

INVESTIGATIVE LEARNING MATERIAL AND ITS EFFECT ON STUDENTS' ACHIEVEMENT IN COLLEGE ALGEBRA

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ABSTRACT: This paper reports the effects of developed investigative worktext on students' achievement in College Algebra. The study utilized two intact classes who were randomly treated as experimental and control groups. The researchers employed a quasi-experimental pretest and posttest control group design to determine the effectiveness of the use of investigative worktext on students' achievement in College Algebra. The quantitative data gathered were analyzed using Analysis of Covariance (ANCOVA). The results revealed that the students who were exposed to the investigative worktext significantly outperformed those who were subjected to the lecture-discussion method. Researchers infer that investigative worktext has improved the conceptual understanding and processes of students.

Keywords: Investigative worktext, achievement, retention, collaborative, investigation

1.0 INTRODUCTION

The mathematics achievement of students is one of the essential concerns of mathematics educators. Mathematics educators take a significant role in the development of the mathematical understanding and skills of students. Their key function as an architect of students' mathematical competency is to provide a favorable classroom atmosphere that can promote a better understanding of mathematical theories and concepts. Teachers must provide learning activities that will motivate students to engage in their learning process to achieve mathematical excellence. [1] claimed that administrators, teachers, researchers, and parents commonly concur that teachers are the critical contributory factors to student achievement. Moreover, [2] claimed that differences in mathematics instructions lead to significant differences in student achievement. That is, the quality of teacher instruction in mathematics has a significant effect on students' achievement.

Advocates of mathematical investigation believed that investigation is an ideal vehicle for developing students' mathematical knowledge and competencies. A mathematical investigation is a thought-provoking activity [3] since it provides a context for the development of mathematical literacy. This approach develops students to engage and explore different mathematical tasks. This also provides students the opportunity to analyze situations, explain their thinking, reason out, and justify their answers which are indicators of mathematical understanding and competency [4]. Investigations are designed to be explored collaboratively by students [5]. Moreover, mathematical investigations are contextualized through problem-solving tasks where students can make conjectures, test ideas, and generally can defend their answers [6]. Engaging students in mathematical investigations are suggested to be used in class because it is believed to be an effective approach to facilitating students' mathematical learning. It can optimize students' potential to grasp the processes of learning thus making them analytical and critical thinkers instead of passive learners [7].

This study is anchored on the theory of discovery and inquiry approach to learning. [8] stressed that students are more likely to retain information and expand their thinking abilities if they are allowed to ask, investigate, discover, create, share and reflect on ideas. [9] claimed that non-

traditional approach like inquiry-based teaching provides benefits to students. Hence, mathematics students need to be engaged in inquiry-oriented experiences because it develops their mathematical reasoning when exposed to different problem-solving tasks, increases their flexibility in approaching and evaluating solutions, and promote a greater understanding of the language of mathematics. Investigative teaching materials are appropriate tools to support and enhance inquiry-based teaching methods because these allow students to develop their pattern of assimilation of concepts. This study is also anchored on the theory of collaborative work. Collaborative learning is the process of gaining information or learning a concept through the help of peers or a group of learners. It is believed that the concept is easily understood if it is discussed through the combined efforts of students. [10] his theory of Zone of Proximal Development (ZPD), emphasized that in a social environment the students can learn and understand the concept through collaboration or guidance of a more learned individual or capable peers. Moreover, it is also anchored in the theory of learning by doing. [11] advocated that learning by doing helps students learn the concepts better than just being told. Students are engaged to learn using an investigative process and solve a problem that requires them to hypothesize, ask questions and discuss topics. It provides opportunities for students to work together and share ideas with colleagues in groups to solve problems.

Given the theories mentioned, this study was undertaken to develop students' mathematical competencies and presupposed that the utilization of Investigative Worktext in teaching College Algebra may help improve students' achievement. The material provides mathematical tasks which collaboratively engage students in the processes of learning. It requires them to investigate, discover patterns, and formulate conjectures about the concepts studied. It allows students to gain insight into the concepts through pedagogy in the text. Hence, this study explores the influence of investigative worktext on students' achievement in College Algebra, and if this investigative learning material is capable of improving students' achievement.

2. METHODOLOGY

2.1 Research Design

This study used the quasi-experimental pretest and post-test control groups designed to determine the effectiveness of the use of investigative learning material on students' achievement in College Algebra. The pretest and posttest were administered to two intact classes who were randomly selected as experimental and control groups.

2.2 Research Instruments

The researcher developed a 50 - item achievement test on selected topics in College Algebra with a table of specifications as a guide in the construction of the test items. The topics included the following: Algebraic Expressions, Laws of Exponents, Polynomials, Addition and Subtraction of Polynomials, Product of Polynomials (Distributive Property and Special Products), and Factoring. The test was shown to fellow mathematics teachers and advisers for corrections, comments, and suggestions. The test was tried out for validation by a group of College Algebra students who were enrolled at NMSCST during the second semester of the collegiate year 2014-2015. The test result was corrected and item analysis was done. Out of the 50 items only 31 were considered good items with a reliability coefficient of 0.72.

2.3 Research Participants

The participants of the study were 62 BS in Information Technology students who enrolled in the College Algebra course during the first semester of the school year 2015-2016 at Northwestern Mindanao State College of Science and Technology (NMSCST). The researcher utilized two intact classes that were randomly assigned as experimental and control groups. The experimental group was composed of 31 students who were exposed to the utilization of developed Investigative Worktext in teaching College Algebra while the control group was also composed of 31 students who were subjected to the lecture-discussion method without Investigative Worktext in their College Algebra classes.

2.4 Data-Gathering Procedure

At the start of the experimental period, the researcher-made achievement test was administered to both the experimental and control groups as their pretests. The test was given during their respective class schedules. The students were given one hour and thirty minutes to answer the achievement test. After administering the test instruments, College Algebra instructions started for both groups in their respective class schedule where the researcher handled both classes. The lessons taken by the two groups for the whole duration of the experiment were the same. In the control group, the students were subjected to the lecture-discussion method of teaching with a commercialized non-investigative algebra book as a reference. The teacher-researcher gave lectures to the class, discussed the definition of terms, illustrated the concepts, and gave examples of the application of concepts and processes. After conducting lectures, the students were given exercises and were asked to do such as seatwork. They were allowed to ask for further clarifications from the teacher regarding their lessons if they wanted clarification of ideas, and a teacher-student discourse took place in the class. The students were given more mathematical problems as their seatwork and assignment to master the College Algebra concepts introduced by the teacher. Quizzes were given after doing seatwork and instruction. The concept coverage

in the control group was the same as in the experimental group. While, in the experimental group, the students were exposed to the utilization of the developed Investigative Worktext. The class was divided into groups composed of three to four members for them to work collaboratively on the mathematical tasks stated in the learning material. Each group was composed of heterogeneous students with one of its members being a fast learner and was tasked to apply scaffolding in the learning process. Each student in the group was provided with a copy of the topic in the Investigative Worktext every time a new lesson is introduced. Each member also was allowed to act as a leader, recorder, or timer for every mathematical investigation they made. They worked as a team in investigating the illustrations in the work text, shared their ideas, discovered formulas or patterns, and formulated their definitions of mathematical concepts as stated and asked in every lesson. The students were also given a specific time for group investigation and oral presentation. After the group activity, the oral presentation of their outputs to the class took place. The teacher-researcher facilitated the class discussion and acknowledged the group member to answer the moral question. The teacher did not give a lecture; however, she checked the students' misconceptions about some College Algebra concepts. After the class interaction and discourse, the quiz was given to students to be answered individually. After all the topics specified in the experimental period were discussed, the posttest achievement test was administered to both groups.

3.0 RESULTS AND DISCUSSION

The analyses and interpretations of the student's pretest and posttest scores in the achievement test in College Algebra revealed the following findings:

Table 1: Mean and Standard Deviation of the Pretest and Posttest of Students' Achievement Test Scores in College Algebra

Groups	n	Pretest		Posttest	
		Mean	SD	Mean	SD
Control	31	8.81	3.26	13.13	4.20
Experimental	31	11.42	4.57	18.77	6.06

Perfect Score:31

Table 1 shows the mean and standard deviation of the pretest and posttest of students' achievement test scores in College Algebra. It can be noted that the experimental group obtained a pretest mean score higher than the control group with a difference of only 1.61. This means that the gap between their scores is not very far and that the two groups are comparable because the ratio of the variance is less than the critical value at 0.05 level. In the posttest, the two groups exhibited an increase in their mean scores. The increase of those who were exposed to investigative worktext is 7.35 while those taught using the lecture-discussion method is 3.32. The experimental group had a higher increase compared to the control group. It can be observed further that the scores of the experimental group are more dispersed compared to the scores of the control

group as shown in the standard deviation. This may indicate that the students who used the investigative worktext obtained different scores, that is, some of them got very high scores, average scores, and others also got very low. This means that the investigative worktext showed a varied effect on students' learning.

To determine if there is a significant impact of the use of investigative worktext on the students' mean scores further analysis was done using Analysis of Covariance (ANCOVA).

Table 2: Summary of Analysis of Covariance (ANCOVA) of the Students' Achievement Test Scores in College Algebra

Sources of Variation	Adjusted Sum of Squares	df	Adjusted Mean Squares	F - ratio computed	P-value
Treatment Between Groups	234.12	1	234.12	22.55	0.001*
Error Within	612.40	59	10.38		
Total	846.52	60			

* Significant at $p < 0.05$ level

Table 2 shows the result of the analysis of covariance of the student's achievement scores in College Algebra. The analysis yielded an F-ratio of 22.55 with a probability value of 0.001 less than the critical value at 0.05 level. This result led to the rejection of the null hypothesis. This implies that the achievement of the students in the experimental group with a mean of 18.77 is significantly higher than the achievement of the students in the control group with a mean of 13.13. The students who were engaged in collaborative investigation significantly outperformed those students who were subjected to the lecture-discussion method. This signifies that the collaborative investigation of the worktext exhibited a positive impact on students' learning processes and it is effective in improving students' achievement in College Algebra. The approach has enhanced students' performance. This result supports the findings of [12] who emphasized that when learners are allowed to construct their learning, they have better assimilation of a concept because they did deliberate efforts to make sense of the information they met in the process. They have manipulated the materials, discovered the process, and created knowledge to strengthen their understanding of concepts, learning is enhanced by social interaction since the students have the opportunity to compare and share their ideas with others thus learning occurs as students attempt to resolve conflicting ideas. Hence, in the process, students learn from each other because they have discussed multiple views and opinions on the concepts being studied. Small group discussion provides students the opportunity to test their understanding and validate their conjectures through arguments with peers.

4.0 CONCLUSION

Based on the findings, the study concluded that the utilization of investigative worktext in teaching College Algebra is effective in improving students' achievement and in enhancing students' retention of concepts and processes. Collaborative investigation positively impacts students' assimilation and retention of concepts.

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