

The Effect of Using Concept Maps in Elementary Linear Algebra Course on Students' Learning

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Abstract. This paper presents the results of a classroom action research that was done in Elementary Linear Algebra course at Universitas Negeri Padang. The focus of the research want to see the effect of using concept maps in the course on students' learning. Data in this study were collected through classroom observation, students' reflective journal and concept maps that were created by students. The result of the study was the using of concept maps in Elementary Linera Algebra course gave positive effect on students' learning.

1. Introduction and Theoretical Background

The purpose of this research was to improve teaching and learning mathematics in higher education in Indonesia. One of the issues that have been encountered in education in Indonesia are the low level of students' involvement in mathematics learning. As a mathematics lecturer at Universitas Negeri Padang, I also found that this issue has become major problem of my teaching practice.

Students' learning in mathematics is a problem in mathematics education. According Brijlall and Maharaj[1], many students perform poorly in mathematics because they are unable to adequately handle information given in symbolic form which represent objects, for example mathematical expressions, equations and functions. Besides that problem, according to Maharaj [2] a high percentage of students have a static view about mathematics; students with such a view will experience difficulties in learning mathematics in depth and will find it difficult to engage in teaching and learning processes. To improve my teaching and learning practice and to overcome this issue I chose to implement the concept maps as a strategy.

Concept maps were used in this study as a students' activity before class. Students were required to create concept map about the topics that would be discussed in the class. Through this concept map activity students were encouraged to be actively involved in the learning process to enable them to construct their own understandings.

Concept mapping is derived from a constructivist approach to teaching and learning. Concept mapping is a technique used for representing knowledge graphically, where the knowledge that is represented is related to concepts that are interconnected. A concept map consists of nodes and links. The nodes correspond to important terms representing concepts and the links represent the relationship between the concepts [3]. The concept map is intended to demonstrate the level of deep understanding of the students through their illustration of connections between concepts [4].

Concept maps were first introduced by Novak as a research tool. The method of concept mapping has been developed specifically to tap into a learner cognitive structure and to externalise what the



learner already knows [5, 6]. Although the primary intention was to use concept mapping in research, it was also found to be a useful tool in the teaching and learning process, helping students to learn.

Traditionally, people tend to have the view that the result of students' learning in mathematics can be seen through their achievement in mathematics tests. This view is demonstrated by the extensive use of tests by educators in their practices. The use of tests to evaluate students' performance in learning has many weaknesses. According to Stake [7] mathematics test scores are not a basis for indicating how well students have become successful in learning mathematics. They do not directly measure how well educated in mathematics the student is becoming. They do not identify the cognitive structures of students' thinking.

In fact, students' learning in mathematics can be obtained through a variety of ways. One of them is through authentic assessment. This kind of assessment looks directly at students' work and their performance as a result of their mathematics learning. Such assessments include students' written tasks, students' solution of problems, students' presentations, students' experiments, and teachers' classroom observations [8].

According to Battista [9] the focus of students' learning in mathematics must be on problem solving, mathematical reasoning, justifying ideas, and independently learning new ideas. Students have to be given opportunities to develop their communication ability in mathematics or to increase their ability to read, write, and discuss mathematics. The National Council of Teachers of mathematics (NCTM) has identified five process standards in teaching and learning mathematics: problem solving, reasoning and proof, communication, connection and representation. The result of students' learning in mathematics can be achieved with active involvement in learning using these processes. These processes enable them to deepen mathematical understanding that leads to increasingly sophisticated abilities required to meet mathematical challenges in meaningful ways [10, 11]. In this paper, the students' learning will be seen through problem solving process.

Students' activities that relate to the problem solving process standard are: (1) use problem solving approaches, (2) formulating problems in everyday life and mathematical situations, (3) developing and applying strategies to solve a variety of routine and non-routine problems, (4) verifying and interpreting results with respect to the original problem, and (5) distinguishing between necessary and irrelevant information in solving problems [10].

Research question to be answered in this paper is, "How is the effect of using the concept map in Elementary Linear Algebra Course on students' learning?"

2. Method

In this study, I used an action research methodology. Action research is a systematic investigation conducted by teacher researchers to gather information about how they teach and how well their students learn [12, 13]. According to Atweh [14] through action research teachers have an opportunity to improve their practice and to develop an understanding of their practice that will enable them to develop professionally. The participants in this study consisted of 37 students enrolled in the Elementary Linear Algebra course. One cycle of action research (planning, acting, observing, reflecting and creating a revised plan) was conducted during each week.

I used 'concept mapping activity' in every weekly lesson. Students created the concept maps through the discussions in their small groups. They created the maps outside the class. The groups comprising two or three students were formed based on the ease of their meeting outside the class. The presentation and discussion of mathematics concept maps was done at the beginning of the class, when it took about 15 to 20 minutes. After the presentation, the activity continued by a discussion about the concept map.

The students' learning that were observed was students' ability in problem solving. To evaluate students' ability in problem solving, the researcher would use the qualitative data from focus group interview and classroom observations.

3. Results

The aim of this section is to investigate students' ability in mathematics problem solving as consequence of the use of the concept maps approach in Elementary Linear Algebra course. The data that was used to perform the analysis in this section came from the focus group interview and the classroom observations on the discussions of group B during Week 2 and Week 6.

In focus group interview, Budi revealed his ability and his group strategy in handling problem solving,

In problem solving, I always found easy problems and difficult problems to solve. When I found the difficult problems I got help from friend in the group. Our strategy to solve mathematical problems in the group; if we were given a lot of problems to solve then we shared the problems so that each of us could work individually first, and then we discussed them together. So, in the group to create concept maps there was mutual exchange of information that increased my ability to solve the problem.

Budi's comment above reflected that the use of concept maps strategy had facilitated his ability to solve the hard mathematical problems that he faced through group discussion.

In the classroom observations on the discussions of group B during Week 2, the discussions that took place were about solving selected mathematics problems. Through the discussions, students had the opportunity to sharpen their ability in solving mathematics problems. As was observed in the group discussions, Salsa and Vera were involved in a conversation to evaluate their results in solving a linear equations system.

What you did on number 2 is simpler than what I did Vera, you only used 5 elementary row operations.

Salsa revealed this conclusion after she compared her job with Vera's job.

Vera gave her response,

Maybe you did not follow the procedure in using the elementary row operation to change its augmented matrix to the reduced row-echelon form.

Salsa said,

O ya, I did not pay attention to it, I will see.

Through this comparison, Salsa had the opportunity to improve her ability to solve the problem; she learnt about the technique which was used by Vera to solve the problem.

In the discussion during Week 2, they were active in finding and sharing ideas to get better answers when solving mathematics problems. Sharing ideas was really helpful for them to understand the topics and to solve the problems. After Vera's assistance about how to use the elementary row operation in solving the linear equations system, Salsa was able help Eki who did not know how to complete his job. In solving the problem, Eki said,

I am stuck here. I am not sure what I have to do next.

Salsa gave her assistance,

You see, all entries on this row are zero, so you can interchange the row with the last row. Its meaning will not change.

Eki's response,

Thanks Salsa, I understand how to do it now.

The assistance that was given by Salsa helped Eki to better understand how to use the elementary row operation to solve the linear equations system problem.

The time allocated for discussions was limited to only 50 minutes. During Week 2 discussions, they had used most of the time to work independently. As a result, there was not enough time for them to discuss all issues that emerged from the problems so that not all members understood the solving of the problems. At the end of the discussion, Vera said, "I still don't understand yet how to decide if a system of linear equations has exactly one, infinite, or no solution by using the augmented matrix, but the time is over." This experience indicated that they needed much more time to discuss so that all members in the group were better able to understand the topics.

During Week 6, each member of the group first solved different problems. On this occasion, there were five problems to be discussed. So, one student would attempt to solve one problem, after which they discussed the solutions together to arrive at the best answer. They had arranged how long they would work independently, how long they would work together, and who was to write the final report.

The students not only asked their friends but also criticised their own work, like what was revealed by Revi in the group discussion in Week 6. Revi was not satisfied with her answer on a determinant problem; she had used many more steps to reach the result. Revi said, "Why has my answer so many steps, while your answer is so simple? How do you do that Vera?" Vera gave her response, "Let me see. I combined the expansion of cofactor and row reduction". Revi's response, "I see, I only used row reduction."

This experience encouraged them to be involved in discussions to evaluate and compare the differences of their methods. They realized that there were several ways to solve the problem. This teaching and learning strategy had enabled them to compare and discuss alternative strategies to solve the problems.

So, the use of the concept maps strategy in the Elementary Linear Algebra course had enabled students to discuss the solving of the mathematics problems. Through the discussions to create concept maps they had the opportunity to share knowledge and strategies on how to solve the problems so that their ability to solve the mathematics problems improved. In the conventional classroom that I taught before, students did not have much opportunity to share knowledge and strategies in their effort to solve the mathematics problems in the classroom. So, the use of the using of concept maps in Elementary Linera Algebra course gave positive effect on students' learning.

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