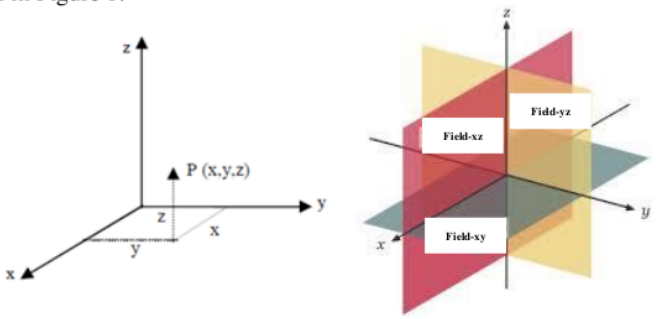

Figure 1. Cartesian coordinate in R3

Figure 1 is shown the Cartesian coordinate in R3. At this coordinate, there are three x-axis, Y and Z are divided into eight octane and three fields are XY, XZ and YZ. Moreover, the student's difficulties are in understanding the length comparison of X, Y and Z axes and the location of a point.

3.2. Students' worksheet

At this stage, the students are given gradual assignments from simple to complex. The initial step, the students were asked to determine the points at coordinates in R3. The goal is that students can determine the comparison of the X.Y. and Z axes. The next stage of the student is required to determine point P (3, 5, 2), Q (5, 2, 4) and S (-2,-4, 5) at the coordinates of Cartesian in R3. Then, the material is extended by drawing the graph of one linear equation with 2x + 3y + 4z equation = 12. The result can be seen in Figure 2.

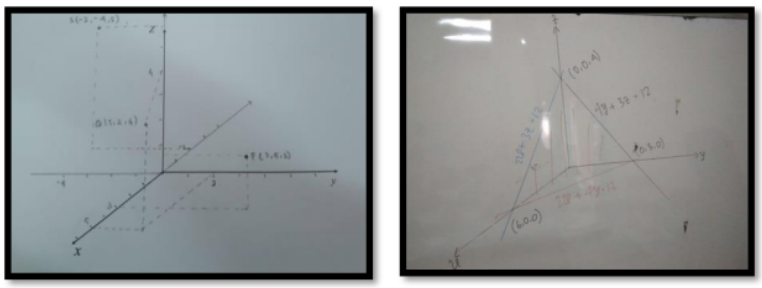

Figure 2. Cartesian coordinate in R3

In this activity, students develop their ability positively. Students are expected to not only specify the point location but also can determine the point and connect that point so that they can create a flat field. The last stage, the students are required to draw a graph of quadratic equations in R3 which becomes a solid object. At this stage, it is the most complex than before. There are three stages of difficulty in determining the dots, connecting the dots according to characteristics and lastly should be able to create a solid object formed.

3.3. Draw graphics in software maple

At this stage, the students are required to create a point, build flat and solid objects using maple software. The purpose of this stage is in order for the students can comprehend the difference drawing

on paper and maple. Through this activity, the students are expected to see a point, spaces and solid objects from various directions. Therefore, the visualisation of the drawn shape can be visible. Through this activity, the students can not only imagine an object drawn, but can be direct to see it. So, the students can see a form in R3 in reality. The figure results using Software maple can be seen in Figure 3.

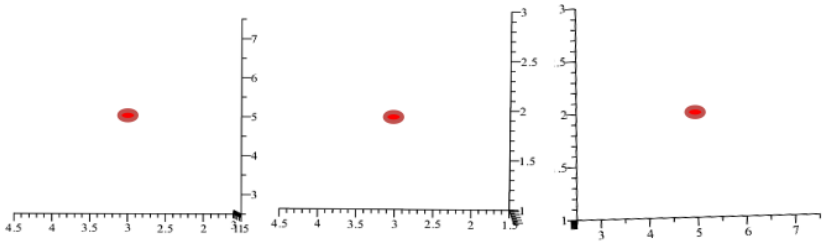

Figure 3. P (3,5,2) is shown from three areas, such as xy, xz, and yz

In Figure 3, the point P is (3, 5, 2) can be seen from 3 areas, i.e. XY, XZ, and YZ. In this field, it is the same comparison between x, Y and Z. Also, that point is the location. It will add the students ' spaces ability. Furthermore, students are required to draw 2x + 3y + 4z = 12 graphic which can be seen in Figure 4.

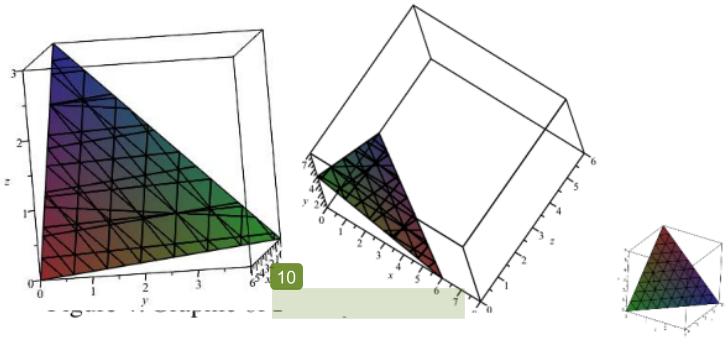

Figure 4. 2x + 3y + 4z = 12 Graphic

In Figure 4 shows that 2x + 3y + 4z = 12 which can be seen from various sides. In that field, it is obvious how the fields are created using maple. It will add the ability of students' spaces, and the students can compare with different viewpoints.

3.4. Compare figure at students' worksheet and maple

At this stage, the students are required to compare figures on the maple paper and software. By using maple, students can see the location of the point in a clear. These points can be seen from the fields XY, YZ, and XZ. Through comparisons of these three areas can make students more real. On the flat and solid fields, students can see from various fields so that they will know the real thing that is formed. How is the real difference between both figures?

3.5. Students present the discussion result

Students are asked to present the group discussion results. In this activity, the students are asked to display their findings. The findings of each group will be compared to other groups. Through this stage of discussion, we can find a significant difference in the sheet of paper and maple. Besides, it can be seen the student's thinking patterns through image identification in maple.

3.6. Lecturer gives feedback and makes a conclusion

At this stage, the results of the discussion and group presentation will be discussed in depth. Lecturers will give a broader picture related to this material. The last lecturer will give a conclusion related to the coordinate material in R3.

The use of Maple software on learning multivariable calculus is one of the technology implementations in learning. Maple makes students more active in learning and makes students more challenged in lecture activities. The use of technology in learning can increase the motivation of students, and this is in line with the study[6].

The implementation of Multivariable calculus learning begins the learning of contextual emphasis through complex activities [13]. The learning of an essential thing is determining the dots at the coordinates of Cartesian R3. Then, draw linear equations, squares and last draw a solid object. Through the most fundamental activities until the student complex can improve the skills of the kerning little by little. Absorption of the concept and pattern of drawing graphics is well mastered. Through the ability of the spatial, it takes excellent visual skills. It is in line with [14] propose that a student who has an advantage over visuals relies heavily on visual thinking in this sense of capacity.

When students have difficulty in drawing manually, students are given the task of drawing charts on the Maple software. Through the help of the Maple software, students can see clearly how to layout the actual point. Students can also see a graphic image of linear equations and squares in depth. See from a variety of different fields and viewpoints. Students can explore the chart from all sides. It can improve the ability of students ' spaces in the activity created worksheet design that can construct the knowledge of students. The students' worksheet can improve the ability to comprehend the learning materials [15] & [16].

Based on the implementation of learning in the course of multivariable calculus can be seen, the Maple software can improve the ability of the students. The evaluation for the fore is on the drawing material graph in R3 for the further split between material linear equations and quadratic equations. Hopefully, the students are more mature in mastering the concept of drawing graphs of linear equations in R3. Then, they learn the drawing graphs concepts of quadratic equations in R3. Through this stage, the ability of the students will increase.

4. Conclusion

Based on the research results, it can be concluded that the implementation of Maple Software can improve the students' ability in Multivariable calculus courses.

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