Maple app: specifies the vector derivative

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Abstract. This study aims to analysis the students' representation ability of mathematics teacher candidate in using maple to determine vector derivative. This research uses quasi experimental method. Result of research indicate that student representation ability of teacher candidate can be classified into 3 based on indicator ability of mathematical representation that is: visual representation, representation of mathematical model and word representation. Three indicators on the ability of mathematical representation with words is a lower ability than other indicators. This study provides a mathematical representation profile of mathematics teacher candidates in vector-based analysis of maple analysis.

1. Introduction
CAS or Computer Algebra System has penetrated the study of mathematics and science. CAS is widely used in various countries [1], and has a significant effect on the understanding of its users [2]. CAS can help learners to explore relationships between different representations of functions and other mathematical objects using a combination of visual, symbolic and computational approaches [1]. Maple is one of the leading CAS that has many advantages. Maple is an application that can be run with simple instructions so good for beginners [2]. Maple development can be used vector calculus in determining gradient, divergence and integral [3]. Vector is a subset of calculus, calculus is one of the branches of mathematics which is widely taught in mathematics degree programs and is a concept widely used in other mathematical concepts [4].

In vector calculus material students are required to be able to connect various representations, either visual representation, mathematical expression, or representation using writing. However, students have difficulty in representing vectors, especially on vector derivative material. Learners have difficulties in processing the mathematical, representational and mathematical representations of knowledge [4]. Whereas representation is one of the expected abilities in mathematics, in addition to other abilities such as abstraction abilities, the ability to understand the relationship of abstraction and representation and creativity [5]. Many forms of representation commonly used in mathematics such as graphics, tables, mathematics expressions that use symbols and so forth. Representation is a very important skill [6] [7] [8], and representation greatly affects problem solving [9] furthermore the ability of connecting various representations is also important [10].

Before attempting to improve the ability of mathematical representation to take place, it is important to know how the profile of student representation skills using maple in vector derived material. Mapping of students' mathematical representation capability will give an idea how to improve the representation ability of math teacher candidate. This research is a preliminary of research development of teaching materials using maple in order to improve the ability of mathematical representation of mathematics.
teacher candidate. The function of all kinds of representations is to communicate mathematical ideas, and that each representational system adds effective communication and helps to convey different meanings of a mathematics concept [11]. Because teachers are important stakeholders [12], mathematics teacher candidates need to have a good mathematical representation. There are two main factors in learning and understanding of concepts, namely the ability to transfer learners’ knowledge in one form to another and the ability to move to different representations in mathematical objects [1]. Many ways are used in studying mathematics, so that students of mathematics teacher candidate learn effectively. One of them with the use of computer technology, this refers to the fact that today learners are more interested in learning by using modern technology, the use of effective software and user friendly help them more easily understand the material [3]. Different from previous research [2], [14], [15] this study aims to determine the ability of representation of prospective mathematics teacher students who learn to use Maple to determine the vector derivative. This is done to determine the level of student representation so that follow-up can be done to improve the ability of representation, and to know whether there is different of student representation ability before and after using Maple in vector.

2. Theory
The material used in this study includes vector derivatives and partial vector derivatives.

2.1. Vector derivatives
Vector function: if any scalar value \( t \) corresponds to a vector \( A \), then \( A \) can be expressed as a vector function of \( t \) or \( A(t) \), is a vector whose components are functions of the scalar value \( t \). In \( \mathbb{R}^2 \), the usual vector function \( A(t) \) is written with,

\[
A(t) = A_1(t)i + A_2(t)j
\]  

In \( \mathbb{R}^3 \),

\[
A(t) = A_1(t)i + A_2(t)j + A_3(t)k
\]  

The concept of this vector function can be extended, if any point \((x, y, z)\) in \( \mathbb{R}^3 \) is associated with a vector \( A \), then \( A \) can be expressed in the form of a vector function as follows:

\[
A(x, y, z) = A_1(x, y, z)i + A_2(x, y, z)j + A_3(x, y, z)k
\]  

Once we know the vector function, then we next learn the usual derivative of the vector function. Normal Vector Derivative: \( A(t) \) is a vector function that depends on a variable \( t \), defined derivative of \( A(t) \) as follows:

\[
\frac{dA}{dT} = \lim_{\Delta t \to 0} \frac{A(t + \Delta t) - A(t)}{\Delta t}
\]  

If there is a limit. If vector function

\[
A(t) = A_1(t)i + A_2(t)j + A_3(t)k
\]  

Scalar function

\[
D_1(t), A_2(t), A_3(t)
\]  

Can be differentiated to the variable \( t \), then \( A(t) \) has a variable derivative of \( t \) formulated as follows
\[
\frac{dA}{dt} = \frac{dA_1}{dt} i + \frac{dA_2}{dt} j + \frac{dA_3}{dt} k
\]  
(7)

2.2. Partial vector derivatives

If A is a vector that depends on more than one scalar variable, for example x, y and z then we write A = A(x, y, z). Partial derivative of vector A to x

\[
\frac{\partial A}{\partial x} = \lim_{\Delta x \to 0} \frac{A(x + \Delta x, y, z) - A(x, y, z)}{\Delta x}
\]  
(8)

Partial derivative of vector A to y

\[
\frac{\partial A}{\partial y} = \lim_{\Delta y \to 0} \frac{A(x, y + \Delta y, z) - A(x, y, z)}{\Delta y}
\]  
(9)

Partial derivative of vector A to z

\[
\frac{\partial A}{\partial z} = \lim_{\Delta z \to 0} \frac{A(x, y, z + \Delta z) - A(x, y, z)}{\Delta z}
\]  
(10)

3. Method

Population in this research is all student of candidate of math semester 4 teacher at UIN Sunan Gunung Djati in Bandung, while sample taken 37 student taken by purposive sampling technique, with consideration of student taking vector calculus course. The research was done by giving the initial test in the form of representational questions about the vector derivative, then given the action in the form of learning using Maple. After that the final test is a matter of representation. Data analysis was done by assumption test in the form of normality test and homogeneity of data. Then in comparing the initial test score with the final test.

4. Result and discussion

Normality test results show that the data is normally distributed, the results of normality test can be seen in table 1.

| Statistics | df  | Sig. |
|------------|-----|------|
| Pretest    | 0.109 | 37  | 0.200 |
| Posttest   | 0.126 | 37  | 0.149 |

The average difference test result is known that the sig value. Less than 5% significance level so it can be concluded that there is a difference between the ability of mathematical representation of students before and after being given treatment using Maple. The difference test results can be seen in table 2.

| t       | df  | Sig. |
|---------|-----|------|
| -6.525  | 36  | 0.000 |

The level of student representation ability is analysed based on three indicators, visual representation, mathematical model representation or mathematical expression and representation using words.
Table 3. Recapitulation of student representation analysis results.

| Indicator                        | Error Percentage |
|----------------------------------|------------------|
| Visual Representation            | 27%              |
| Mathematical Model Representation| 40.5%            |
| Word Representation              | 54%              |

Based on the results of the student's answer analysis found that there are 8 students who have difficulty in describing the vector equation graphic equation, 15 students have difficulty in representing into the mathematical language, in the form of equations consisting of symbols. More than half of the students who were sampled had difficulty in explaining the results that had been obtained using words.

One example of student error appears in the following work. A particle moves along a curve where \( t \) is the time and equation of the parameter as follows

\[
x = e^{-t}, \ y = 2 \cos 3t, \ z = 2 \sin 3t
\]

(11)

Students are required to determine speed and acceleration at any time, and students are required to be able to find and explain speed and acceleration at \( t = 0 \). Students' answers show that students can determine the vector \( r \) first when requested particle speed and acceleration. And can not explain how the velocity and acceleration of the particle when \( t = 0 \) as shown in figure 1.

![Figure 1. Student error in working problem.](image)

Based on figure 1 it can be seen that the workmanship of the students shows that the student has not been able to determine the vector of what is known in the problem. The student should first determine the vector of the given problem after it determines the speed and acceleration using the vector derivative.

5. Conclusion
The results showed that the representation using words still need to be improved. This can be a consideration that in the future learning of mathematics students are required to more often express the argument using words, interpret the results of a calculation and test an allegation that can be explained
again using words. Besides, although the visual representation and representation of mathematical expression has a lower error presentation it does not mean it does not need to be improved. Maple is recommended for use in mathematics learning, this is evidenced by the influence of Maple's use of student representation skills.

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