Volume 19, Number 1, 2017

Global Journal of Engineering Education

Improving conceptual understanding and problem-solving in mathematics through a contextual learning strategy

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ABSTRACT: Mathematics is a basic fundamental of science and technology. However, most students find it difficult to understand and to apply the concept of mathematics in a real-world context. The difficulty is due to the conventional learning strategy used, which is unable to improve the students' ability. This experimental study aimed to discover the implementation of a contextual learning strategy to improve mathematics conceptual understanding and problem-solving. The two above-mentioned issues have been examined by using a pre-test and post-test, and compared by using a control group with conventional learning. The results showed that the contextual learning strategy significantly affects the conceptual understanding and the ability to solve problems in mathematics subjects.

Keywords: Mathematic concepts, mathematic problem-solving, contextual strategy, conventional strategy

INTRODUCTION

Mathematics is a foundation *science*, which is an essential component of science and technology development. Mathematics is also considered to be a formidable subject and difficult to learn and to fully master. This perception emerged a long time ago and continues to exist.

The inability of students to understand the concepts and to solve problems is due to the conventional learning during mathematics courses. According to Schoenfeld, the conventional learning of mathematics only enables students to perform algorithmically and understand mathematics without reasoning [1]. Jenning and Dunne have expressed the view that most students have difficulty in applying mathematics in real-world situations [2]. Also, Van den Heuvel-Panhuizen argues that students will most likely fail to remember the concepts and will be unable to apply mathematical concepts [3]. In addition, the study of mathematics is an abstract matter in which the teacher will most likely find it difficult to teach using conventional teaching [4]. The challenge for the mathematics teacher is to eliminate the perception of mathematics as a formidable subject [5]. The choice of learning strategy, therefore, could positively influence the learning outcomes of the students since it could establish a conducive atmosphere of learning activity and create a meaningful learning. To resolve the above-mentioned problem, it is imperative that a contextual learning model be used. When such a model is used, students are involved in solving a particular problem through several scientific methods and are learning the related knowledge all at once [6].

In this article, the authors discuss the use of contextual and conventional learning strategies within the mathematics subject. The two strategies will be examined and compared to establish, which strategy is the best.

RESEARCH METHOD

This experimental study examined the two strategies: contextual learning strategy and conventional learning strategy, based on the procedures of the two strategies. This study used a 2 x 2 factorial pre-test post-test non-equivalent control group design experiment arrangement [7].

This study consisted of two groups. The cluster random sampling technique was used to determine the groups [8][9]. The subject of this research was considered according to pre-test equivalence. Two groups were randomly chosen by using cluster random sampling. One group performed according to the contextual strategy and one group performed in line with the conventional strategy. Each group consisted of 28 students.

This study allocated 18 hours of courses during which the mathematics course used 12 x 35 minute sessions and 5 x 35 minute sessions for the test. Also, 1 x 35 minute session was allocated for a motivational test, 2 x 35 minute sessions were allocated for a conceptual understanding test and 2 x 35 minute sessions were allocated for a problem-solving ability test.

Contextual Learning Strategy

The formulation of contextual learning characteristics in mathematics/PMR, are:

By using a real-world context, a variable model accentuates the students' contribution and interaction, and material intertwining [3][10-14].

By adopting a contextual learning strategy in mathematics through seven steps formulated [10][11][14][15] as follows:

Early Stage: Introductory

- Step 1 - students conditioning in lesson activity:
  - The teacher initiates the lesson by explaining the purpose and outlining the topic that will be discussed.
  - The teacher explains realistic mathematic learning.
  - The teacher gives the students questions regarding the prerequisite skills of the students.
  - The teacher gives a contextual problem related to the discussed material.
  - The problems given are attached to the students' textbook.

Core Stage: Understanding Contextual Problem, Solving Problem through Discussion

- Step 2 - understanding contextual problem:
  - The teacher asks the students to learn and understand the problem in the textbook individually by asking them to write down what they know and preparing for the question.
  - The teacher gives direction to the part of the situation and condition of the problem according to the students' needs.
- Step 3 - solving contextual problem:
  - Students are divided into groups to solve the problem their own way. As a consequence, it is possible to have a different solution from each student.
  - The teacher observes, motivates, gives limited guidance and finalises students' work during problem-solving.
- Step 4 - comparing the answers through group discussion:
  - The teacher asks the students to compare and discuss the answer, particularly discussing the reason behind their answer.
  - Through discussion in the group, the students will also learn how to express their opinions and respect the opinions of others. As a result, it creates an interactive learning process and promotes a better relationship among students and between students and teacher during problem-solving about the material discussed.
  - The teacher observes the discussion of the students and provides assistance only if necessary.
- Step 5 - comparing the answers through class discussion:
  - The teacher appoints a representative of each group to write down their answer and the reasons for it.
  - The teacher, as a facilitator and moderator, directs the students' discussion and guides them into drawing a conclusion in advance of formulation of the concept, principle, or algorithm based on formal mathematisation.
- Step 6 - doing exercise in the students' text-book:
  - The teacher asks the students to do the exercise in the given textbook.
  - The teacher asks one of the group representatives to do the exercise on the board, while the teacher gives direction until the right answer is obtained.

Final Stage: Conclusion and Giving Home Work

- Step 7 - concluding and giving home work:
  - The teacher guides the students towards drawing a conclusion about a particular concept, principle or an algorithm based on the discussion of the results.
  - The teacher gives homework as a form of exercise to internalise the particular concept, principle or algorithm.

Conventional Learning Strategy

The conventional learning strategy in this article refers to Slavin's argumentation, which states that the activity within the conventional learning strategy is a stated learning objective to orientate the student to the lesson [16]. The method used during the conventional learning strategy involves lecturing, question-answer sessions, and assigning work and exercises. The syntax within the strategy are:

Early Stage: Introductory

In initiating the material, the teacher gives an explanation regarding the purpose of the lesson, and reviews the initial understanding of the students related to the pre-requisite material.

Core Stage: Explaining Concept, Giving the Example of Exercise, Giving the Exercise and Giving Feedback

- The teacher gives a lecture to explain a particular concept, theory or definition, theorem, fact and mathematical formula. The lecturing is conducted to explain the general material of a subject.
- The teacher gives an example with an exercise and the solution.
- The teacher gives an exercise to the students and the students solve the exercise based on the example and solution. Later, each student does the exercise on the board.
- The teacher gives feedback to the students. The feedback is given on the exercise done by the students, while the students observe the feedback.

Final Stage: Concluding and Giving Home Work

Relevant to the set of conducted learning, the teacher gives a conclusion and summary of the discussed material and, then, gives homework to the students.

RESULTS AND DISCUSSION

All students in both the contextual learning and conventional learning strategies experimental classes were given a pre-test to test their conceptual understanding and problem-solving ability in mathematics. At the end of the lesson, both groups were given a test to examine the students conceptual understanding. Table 1 compares pre-test and post-test of the two groups being examined.

Table 1: The comparison of pre-test and post-test.

Ability	Conventional		Contextual	
	Pre-test	Post-test	Pre-test	Post-test
Conceptual understanding	34.1	55.53	34.82	73.92
Problem-solving	19.64	45.35	19.68	71.25

Generally, both pre-test and the post-test scores improved the ability of the students (conceptual understanding and problem-solving). Table 1 also informs that there was no significant difference between the pre-tests in either experimental class. However, it can be seen that the average of post-test results in both conceptual understanding and problem-solving within contextual learning experimental classes was higher than in the conventional learning experimental class.

In contrast with conventional learning, which gives the teacher the prominent role in the class, contextual learning only places the teacher as a facilitator whose role is only to guide, direct, evaluate and take a role as moderator, while the role of the students is predominant in the class. The students perform a prominent role of thinking in the early part of the lesson, absorbing the lesson, communicating and sharing during the lesson, and constructing mathematical concepts individually.

This model of learning creates a crowd instead of silence. The crowd is a result of students' discussion. Allsopp et al expound that the learning involves students' experience and the environment helps the students to increase their understanding, as well as their enthusiasm [17]. Further, Becher and Selter discovered that contextual learning gives a positive impact to improve the mathematics learning outcome of students [18]. Also, Hadi found that contextual learning promotes students' motivation and fosters the creativity and activity within the learning [15].

Substantively, according to the constructivist view, learning mathematics is a process to solve a problem [19]. In this context, the substantial focus of learning mathematics is to empower students to think and construct mathematics knowledge invented by former expertise. From the perspective of the constructivist, the evaluation occurs during the learning or during the so-called on-going assessment.

The results of this study show that the learning, particularly problem-solving ability, will be positively affected and will have an additional benefit. Hoyce and Weil suggest that there are direct learning outcomes from instructional effects and additional outcomes derive from nurturant effects [20]. Nurturant effects commonly deal with the attitude and behaviour of students. The learning strategy, which constructs the attitude and behaviour of students will most likely affect the learning outcome. According to Retnasari et al contextual learning creates a positive response from students since it promotes a conducive atmosphere in which the students are able to relax and are contented during the lesson, which enforces their motivation [21].

CONCLUSIONS AND SUGGESTIONS

According to the results of this study, it can be concluded that the contextual learning strategy instead of using the conventional one improves the learning outcome of students in the form of conceptual understanding. It can also be seen clearly that the ability of problem-solving is increased within the contextual learning strategy.

To examine the effectiveness of contextual learning further, several variables, which involve the learning outcome, such as learning style, IQ, students' behaviour, etc, must be taken into account.

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BIOGRAPHIES

Ahmad Jazuli received his Bachelor of Science in Mathematics at Muhammadiyah University Surabaya in 1993, and obtained his Master of Management at the Islamic University Kadiri in 2003 and his doctoral degree in education technology at the State University of Malang in 2016. He has worked as a lecturer at the College of Tarbiyah Studies Raden Santri Gresik (STIT) and at the College of Islamic Studies Darut Taqwa (STAIDA). Among his achievements within the education field, he was the First Place of Mathematics Teacher based in Information Technology in East Java level in 2007 and the First Place among East Java School Principals in 2009. His research interests focus on the development of mathematics teaching through realistic mathematic education or RME and information technology.

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Sulthon is a lecturer in education technology at the State University of Malang. He completed a Bachelor of Education in technology curriculum of education at the State University of Malang in 1982 and received his Master of Educational Technology at the State University of Malang in 1992. In 2003, he received his doctorate in education technology at the State University of Malang. He is currently research-active in areas related to development technology within education. His most recent publication is entitled: Width and Equitable Access to Higher Education through an International and Competitively Instructional Digital Broadcasting System, presented in during the proceedings of the Scientific Forum-Faculty of Education Department of Science Education (FIP-JIP). He is also active in several areas as a keynote speaker. Recently, he was a keynote speaker on Character Training for Doctor Advising Clinical Education in RS Blambangan Banyuwangi, in cooperation with UNISMA Malang.

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