Analysis mathematical representation ability by self-efficacy of prospective mathematics teachers

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Abstract. This qualitative research purpose to analyze the mathematical representation ability of students in solving problems viewed from the level of self-efficacy. This research was conducted on 6E grade of mathematics education students at the University of Singapore Karawang. This research is focused on the ability of visual representation, equations representation or mathematical expressions, and words representations or written texts as seen from the level of student self-efficacy. The dimensions of self-efficacy include magnitude, strength, and generality. This study uses a qualitative approach with data collection techniques such as tests, questionnaires and interviews. The results showed that the ability of mathematical representation is very important and needed by students in understanding material and solving problems, if the ability of mathematical representation is lacking then it causes a lack of student understanding of the material given so that students have difficulty in working on given problems. A good mathematical representation ability is supported by good student self-efficacy, with optimism and never give up in working on any given problem by thinking of strategies for solving the solution.

1. Introduction
The general goal in learning mathematics is problem solving, while the ability to solve problems is a basic ability in learning mathematics [1]. The success of problems solving depends on the ability to representation problems including making and using mathematical representations in the form of words, graphs, tables, and equations, solutions, and symbol manipulation. This shows that representation is one of the standard abilities that must exist in mathematics learning.

The representation is a form of students' interpretation thoughts to problem, which is used as a tool to find the problems solutions [2]. In addition, students also easily get problem solving strategies. The representation acts as a bridge that connects abstract mathematical concepts with the context of everyday life[3]. Based on the experiment, need to give a picture to students about mathematical representation before starting to invite students to apply mathematical representation in solving everyday problems. The forms of student interpretation can be in the form of words or verbal, written, drawing, tables, graphs, concrete objects, mathematical symbols and others [4]. Therefore, representations are inseparable in mathematics learning, because to solve mathematical problems, the ability to make mathematical models and interpret solutions is needed. Representation is a configuration that can representation something else in several ways [5]. For example, a word can representation a real-life object, a number can representation a person's weight size, or the same number can representation a position on a number line. Making problems more real can result in better student performance. Students can describe the actual situations into mathematical concepts by using...
clear representations [6]. Mathematical representation can help students creating mathematical models that can help in solving mathematical problems.

Mathematical representation is also one of the cognitive abilities that influence student learning outcomes in mathematics. The ability of mathematical representation significantly contributes 9.42% to mathematics learning achievement, both directly and indirectly [7]. In other words, mathematics learning achievement or outcome is determined by the ability of mathematical representation. In addition, the ability of mathematical representation is also closely related to the ability of students to solve problems. With high representational skills, students will more easily find problem solving to solve exam questions. Problem solving depends on one's ability to think in different representation systems during the problem solving process [8]. Thus, the ability of mathematical representation can be one of the factors causing less optimal student learning outcomes in mathematics.

In learning mathematics, there are three aspects abilities should be have student, they are cognitive, affective and psychomotor abilities. These three aspects are interrelated [9]. In addition to cognitive aspects, affective aspects are also important and play an important role in learning success. There are three affective factors that can affect the learning process, namely: beliefs, attitudes and emotions. The belief factor will affect when students carry out an investigation process that is reflected in the actions, efforts, perseverance, flexibility in differences, and the realization of goals. One part of the belief is their self-confidence in mathematics or self-efficacy, which consideration of their ability to achieve the desired or determined level of performance, which will influence subsequent actions [10].

Regarding the role of other self-efficacy, Garfield and Ben-Zvi asserted that to be able to do mathematics is not enough to know how to do it, but must be accompanied by self-efficacy about the truth of the concepts and procedures they have [11]. For example, when doing calculations manually or by using a calculator, the element of self-efficacy is in it. Self-efficacy of mathematics possessed by students is not permanent but can be changed for the better. For example in research [12] states that the development of students' self-efficacy by applying active learning and the result were that students' self-efficacy could be increased through active learning. Self-efficacy is growing in students whose development is influenced by the condition of the students themselves and the surrounding environment [13].

Student self-efficacy is influenced by several factors including the teacher, textbooks, learning strategies, and the main thing is the utilization of daily problems that exist around students in learning activities. The characteristics of contextual learning that uses students' daily learning environment as a starting point of learning, multi-directional interaction (teacher with students or students and students), the existence of a model (teacher/student) can increase student self-efficacy. Because changes in self-efficacy are influenced by many factors, efforts to increase self-efficacy must be made by considering all of these factors [14].

Hall dan Vance melakukan penelitian untuk membandingkan self-efficacy dua kelompok siswa dalam memecahkan masalah matematika melalui pembelajaran konvensional dan pembelajaran menggunakan web. The instrument used consisted of 10 items regarding how confident students were in solving mathematical problems. The study revealed that students' self-efficacy in solving statistical problems was still low for both groups of students. To enhance students' self-efficacy, Hall and Vance suggest the use of social cognitive theory as a framework, according to the theory the feedback variable pattern allows teaching and learning efforts touch personal directly, environmental and behavioral factors [15].

In his study revealed that self-efficacy of students who get ordinary learning is still low. According to [16], this self-efficacy can be improved by the use of inquiry learning; evident from the results of his study which concluded that the self-efficacy of students who get inquiry learning is higher than the self-efficacy of students who get ordinary learning. The individuals who have high self-efficacy generally believe that they have a higher level of control over their lives such as taking action and making choices directly that will affect their lives [17].

Dimensions of self-efficacy according to Bandura [18] namely: 1) magnitude relates to the level (level) of difficulty faced by a person's task. Someone's belief in a task varies. 2) generality is a feeling
of ability shown by individuals in different task contexts. 3) strength is the strength of a person's beliefs regarding their abilities. The explanation of each aspect or dimension as stated by Ika Maryati [19] is as follows: a) the level of difficulty of the task (magnitude). This aspect has implications for the selection of behavior that individuals will try based on their understanding of the level of difficulty of the task. If the tasks assigned to an individual are arranged according to their level of difficulty, then the difference in individual self-efficacy may be limited to simple, medium or high tasks. Individuals will try to carry out tasks that are considered workable and avoid situations and behaviors that are beyond their capabilities, b) generality. This aspect is related to the scope of behavior where individuals feel confident about their abilities. An individual's confidence in his ability depends on understanding his ability in a particular/limited activity/situation or a wider and more varied set of activities/situations. c) the strength of belief (strength). This aspect is related to the strength of one's belief in his ability. A strong hope in the individual will encourage persistent efforts to achieve goals, even though they may not have the supporting experience.

In this research, it can be seen that the ability of mathematical representation is very important and it is needed by students to understand the material and to solve problems.

2. Methods
This type of research is descriptive research. This study uses a qualitative approach that aims to obtain in-depth data and information to analyze the mathematical representation ability of mathematics education students at Singaperbangsa University, Karawang in solving vector calculus problems viewed from the level of student self-efficacy. The instruments used were tests and questionnaires. Data collection techniques in this study were tests, questionnaires and interviews. The test is used to obtain student representation data in solving vector calculus problems. The questionnaire was used to obtain student self-efficacy data. Interviews were conducted to dig deeper information about students' mathematical representation capabilities seen from the level of student self-efficacy.

3. Results and Discussion
Mathematical representation ability is the ability of students to express mathematical ideas such as diagrams, pictures, tables, graphs, mathematical symbols, mathematical models, words, and so on. It is a tool to solve problems. The ability of mathematical representation consists of visual representations, representations of mathematical equations or expressions, and representations of written words or texts. The ability of mathematical representation consists of visual representation, representation of equations or mathematical expressions, and representations of words or written text [20].

In addition to being viewed from the cognitive aspect, we see the ability of students from the affective aspect, namely through the results of a self-efficacy questionnaire. Self-efficacy interpretations are presented in the following criteria: very high, high, high enough, moderate, low enough, low, and very low.

3.1 Visual Representation Ability
The ability of visual representation can be seen from the exposure of student identification in working on problem 1 as follows with the indicator students can display the ability of visual representation.

If vectors A, B, and C as shown in the image below, draw them \[ \mathbf{R} = -\mathbf{A} - 2\mathbf{B} - \mathbf{C} \]
In question number 1 as shown in Figure 1, most students were able to present the answers in the form of pictures correctly. However, there are some students who have not been able to draw correctly. In this answer, the researcher sees that they are able to draw together the explanatory components in the picture. Based on the results of interviews, the steps taken by students in drawing are as follows: (a) looking at the direction of vector A, (b) drawing vector A, (c) looking at the direction of vector B, (d) depicting vector B by placing the base point of vector B at the endpoint at Vector A, (e) see the direction of vector C (f) illustrates vector C by placing the base point of vector C at the end point of Vector B and (g) to get R then draw a straight line from the base point of vector A to the end point of the vector C. All vector lines are given information according to their respective vector names and marks for the vector information. However, some students have not representationed the answers.

It can be concluded from the results of the self-efficacy questionnaire, it appears that students with a very high level of self-efficacy can work on question 1 properly and correctly without any errors. Students with a moderate level of self-efficacy can work on problem 1 well and correctly but are incomplete in giving symbols to each vector that is being operated. Whereas for students with a very low level of self-efficacy in working on problem 1, it can be seen that in determining the direction of the vector it is not correct.

Based on the results of tests, questionnaires and interviews, the researcher concluded that students were able to describe the objectives of the questions along with the steps and giving symbols or numbers to clarify the image and the ability of students to visual representations above and below the average mathematical representation ability of number questions. 1 is good. However, a lack of understanding of the concept of vector direction made students unable to visually represent the information in question number 1 correctly. The students' lack of understanding is due to the lack of confidence in the students in solving the questions. Students must feel optimistic and try to solve problems by finding strategies to solve them well.

3.2 Equations Representation Ability
The ability to represent equations describes the identification of students in working on question 2 as follows with the indicator that students are able to use the representation of equations or mathematical expressions in solving problems.

\[
\text{If } f(t) = 2t^2\mathbf{i} + 3t\mathbf{j} + t^3\mathbf{k} \quad g(t) = t\mathbf{i} + 2t^2\mathbf{j} + \mathbf{k} \quad h(t) = 2t\mathbf{i} + \mathbf{j} + 2t\mathbf{k} \quad \text{Please divide } \frac{d}{dt}[f \cdot (g \times h)] \text{ pada } t = 1!
\]
All students answer the same way and most students have the right answer, only a few students have a few mistakes. In answer number 2 as shown in Figure 2, there are some students who have not been able to perform operations on vectors according to the correct rules. Meanwhile, students' mathematical representation ability is still below average, they are wrong in solving the questions and in a messy arrangement and in solving the problems by writing the calculations used tend to write the final answer only without carrying out the calculation process systematically. Based on the conclusion interview, students actually know the steps in the process of solving the given problem, but students still do not understand correctly. They don’t know the concept of arithmetic operations on vectors.

Judging from the results of the self-efficacy questionnaire, it appears that students with very high levels of self-efficacy can work on problem 2 systematically and produce solutions correctly, but at students with self-efficacy levels can work on problem 2 systematically but the final results are obtained is still not quite right, this is due to lack of accuracy of students in doing calculations. While students with a very low level of self-efficacy in working on problem 2 show that students do not yet understand the arithmetic operations on vector functions, resulting in inaccurate final results in calculations.

Based on test results, questionnaires and interviews can be concluded that the ability of representation of equations or mathematical expressions of students above the average mathematical representation ability is good enough. While the ability to represent students' mathematical expressions is below the average, the ability of mathematical representation is still lacking. In working on the problems, students must understand the basic concepts of calculating vector functions.

3.3 Words Representation Ability

The ability of word representation can be seen from describing the identification of students in working on problem 3 as follows with the indicator students are able to use the ability of word representation or written text.

In question number 3 in Figure 3, most of the students were able to give explanations properly and correctly on the answers to problem solving. However, there are some students who have not been able to give a proper explanation about problem solving. Based on the results of interview, there are student able to explain about integral vector but there are some students who were still confused in explaining about integral vectors. Students who are above average ability are good enough because they can explain integral vectors well and smoothly. Students who are below average ability are still lacking because students cannot explain integral vectors well and are still confused.
Judging from the results of the self-efficacy questionnaire, it appears that students with very high levels of self-efficacy can work on problem 3 by providing correct explanations with systematic completion steps and producing correct answers, but in students with moderate self-efficacy levels has been able to provide a correct explanation with systematic steps for completion, but the final results of the calculation are not yet right, there are still errors due to lack of accuracy in the calculation. Whereas students with very low levels of self-efficacy in working on problem 3 show that students have not been able to provide explanations correctly related to problem solving solutions.

Based on tests, questionnaires and student interviews that are above the average mathematical representation ability, already understand the integral vector and can provide an appropriate explanation. While students who are below the average mathematical representation ability do not understand integral vectors and cannot provide answers and explanations because they lack understanding of integral vectors. Students must feel optimistic when faced with complicated questions. Students must try to find other solutions so that problems can be solved.

In this study, it is seen that the lack of knowledge and understanding of concepts has an effect on the mathematical representation of students. Researchers also see students' mathematical representation will also determine whether or not the strategy used in solving problems. When the representation is presented correctly, the strategy used to find the answer is also true. However, when the representation presented is wrong, then the strategy and the final answer found also becomes inaccurate.

This illustrates that when faced with challenging and difficult questions the level of tenacity and perseverance, they will not be easily discouraged or avoid the assignments that have been given. In addition, the degree of anxiety or calm they experience when defending questions that cover their lives is also quite good. This means that students are not too anxious and not too optimistic or confident but remain calm.

Based on the magnitude dimension, it can be seen that students will try to do the tasks they think can be carried out and avoid situations and behaviors that are beyond their ability. Furthermore, in the dimension of strength, it was seen that students' confidence in completing assignments with different types of questions was at a high level. Students feel optimistic and try to complete different tasks by finding strategies to complete them well. The last dimension is generality, which shows that students have strong and steady expectations so that students are persevered in trying to complete the task well even though they do not have supporting experience.
4. Conclusion

Based on tests, questionnaires and student interviews, students have mathematical representation ability above average already understand the integral vector and can provide an appropriate explanation. Students who are below the average, they do not understand integral vectors and cannot provide answers and explanations because they lack understanding of integral vectors. Students must feel optimistic when faced with complicated questions. Students must try to find other solutions so that problems can be solved.

Judging from the results of the self-efficacy questionnaire, students with very high levels of self-efficacy have good mathematical representation abilities, because students seem to be able to solve all questions based on indicators of mathematical representation ability properly and correctly. While students with moderate levels of self-efficacy have good mathematical representation abilities, this can be seen from the way students work on problems systematically, but the final result is not right due to lack of accuracy. Then students with a very low level of self-efficacy have poor mathematical representation skills, this is due to the lack of understanding of students on the basic concepts of vectors and students' hesitation to initiate each step of solving, resulting in inadequate problems. Complete the results.

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