Constructivistmethod: Effects on Achievement and Retention in Analytic Geometry

Jumar Maranon Valdez

***Abstract*— This study examined the effects of the constructivist teaching method on achievement and retention of students on selected topics in Analytic Geometry particularly circle, parabola, ellipse, and hyperbola. A quasi-experimental pretest-posttest non-equivalent control group design was utilized in the study. The experimental groups were exposed to the constructivist teaching method and the control groups represented by were exposed to the conventional teaching method. Results showed that the pretest performance of the high mathematical students under the constructivist teaching method showed more students getting below the mean while those students under the conventional method had more scores centered on the mean. However, mean scores were comparable. The pretest achievement of the low mathematical ability students under the constructivist and conventional groups was slightly higher than the students of the constructivist group. In the posttest, the constructivist group showed higher scores in Analytic Geometry than the students under the conventional method. Both low and high mathematical ability students in the constructivist group scored higher on their counterpart under the conventional method. The students taught by constructivist method achieved significantly better in Analytic Geometry than the students taught in convention method of teaching. However, there was no interaction effect between teaching method and mathematical ability on the performance of students in Analytic Geometry.**

***Index Terms*— constructivistmethod, analytic geometry, quasi-experimental research design**

I. INTRODUCTION

One of the thrusts of the national development program is upgrading the quality of science and mathematics education. This is in recognition of the fact that economic advancement depends on the country's competency in science and technology. The students therefore must be provided with developmentally appropriate opportunities to investigate, explore, and construct meaning for themselves in order to react and function effectively in a rapidly changing society.

The past few decades saw the conduct of researches which centered on the educational implications of the behavioristic and Piagetian views of learning as well as the information processing theory. Teaching methods such as individualized instruction, modular approach, and programmed instruction were tried in the classroom setting and found more effective than the conventional lecture-discussion method. However, in spite of these efforts to improve instruction, students' achievement in science and mathematics remained low and thus, not globally competitive. This observation is supported by the results of the Third International Mathematics and Science Study (TIMSS), conducted by the International Association for the Evaluation of Educational Achievement where the Filipino students scored low as compared to many of their international peers. Among the 39 countries studied, the Philippines ranked 37th in mathematics and 38th in science according to Swetz (2003).

For the past twenty five years of teaching mathematics, the present researcher has observed that the students had difficulties in learning concepts and processes in Analytic Geometry. More often than not, students lack the necessary mathematical concepts and principles as well as the ability to solve mathematical problems necessary to take higher mathematics subjects. The failure to acquire said skills will redound to failure in the next course. In the conventional teaching approach, the teachers expose students to the one way lecture method. The feedback is limited to results of test. This method is limited only to interactions, which seems lacking in mathematics. Thus, the teacher's knowledge of the students' problem is minimal. Students who are weak in mathematics because of their limited background remain weak because of compounding unlearned concepts which build up one after another. This is seldom checked in the conventional teaching method because the teachers will not sacrifice the whole class for a few students who could not cope with the lesson. Students take removal examinations or fail. But, their weaknesses in mathematics remain and this results to a teaching-learning situation that is a burden to both the teacher and the students.

It is for these reasons that various innovations and techniques were applied or are being tested. No single technique or approach has been proven to maximize student performance. Hence, it is an added responsibility of a teacher to select, organize and present the lessons in a developmental manner tailored to the objectives of the course and the needs of the students at the time of instruction.

Attempts must therefore be done to look for methods that can raise the level of mathematics performance. Cognizant of this need, this study focused on the effects of the constructivist teaching method on the achievement and retention of students in Analytic Geometry. Selected topics on the said subject served as the avenue for testing the constructivist approach.

Within the constructivist framework, learning is viewed as an active process of constructing meanings and linking new information with experience. Constructivism does not support the traditional definition that learning is the transmission of knowledge from expert (teacher) to novice (student). Instead,

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it suggests that learning is the interpretation of ideas through social collaboration as individual learner.

Constructivist learning theory takes the view that students construct their own beliefs and knowledge of mathematics over time and that these constructions are built upon sets of beliefs already held. In this view, significant new knowledge cannot be transmitted directly but must be constructed by the student from elements of prior knowledge.

In constructivist teaching, the students' ideas are elicited and discussed. Students are stimulated to review what they have learned and reflect on the process they went through. On the other hand, the constructivist teacher sets up problems and monitors student exploration, guides the direction of student inquiry and promotes new patterns of thinking. Classes can take unexpected turns as students are given the autonomy to direct their own explorations. Thus, the great strength of constructivism is that it leads one to think critically and imaginatively about the teaching-learning process.

Viewed in this context, the effectiveness of constructivist teaching method was tested in teaching Analytic Geometry to determine whether it can help lessen the students' difficulties in learning concepts and processes. This study was designed to support the recommendation of the Commission on Higher Education relative to the incorporation of alternative teaching methods that enhanced students' competency in mathematics.

II. STATEMENT OF THE PROBLEM

This study attempted to investigate the effects of the constructivist teaching method on the achievement and retention of students on selected topics in Analytic Geometry particularly circle, parabola, ellipse, and hyperbola.

Specifically, this study sought answers to the following questions: (1) What is the pretest performance of the students taught using the constructivist approach and the conventional approach according to mathematical ability? (2) What is the posttest performance of the students taught using the constructivist approach and conventional approach according to mathematical ability? (3) Is there a significant difference in the performance of students taught using the constructivist approach and those taught using the conventional approach? (4) Is there a significant difference in the performance of students according to their mathematical ability level? (5) Is there a significant interaction effect of teaching approaches and mathematical ability on the performance of students in Analytic Geometry?

Based on the problems which the study sought to answer, the following hypotheses were tested: (1) There is no significant difference between the performances of the students taught using the constructivist approach and those who taught using the conventional approach. (2) There is no significant difference between the performances of students according to their mathematical ability level. (3) There is no significant interaction effect of teaching approach and mathematical ability on the performances of students in Analytic Geometry.

III. METHODOLOGY

A. Research Design

A quasi-experimental pretest-posttest non-equivalent control group design was utilized in the study. The experimental groups were exposed to the constructivist teaching method and the control groups represented by were exposed to the conventional teaching method. There was a replication for each experimental and conventional group in order to have consistency in the result of the experiment. Before the start of the treatment, the experimental and control groups were given a pretest. After the treatment, the groups were subjected to a posttest to determine the achievement of the students in Analytic Geometry.

B. Subjects of the Study

The study utilized two intact classes of first year students from two different colleges of Tarlac State University, Tarlac City currently enrolled in Analytic Geometry. The colleges used in the study were the College of Engineering and College of Architecture and Fine Arts. The average enrollment per class was forty. College of, Architecture and Fine Arts composed the experimental classes that were exposed to the constructivist teaching method while the College of Engineering composed the control classes that were subjected to the conventional method .

C. Instruments

Pretest/Posttest in Analytic Geometry consisted of 25 multiple-choice items with four options. It covers the following topics: circle, parabola, ellipse, and hyperbola. The format chosen was mainly of a multiple-choice character to facilitate the categorization of responses, which was necessary in order to see whether students change their options. The test was administered to the students in both experimental and control classes at the start and end of the experiment. To determine the subject retention of the students, the same test will be given two weeks after the treatment period.

The number of items per topic was based on the prepared table of specifications and specified in the course syllabus. The specific objectives attained were knowledge, comprehension, application, and analysis. The teacher-made test was used as a measure of the entry behavior of the respondents (pretest and was utilized too, to measure the performance of the students (posttest) after the treatment.

The test was content validated by five mathematics instructors/professors of Tarlac State University who have been teaching the course for at least five years for comments and suggestions. In addition, experts on curriculum and in test construction were requested to evaluate the test. Corrections, improvements and suggestions were considered.

First, the 40-item multiple-choice test with four options was administered to the randomly chosen students of Tarlac State University who had taken Analytic Geometry during the

second semester of the preceding school year. Results were subjected to item analysis where the difficulty and discrimination indices of each item were computed.

Based on the results of the item-analysis, the test was revised to come up with the second version of the test and in accordance with the table of specifications. Only 25 items were included in this version. The test was then administered to another group of students chosen at random who have finished the course to determine the exact time allotted. Using Kuder-Richardson Formula 20, the coefficient of reliability was found to be 0.77 which indicates the test results have adequate reliability.
The mathematical ability was measured using the average final grade of the respondents in College Algebra and Plane Trigonometry. It was adopted to classify the students' mathematical ability into high and low categories. Students whose average final grades were between 2.00 to 2.50 were considered as high mathematical ability and students whose average final grades were between 2.51 to 3.00 were considered as low mathematical ability.

D. Procedure of the Experiment

The study started in the middle of the second semester of the School Year 2000-2001. Several weeks prior to the treatment period, the researcher asked permission from the President of Tarlac State University for the conduct of the study. Lesson plans and research instruments were prepared in both experimental and control classes.

The mathematical ability data were taken from the Office of the University Registrar two weeks before the start of the treatment. Followed by the pretest a week before the formal start of the experiment which was administered by the researcher herself and with the assistance of some instructors.

In constructivist teaching approach the general teaching method was adopted from Driver's (1986) strategy. This was used in teaching the experimental classes. The role of the teacher in this approach was facilitator of learning. Some of the strategies involved posing of problems or tasks, encouragement of reflections, and the ability of the teacher to plan and create situations of learning so that there will be an interactive communication between students and teacher. The communication is such that it leads students to modify their existing knowledge and construct meaningful learning. The phases of constructivist teaching approach were orientation, elicitation, discussion, application and summary and review.

The conventional teaching approach was used in teaching the control classes. During the lecture period, the instructor did the presentation of the lesson, gave lecture, exercises, assignments, problem sets and occasionally asked questions. She tried to answer all questions asked by the students and encourage the students to make all the requirements. The knowledge and the skills gained by the students depended mainly on the inputs of the instructor.

The lesson plans for experimental classes involved students opportunities to discover, generalize concepts, and derive formulas. The objectives of the lesson plans prepared based on the nature of the subject matter vis-á-vis the domains of learning. The final form of the lesson plans were shown to education specialists for comments and suggestions. At the end of every lesson, students in the experimental class were asked to answer the worktexts and submit this to the researcher. The worktexts were not graded. Quizzes were also given in both groups after every chapter discussed. Results were recorded to compute the students' grade in Analytic Geometry and the time spent was not included to the activity. For every lesson, both groups consumed one and a half hours.

The experiment lasted for six weeks and the intact classes were not informed of the on going experiment. The Accrediting Agency of Chartered Colleges and Universities of the Philippines' (AACCUP) observation form was adopted to determine the observable teacher behaviors in both experimental and control groups. After the last lesson was done, the posttest was administered using the same test to measure the performance of the students on the topics in Analytic Geometry.

To minimize the effect of teacher and time element factors in the experiment, the researcher taught the four groups. Contamination among the groups was avoided since the four colleges were located on different campuses.

E. Statistical Treatment of Data

The mean, standard deviation, skewness, kurtosis, and coefficient of the variability were used to describe the distribution of the scores of the students in both pretest and posttest for the mathematical ability groups and the treatment groups. These descriptions were accompanied by the histograms of the distributions with the normal curved imposed.

The Two-Way Analysis of Covariance was used to determine the significance of the difference between the high mathematical ability and low mathematical ability groups and between the treatment and control groups in terms of their performances in Analytic Geometry. Pretest scores were used as covariate.

In testing the hypothesis, the level of significance was set at an alpha level .05. All the results were processed using the SPSS at the University Research Office of the Tarlac State University.

IV. RESULTS AND DISCUSSION

A. Pretest Performance According to Mathematical Ability

The subjects of the study were selected and classified according to mathematical ability and the randomly assigned to the two approaches in teaching Analytic Geometry. There were 58 low mathematical ability students assigned to the constructivist group while 55 students were assigned to the conventional group. There were 26 high mathematical ability students assigned to the constructivist group while 21 students were assigned to the conventional group. Table 1 shows the pretest performance of the low ability and high ability groups assigned to the constructivist and conventional approaches.

TABLE 1
PERFORMANCE OF THE LOW AND HIGH MATHEMATICAL ABILITY GROUPS IN THE PRETEST

Statistics	Low Mathematical Ability		High Mathematical Ability	
	Constructivist Approach	Conventional Approach	Constructivist Approach	Conventional Approach
Highest Score	10	11	15	12
Lowest Score	5	3	5	4
Mean	6.72	6.85	8.89	7.86
Standard Deviation	1.25	2.14	2.29	2.43
Skewness	0.33	0.67	0.72	0.07
Kurtosis	-0.55	-1.00	0.89	-0.82
Coefficient of Variation	1.57	4.57	5.23	5.93
Number of Respondents	58	55	26	21

The pretest performance of the low ability groups assigned to the constructivist group obtained a mean of 6.72 with a standard deviation of 1.25. The distribution has a positive skewness of 0.33 indicating more scores below that above the mean. It has kurtosis of -0.55 which reveals that the distribution is platykurtic, that is, the scores were widely spread about the mean. The distribution has a coefficient of variability of 1.57%. On the other hand, the pretest scores of the conventional group had a mean of 6.85 with a standard deviation of 2.14. It is skewed positively by 0.67 which indicate that the distribution has more scores below that above the mean. Its kurtosis which is -1.00 indicates a widely spread distribution. This is shown also by the coefficient of variability of 5.93.

The pretest performance of the high mathematical ability group assigned to the constructivist group obtained a mean of 8.88 with a standard deviation of 2.29. The distribution has a positive skewness of 0.72 which indicates that there are more scores below than above the mean. The positive kurtosis of 0.89 implies a clustering of the scores close to the mean – the distribution is leptokurtic. The distribution has a coefficient of variability of 5.23. On the other hand, the conventional groups obtained a mean pretest score of 7.86 with a standard deviation of 2.43. The distribution of scores is only slightly positively skewed by 0.07 indicating an almost symmetric distribution of scores on both sides of the mean. Its kurtosis of -0.82 describes a widely spread distribution of scores about the mean.

B. Posttest Performance According to Mathematical Ability

The different groups were exposed to the assigned teaching approaches. After the experiment, the posttest was administered. The results were summarized in Table 2.

TABLE 2
PERFORMANCE OF THE LOW AND HIGH MATHEMATICAL ABILITY GROUPS IN THE POSTTEST

Statistics	Low Mathematical Ability		High Mathematical Ability	
	Constructivist Approach	Conventional Approach	Constructivist Approach	Conventional Approach
Highest Score	18	18	19	15
Lowest Score	8	7	7	6
Mean	11.91	10.22	13.96	11.14
Standard Deviation	2.81	2.62	3.05	2.39
Skewness	0.26	0.76	-0.65	-0.14
Kurtosis	-0.76	0.11	0.69	-0.45
Coefficient of Variation	7.87	6.88	9.32	5.73
Number of Respondents	58	55	26	21

The posttest performance of the low ability groups assigned to the constructivist group had a mean performance of 11.91 with a standard deviation of 2.81. The distribution is positively skewed by 0.259 indicating more scores below than above the mean. It has a kurtosis of -0.760 which reveals that the scores are more widely spread about the mean than in a normal distribution. The conventional groups obtained a mean 10.22 with a standard deviation of 2.62. The distribution is positively skewed by 0.76 and has a slight kurtosis of 0.11 which indicates that the distribution is slightly more peaked than normal.

The posttest performance of the high ability groups assigned to the constructivist group obtained a mean of 13.96 with a standard deviation of 3.05. It has a negative skewness of 0.65, indicating more scores above than below the mean. Its kurtosis is 0.69 which indicates that there is a clustering of the scores close to the mean. The conventional group had a mean performance of 11.14 with a stand deviation of 2.39. It has a negative skewness of 0.14 which implies that there are more scores above than below the mean. The skewness of -0.45 reveals that the scores are widely distributed about the mean.

C. Effects on Treatment on Distribution Characteristics

The application of the constructivist approach on the low mathematical ability students has affected the distribution characteristics. The group mean increased from 6.72 to 11.91 with an increment of 5.11. Its standard deviation is increased

from 1.25 to 2.81 which, together with the increased in the coefficient of variability form 1.57 to 7.87 indicated that the constructivist approach made the performances of the low mathematical ability group more variable.

There was no significant difference in the Analytic Geometry performance of the low and high mathematical ability students as indicated by a F-ratio of 0.43 which has a probability of 0.51. There was no significant difference between the interaction effects of the mathematical ability and teaching approach on the Analytic Geometry performance of the students at the .05 level of the significance as shown by the F-ratio of 0.09 with a significance of 0.77. The adjusted mean performances of the conventional and constructivist groups were 10.29 and 12.72, respectively with a difference of 2.43. Hence, this difference is significant at the .05 level.

V. CONCLUSIONS

The pretest performance of the high mathematical students under the constructivist teaching approach showed more students getting below the mean while those students under the conventional approach had more scores centered on the mean. However, mean scores were comparable. The pretest performance of the low mathematical ability students under the constructivist and conventional groups was slightly higher than the students of the constructivist group.

In the posttest, the constructivist group showed higher scores in Analytic Geometry than the students under the conventional approach. Both low and high mathematical ability students in the constructivist group scored higher on their counterpart under the conventional approach. The students taught by constructivist approach achieved significantly better in Analytic Geometry than the students taught in conventional approach of teaching. However, there was no interaction effect between teaching approach and mathematical ability on the performance of students in Analytic Geometry.

VI. RECOMMENDATIONS

This study showed that the constructivist teaching approach influenced the performance of the students in Analytic Geometry on circles, parabola, ellipse and hyperbola. Hence, Mathematics teachers should employ the constructivist teaching these topics to improve the performance of the students on the course. The school administrators and subject coordinators should encourage the use of innovative approaches like the constructivist approach in teaching mathematics and other subjects. Training in the use of the constructivist approach for the mathematics should be conducted by the school as a part of the faculty development program. Time allotment for mathematics subjects should be increased to one and a half hours to be able to improve mathematics performance by increasing exercises and problem sets. Replication of the study in other subjects should be conducted to find out if this approach is also viable in other subject areas.

AUTHOR PROFILE

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