

TEACHING HIGHER LEVEL CALCULUS TO THE POSTGRADUATE STUDENTS USING A MODULE-BASED COOPERATIVE LEARNING STRATEGY: AN EVALUATION OF EFFECTIVENESS

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Abstract The quality of teaching and learning is an important educational aspect where students in school or even at the higher level are the core groups that should be given utmost attention in order to gain excellence academically. The idea is to develop and maximize students' understanding by some ideal teaching and learning approaches that make them easy to understand the content knowledge that is being presented to them. A module-based teaching is one of the individual teaching methods that could be of any variations. The purpose of the research is to evaluate the effectiveness of a module-based instruction which utilizes the cooperative learning for teaching higher Calculus topics for limit and continuity, derivative, and integral. The sample consists of 50 first year Masters' students from Sultan Idris Education University. A set of test questions has been used as an instrument to collect the data. To determine whether the use of the module-based instruction could enhance students' understanding and achievement, a quasi-experimental method was employed where pre-test and post-test were administered to both experimental and control groups. The data was analyzed using inferential statistics involving the paired sample t-test and the independent t-test. The findings of this study shows that the teaching method by using modules in learning higher calculus have positive inclination in improving students' understanding and enhance their performance in academic assessments

Index Terms— : cooperative learning

I. INTRODUCTION

Currently, the education system in Malaysia undergoes a rapid process of change in tandem with the country's development as the year 2020 looms. Thus, a quality education has been identified as a channel to develop and maximize an individual's potential. Consequently, various methods to improve the quality of the education system in order to produce students who are knowledgeable and skillful to encounter future challenges have been introduced by the Ministry of Education. Some improvements have been made from time to time in generating a balanced curriculum where emphasis would be given to the cognitive processes in acquiring the content knowledge. The content knowledge can be presented through expanding curricular cognitive processes by using various approaches and thinking strategies in presenting the content. In addition, the teaching and learning activities that focus on students should be able to help them in stimulating and strengthening their cognitive processes.

Mathematics is one of the domains of knowledge which trains our minds especially in problem solving and decision making, hence be one of the most important areas in human development. However, many students assume that mathematics is difficult to learn. According to [1], many students dislike mathematics and reveal that mathematics materials are difficult and tedious. To avoid diminish the students' interest in mathematics, a more important task is to reinforce the mathematical concepts to the students by turning the teaching and learning process be more meaningful and enjoyable as the basic concepts of mathematics could be comprehended well. Beside computing skills that involve thinking and a high level of creativity, based on [2], [3], [4] and [5], learning mathematics also requires precise and comprehensive understanding of concepts.

The quality of teaching and learning is an important educational aspect in schools or even at the higher levels. According to [6], traditional method is preferred by teachers for teaching. More often than not, this causes the teaching and learning environment to be less fun and students get bored with the lessons. Based on the research by [7], the traditional teaching method using textbook to carry out learning activities based on inquiry method only provides a minimal impact. This approach could not improve students' critical and creative thinking skills in general. Therefore, the traditional teaching and learning methods do not always guarantee the effectiveness of the content delivery and consequently do not guarantee students' understanding of the topic that is being taught. For the students' learning, their ability to be creative and to think critically is one of the important aspects that should be emphasized. Thus, the approaches to teaching and learning should be more focused. Some of the ideal teaching and learning approaches may be able to make students easy to understand the knowledge that is being presented to them.

Teaching aids are often used in teaching and learning in order to make the students to understand the lesson better. According to [8], the importance of teaching aids is to enable the teachers to vary the teaching techniques and to provide assistance during teaching so as to not burden them and the students. Generally, the use of appropriate teaching aids can provide a positive impact on students' understanding. There are many different types of teaching aids used by teachers according to their creativity. Teaching and learning module is also one of the teaching aids that can be used by teachers. According to [9], the teaching-based module is one of the individual teaching methods, in which students follow the guidance and direction from teachers, learn the materials lesson through printed guidance or computer software and thus complete the course work by educational units provided. The approach used in implementing the teaching and learning modules could be of any variations. In this research, a module based on a cooperative learning approach is employed. A research by [10] states that, cooperative learning approach still requires further research by researchers from the field of education especially in the domains of experience, attitude and behavior of learners. It is a common teaching strategy that can

be implemented in small groups with each group consisting of four to five students, where they can interact with each other to complete the task as specified by the learning objectives. Through this method, learning and sharing of information between members of the group can be carried out. The construction of the module based on cooperative learning is also seen as being able to create an exciting atmosphere and conducive to learning among students as well as to improve the students' academic achievement.

II. Objective of The Study

The objectives of the study were to:

- a) Determine whether there was a significant improvement in the students' understanding in learning the calculus topics for the control and experimental groups based on the pre and post tests
- b) Determine whether there was any significant difference between control group's post test mean score and the experimental group's post test mean score as far as the effectiveness of the modules was concerned.

III. Methodology

This study employed a quantitative approach and conducted on first year mathematic Postgraduate students from Sultan Idris Education University who took Differential and Integral Calculus. A quasi-experimental method is used for this study to determine whether the use of a module in the teaching and learning of calculus by [11] would be able to improve students' understanding and achievement. This study involved an experimental group and a control group in which both pre-test and post-test involving calculus topics were administered to the respondents. The questions asked in both the pre-test and post-test given to the control and experimental groups were the same. There were 50 respondents involved in the pre-test and post test. Twenty five students were randomly selected through balloting to be members of the experimental group, while the remaining 25 students were selected to be in the control group. For the control group, the teaching and learning processes were carried out as usual, which employed the traditional method. Meanwhile, for the experimental group, the Calculus module was used in teaching and learning. The students handled their own learning where lecturer as a facilitator only helping out when necessary. A pre-test was given at the beginning of the teaching and learning processes while the post-test was given after the completion of the lesson. The questions were constructed based on predetermined Instructional Plan for Differential and Integral Calculus courses. This study used a diagnostic test, which was an achievement test prepared and revised by the researchers. The entire diagnostic test consisted of 24 questions that covered the skills for the planned topics. The answers for each item in the diagnostic tests were revised according to the answers' scheme provided. The researchers then examined each answer's script based on:

Marks obtained = Number of correct question

The questions in this section were subjective questions in order to enable students to show their steps in calculation. The level of a student's understanding and proficiency of each question could be traced from the calculations shown. For validity purposes, researchers met and consulted a few experts in the field of calculus who were the mathematics lecturers from Faculty of Science and Mathematics, Sultan Idris Education University. The experts evaluated the questions for the diagnostic test such that the questions posed would fulfill the proposed objectives of the research, would be based on the syllabus and the language used would be appropriate to the level of the students.

A pilot study was conducted to ensure the reliability of the instrument's diagnostic questions that would be used for actual research. For this purpose, the researchers randomly selected 15 students who took Differential and Integral Calculus courses as respondents. Specifically, the Cronbach alpha reliability index was used to measure the reliability of the instrument's diagnostic questions. In general, the value of 0.8 would be enough to be accepted as a suitable level of reliability. According to [12], if the value were lower than 0.8, then the researchers would need to modify the items concerned and then carried out the pilot study again until attaining the value of 0.8. Cronbach Alpha reliability index values of the instrument's diagnostic questions obtained in this study are as in TABLE (1).

TABLE I. Reliability Test Results for Each Topic

Topic	Number of questions	Cronbach Alpha value
Limit and continuity	8	0.813
Derivative	8	0.821
Integral	8	0.834

Next, the data obtained from the tests were analyzed using the computer software; Statistical Package for the Social Sciences (SPSS). Generally, the process of analyzing data would test the effectiveness of the teaching and learning modules only. Inferential statistical analysis was used to analyze the data obtained. First, paired t-test was used to determine whether there was any significant difference or significant improvement between the pre-test mean score and post-test mean score for the control and experimental groups. Next, the independent samples t-test was used to compare the results obtained from the post-test and to determine whether there was any significant difference between the control group's mean score and the experimental group's mean score as far as the effectiveness of the modules was concerned.

IV. Findings and Discussion

The findings and discussion are based on the research questions as stated previously.

Is there a significant improvement in the students' understanding of the calculus topics for the control and experimental groups based on the pre and post tests?

Table (2) shows the results of paired t-test to see whether there is a significant improvement in the students' understanding of the calculus topics for the control and experimental groups based on the pre and post tests.

TABLE II. Paired t-test results For The Control and Experimental Groups

Group	N	Diff. of Mean	STD	Sig (2 tail)	paired-t value
Experimental	25	34.7	15.721	0.000	12.017
Control	25	7	5.213	0.0039	2.771

TABLE (2) shows the mean score and standard deviation obtained for the experimental group was 34.7 and 15.721 respectively. The p-value obtained was less than the significance level of 0.01 and thus the null hypothesis was rejected. This showed that there was a significant improvement in the students' understanding of the calculus topics for the experimental group. This also showed that the use of teaching and learning modules could help in enhancing student's understanding. Thus, it can be concluded that the usage of modules could help in improving students' understanding. For the control group, the results also showed a significant improvement in the students' understanding of the calculus topics based on the pre and post tests with a p-value equaled 0.0039 (which was less than the significance level of 0.01). One of the factors that could contribute to this result was due to experienced lecturers teaching the course that enabled students' understanding of these topics to improve. However, as a whole, from the results shown, teaching and learning these topics by using modules were significantly better.

Is there any significant difference between control group's post test mean score and the experimental group's post test mean score as far as the effectiveness of the modules was concerned?

TABLE (3) shows the results of independent samples t-test to see whether there was a significant difference in the effectiveness of using the modules in enhancing students' understanding of the calculus topics between the control group and the experimental group based on the post test.

TABLE III. Independent Samples t-test Results for Control and Experimental Group

	N	Mean	STD	t	df	Sig
				7.21	48	0.002
Control	25	26.7	12.5202			
Experimental	25	43.2	7.115			

TABLE (3) shows the post test's mean score for the experimental group was 43.2 (std = 7.115). Meanwhile post test's mean score for the control group was 26.7 (std = 12.5202). Based on the results of the independent samples t-test above showed that there was a significant difference in the effectiveness of using the modules in enhancing students' understanding of the calculus topics between the control group and the experimental based on the post-test with a significant p-value of 0.002 (which was less than the significance level of 0.01). Therefore, the null hypothesis was rejected. This gave an indication that the usage of module was significantly effective in improving comprehension of the calculus topics.

V. Conclusion

Education is an important field, where through this domain it is hopeful that a responsible and well-educated generation would emerge to lead mankind in the future. In order to achieve this goal, many things should be given attention and emphasis. One of many things that should be given attention and emphasis is to ensure that the teaching methods used by teachers are compatible with students, where the main purpose is to ensure improvement in students' understanding and achievement. Thus, the findings of this study clearly show that the teaching method using modules in learning calculus is able to improve students' understanding and enhance students' performance in academic assessments. In addition, students could experience the excitement in learning with a variety of activities throughout the teaching and learning processes. This in turn would result in a more interesting teaching and consequently we would expect our education system to create a generation of students who are smart and competitive in the future. Finally, it is hoped that this study could be a source of reference for future researchers to conduct further study which may yield more thoughtful findings that could render a significant contribution to our national education system

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