UNIVERSITY OF THE VIRGIN ISLANDS

GRADUATE PROGRAM

THE EFFECT OF DAILY WRITING IN MATHEMATICS ON THE MATHEMATICS ACHIEVEMENT OF FOURTH GRADE STUDENTS AT THE PEARL BYRD LARSEN ELEMENTARY SCHOOL ON ST. CROIX

A THESIS SUBMITTED TO

THE GRADUATE STUDIES COUNCIL

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF

MASTERS OF ARTS

BY

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ST. CROIX, VIRGIN ISLANDS

MAY,1993

THE EFFECT OF DAILY WRITING IN MATHEMATICS ON THE MATHEMATICS ACHIEVEMENT OF FOURTH GRADE STUDENTS AT THE PEARL BYRD LARSEN ELEMENTARY SCHOOL, ON ST. CROIX

Abstract

The purpose of this study was to investigate the effect of daily writing in mathematics on the mathematics achievement of fourth grade students at the Pearl Byrd Larsen Elementary School on St. Croix. Fifty subjects participated in the study. During the seven weeks of this investigation, fourteen mathematics objectives were taught to the participants through the use of textbooks, worksheets, lectures by the teacher, and manipulatives. Additionally, the experimental group engaged in a variety of writing activities. They wrote definitions, analyzed errors, and listed the procedure for solving problems. Pre- and posttests were administered and the Analysis of Covariance (ANCOVA) was used to determine the significance of difference between group means. The level of significance was set at .05. The independent variable was type of math program and the dependent variable was mathematics achievement. This study was a nonequivalent control group quasi-experimental design. The null hypothesis stated that there was no significant difference between the mathematics achievement of fourth grade students who engaged in daily writing and those who did not. Although the non-treatment group began with a higher mean score, the experimental group showed greater mean gains in the end. As a result, the null hypothesis of this study was rejected. The researcher concluded that writing is an effective strategy for the improvement of mathematics skills.

To My Precious Children
Cleon and Nahvia
Who Love Me Unconditionally
Even When the Demands of My Studies
Made Me Seem Nonexistent

ACKNOWLEDGEMENTS

I have always heard that "force makes water go up hills". I have just proven that love, support, and encouragement can take a person to even greater heights. It is with sincere appreciation that I thank these persons who have helped me conquer this mountain - my thesis.

My greatest thanks is to you Almighty Father. This is a task that I know could not come to fruition without your continued presence. I express my deepest gratitude.

Dr. Anita Plaskett, my advisor, you cannot imagine how much you have affected my life. You have opened flood gates that I cannot close, even if I wanted to. My profound thanks to you for the invaluable guidance you gave thoughout this study.

In my most frustrating hour you decided to be my second reader. You have been an extremely thorough second reader. Thank you, Dr. Ruth Beagles.

Dr. Gary Harold, you commented on one of my research papers that I wrote well. I believed you and was encouraged to do this study. Thank You.

Lyrhea Bryan and students, this study could not have been conducted without your cooperation. My heartfelt thanks to you.

My sincere thanks to Mr. George Hampson and Iris O'Donaghue, principal and assistant principal respectively, of the Pearl B. Larsen Elementary School, for allowing and supporting this study.

Thank you, Mr. Dindial Birbahadur, for your expertise in calculating the statistics of this study.

To the 1992-1993 students of Room 109 at the Pearl B. Larsen Elementary School, it was you who proved to me that writing in mathematics is effective. You have changed my philosophy of math forever. Thank you.

A warm thank you is expressed to the very able monitors of the computer lab. Thanks for service with a smile.

Elise Meiread Frederick, my mother, my mentor, you have taught me the true meaning of sacrifice. I will be forever grateful for the love, support, and encouragement you continuously give.

To all my sisters and brothers, in particular Ermyn Frederick, Clive Gumbs, and Ciceley Burke, you have always made me feel I can do the "impossible". Thanks for your love and unwavering confidence in me.

Germaine Gumbs, my darling niece, thank you for giving up your word processor for months on end. I appreciated it immensely.

Clinton Henry, my husband, I cannot express my gratitude enough for the overwhelming support you gave throughout my studies. My heartfelt thanks to you.

It is with deepest gratitude that I thank Cleon and Nahvia, my children. You have been my greatest sacrifice. Thank you for understanding why I was absent so often.

Finally, to all my friends, especially Hannah Gibbs and Sandra Cannonier, your laughter lightened the burden on many occasions. Thank You!

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CHAPTER ONE

INTRODUCTION

Mathematics, says Websters' Dictionary, is the science of numbers and their operations, interrelations, combinations, generalizations, and abstractions; and of space configurations and their structures, measurements, transformations, and generalizations. That functional definition, according to Kober (1991) however, fails to capture the importance of mathematics to world culture and human endeavor. On the other hand, it seems to support an erroneous view of mathematics held by many students and teachers - a view that may have a negative effect on these persons' attitude towards the discipline and ultimately their approach to its teaching and learning.

Borasi and Seigel (1989) report that most students perceive mathematics as a dualistic, rigid discipline, where results are always univocally determined and there is no space for personal judgement, values, and taste. As a result, the authors explain, these students interpret their role as mathematics students as essentially acquiring facts and algorithms that can immediately be applied to the solution of problems. Borasi and Seigel (1989) feel that few students expect mathematics to be a meaning making process, and fewer see it as a creative undertaking.

Kober (1991) states that as a result of teachers' erroneous perception of mathematics, students have been taught math as a collection of disjointed facts and formulas to be practiced, memorized, and regurgitated in the form of right test answers. Kober (1991) is convinced that these practices are responsible for the poor mathematics achievement of students in the United States of America (USA). She supports Borasi and Seigel (1989) who sense the need for strategies which will help students understand mathematics as a more humanistic discipline. In recent years, writing has been advocated as an effective strategy for the acquisition of knowledge and skills in the mathematics classroom (Kenyon, 1988).

In March of 1989, the National Council of Teachers of Mathematics (NCTM) published its Curriculum and Evaluation Standards of School Mathematics. In the middle grade section of Standard 2, the authors state, "The ability to read, write, listen, think creatively, and communicate about problems will develop and deepen students' understanding of mathematics" (p. 78). In the high school section of Standard 2, the authors continue with, "It is not enough for students to write the answer to an exercise or even to 'show all their steps.' It is equally important that students be able to describe how they reached an answer or the difficulties they encountered while trying to solve a problem" (p. 140). In the NCTM Standards for Teaching Mathematics, part of the "teacher's role in discourse" is "asking students to clarify and justify their ideas orally and in writing" (p. 35).

Wason-Ellam (1987) also sees writing as an important component in the learning of mathematics. She feels that this type of communication is important to foster in the classroom context since it is one of the primary means students have of personalizing their knowledge. The author cites Smith (1982) and Mayer and Lester (1983) who elaborate on reasons for the inclusion of writing in the mathematics classroom. Smith (1982) explains that writing separates our ideas from ourselves in a way that is easiest for us to examine, explore, and develop. Mayer and Lester (1983) believe writing gives the students an awareness and control of their thoughts. They maintain that it allows students to hold on to ideas long enough to synthesize or to actively think about the investigation of mathematics material, and to become aware of how they consider their answers.

Other proponents present their views. Davison and Pearce (1989) state that writing about something involves many of the thought processes teachers would like to foster in their students. They explain that performing a writing task requires students to reflect on, analyze, and synthesize the material being studied in a thoughtful and precise way.

Wilde (1991) discusses writing as a thinking tool. By forcing a slowdown in thought processes, she explains, it frees the brain to play around with ideas and make new discoveries, and more fully integrate new knowledge. Wilde (1991) also supports writing in the mathematics classroom as a diagnostic tool. She expounds that in most instances, students' writing will confirm their understanding of a concept. The author further postulates that looking diagnostically at students' writing can also help teachers evaluate their teaching.

As the literature reiterates, writing in the mathematics classroom can be quite beneficial for both teachers and students. In spite of this information however, research has not been conducted in the United States Virgin Islands on the effect of writing on mathematics achievement. Though this type of writing has been a rare occurrence, it is worth investigation.

Statement of the problem

According to Mullis, Dossey, Owen, and Phillips (1991), the mathematics skills of our nation's children are generally insufficient to cope with either on-the-job demands for problem solving or college expectations for mathematics literacy. The authors claim that though business and industry spend billions of dollars in training and colleges and universities devote large amounts of resources to remediation, the USA is still having difficulty maintaining its competitive edge in the global market. They further state that not only are students generally ill-equipped to cope confidently with mathematics demands of today's society, in addition, relatively small numbers of students persevere in the study of higher mathematics. For example, of the nearly 10 million secondary students who study mathematics each year, explain Mullis et al. (1991), fewer than 800 eventually receive doctorates in the mathematical sciences, and this number has been declining since the 1970s.

Travers, McKnight, and Dossey (1985) reveal that the performance of U.S. students on international tests of mathematics achievement continues to lag. They point out that the United States precalculus students achieve at a level that is substantially below the internationally mean score for all countries in the study and in some cases are ranked with the lower one-fourth internationally. Their review also showed that only about 15% of the nation's high school students were enrolled in college preparatory mathematics classes.

Medrich and Griffith (1992) found that the United States ranked 11th of the 15 countries compared in the Second International Mathematics Study (SIMS). The highest mean score of the countries studied was 71%, but the USA's mean score was 29%.

The picture seems dismal even when mathematics proficiency of individual grade levels is revealed. Mullis et al. (1991) found in a 1990 study of mathematics proficiency by the National Assessment of Education Progress (NAEP), that only 14% of the eighth graders consistently demonstrated successful performance with problems involving fractions, decimals, percents, and simple algebra. No eighth graders showed the breadth of understanding necessary to begin the study of relatively advanced mathematics. In addition, the authors discovered that 46% of 12th graders demonstrated a consistent grasp of decimals, percents, fractions, and simple algebra, and only 5% showed an understanding of geometry and algebra that suggested preparedness for the study of relatively advanced mathematics.

The mathematics achievement of students in the United States Virgin Islands is just as disheartening. In a study comparing the overall mathematics proficiency of the United States and its territories, the Virgin Islands ranked last (Mullis et al., 1991). The study revealed that 11% of Virgin Islands students attained Level 250 on the NAEP's scale which consist of material introduced by seventh grade. In addition, the study disclosed that none of our students achieve Level 300 and above, levels which contain material generally covered in high school in preparation for the study of advanced mathematics.

Another report published in June 1991 by the Education Testing Services, Princeton, New Jersey indicates that the average proficiency of eighth grade public school students from the United States Virgin Islands on the NAEP mathematics scale is 218. This proficiency is lower than that of students across the Nation whose average is 261. According to the report, "at a 218 average, it means the students' skills are just beyond simple additive reasoning and problem solving with whole numbers" (p. 24).

The Metropolitan Achievement Test (MAT6) results also reflect low scores for the United States Virgin Islands' students. Furthermore, in comparing school districts in the Virgin Islands, St. Croix school results were found to be significantly lower than that of St. Thomas (Boyd & Weiss, 1990).

Miller (1991) is positive that our nation's mathematics ineptitude stems from students' and teachers' perception of mathematics and the way mathematics is taught and learned. The author concluded from her studies that students perceive the discipline as a subject in which answers are right or wrong. They view the teacher as the authority figure whose responsibility it is to pass on knowledge to students. To these students doing mathematics consists of memorizing rules and plugging new numbers into old formulas.

Kober (1991) believes this is the core of the problem. The author is concerned that in too many schools, "mathematics is taught in a fragmented, dry, and watered down way that saps it of power, beauty, and practicality" (p. 8). She emphasizes that mechanics without meaning does not enable children to visualize relationships that make mathematics interesting, elegant, and logical. Kober (1991) further reasons that if students forget the mechanical procedure they have nothing to fall back on. By contrast, she continues, when students understand the why behind something, they remember facts longer, use them more readily and apply their knowledge to learning new tasks.

Borasi and Seigel (1989) also see the teaching strategy as a part of the problem. They suggest that greater emphasis should be placed on the process of doing mathematics rather than on the product.

Archambeault (1991) attributes the problem to our society's tolerance of a lack of knowledge in mathematics. She is outraged that people smile in sympathetic understanding as an adult states that he or she can never accurately balance a checkbook. The author is convinced that these same people would be horrified if an adult stated that he or she could never accurately read a newspaper article. Archambeault (1991) feels that this tolerance sends students an inaccurate message about the value of mathematics in our society.

In light of the evidence presented, it is apparent that our students' mathematics achievement is in need of improvement. Many researchers (e.g., Borasi & Seigel, 1989; Kenyon, 1988; Kober, 1991) advocate writing as an effective strategy for improving students' performance in this discipline. It is, therefore, essential to ask, would daily writing improve the mathematics achievement of fourth grade students at the Pearl Byrd Larsen Elementary School on St. Croix?

Purpose of the Study

It was the purpose of this study to investigate the effect of daily writing in mathematics on mathematics achievement of fourth grade students at the Pearl Byrd Larsen Elementary School on St. Croix.

Null Hypothesis

There is no significant difference between the mathematics achievement of fourth grade students at the Pearl Byrd Larsen Elementary School on St. Croix who engaged in daily writing in mathematics and those who did not.

Definition of Terms

Control Group- the conveniently sampled group which engaged in the traditional approach and the use of manipulatives, but not writing, in an attempt to accomplish 14 mathematical objectives.

D.C. Heath Mathematics- the mathematics program presently used by elementary schools in the United States Virgin Islands.

Experimental Group- conveniently sampled subjects who engaged in writing activities in addition to the traditional approach and the use manpulatives in an attempt to accomplish 14 mathematics objectives.

Mathematics Achievement- was measured by a teacher made test adapted from chapters 8 and 10 pretests and posttests of D.C. Heath Mathematics Test, Level 4.

NAEP- National Assessment of Education Progress

Traditional Approach- the use of textbooks, worksheets, and lectures by the teacher.

Treatment- the teaching of mathematics through the use of writing activities.

Theoretical Rationale

Willoughby (1990) states,

Change in mathematics is needed, not because it has recently deteriorated, nor even because it has always been bad (though it probably has been), but, rather, because the world is changing. The people who are going to solve the problems of the future - or even understand and evaluate those problems and solutions - must have a far better grasp of mathematics than most people have at present, or have ever had in the past (p. 4).

Haggerty and Wolf (1991) recommend that this change should come in the form of writing. They join the Curriculum and Evaluation Standards for School Mathematics which urge all teachers of mathematics, at all levels, to increase the amount of writing that students do in the classroom.

Archambeault (1991) discusses two aspects of the learning theory which support the integration of writing in the mathematics classroom. The theory states that for long term learning to occur the purposeful construction of mental connections between the new material and previously stored information must be made. Furthermore, the theory claims, only in the presence of active processing of material can new information be learned. Automatic processes, such as passive listening and skill practice, are not sufficient to ensure long term retention.

Archambeault (1991) explains that active processing occurs as the learner restates information, applies information in different context, interperts the information in different ways, and organizes the information to represent different points of view. She is convinced, writing exemplifies all of the above.

Sharma (1990) reports that a child's native and mathematics language play an important role in the conceptualization of mathematical ideas and in the use of mathematical information. She points out that a student may have a good grasp of the arithmetic concepts, but if he or she has difficulty in translating the English expression of the problem into mathematics formulae and equations, he or she may have difficulty in solving the problem. Likewise, the author continues, if a student has difficulty in translating mathematics equations into English language, he or she may have difficulty seeing the meaning of mathematics formulations of real life problems. In short, Sharma (1990) concludes, mathematics thinking, to a great extent, is dependent on mathematics language. She believes that if we want to help children to think mathematically, then we need to help them in the acquisition of mathematics language. According to Sharma (1990), writing provides an opportunity for mathematics language to be developed.

In the mathematics classroom, writing can be used effectively for the acquisition of knowledge and skills through the problem solving process. Asking students to write about a problem requires them to clarify thought about how they will approach the problem. This writing makes the concepts about the problem clearer and sharper (Kenyon, 1988).

Kenyon (1988) further explains that in writing, students begin to gather, formulate, and organize old and new knowledge, concepts, and strategies, and learn how to synthesize this information as a new structure that becomes a part of their own knowledge. As students write down, reflect on, and react to their thoughts and ideas, they enhance their problem solving abilities and the problem solving process becomes more effective.

Davison and Pearce (1988) support this premise. They found that when students used writing to practice mathematical tasks their comprehension of the concepts was enhanced and their ability to communicate mathematically improved. The authors believe that since many students view mathematics as a stringent program of rules, facts and figures, writing activities can involve students in useful and enjoyable mathematics activities. These, in turn, say the researchers, can encourage students to become more proficient in mathematics.

Zinsser (1989) wrote that writing frees students of the idea that math is a collection of right answers owned by the teacher. He discovered through his studies that writing forces students to think through both the math and its relationship to their own lives.

In addition to the value writing may contribute to the learning process, it can also serve as a way to stimulate dialogue between student and teacher. Miller (1991) knows that teachers do not have the time to interact with each pupil for five minutes during every mathematics period. However, she believes a five minute writing activity will provide that opportunity. Furthermore, the author explains, writing will provide an opportunity for students who will not ask questions in class to express their confusion of concepts, privately.

There is also a practical rationale for the inclusion of writing in the mathematics classroom. Archambeault (1991) is adamant that such writing not only enhances the learning of the discipline, but it is also a way of dissipating math anxiety.

The theoretical rationale of this study supports the assumption that writing in the mathematics classroom is beneficial. There is limited research however, on the effects of writing on mathematics achievement. It is, therefore, the desire of the researcher to embody the existing research through the use of collected data.

CHAPTER TWO

REVIEW OF THE LITERATURE

"The traditional view has been that students learn to write in English classes and compute in mathematics classes and 'never the twain shall meet' " (Davison & Pearce, 1988, p. 42). Though writing across the curriculum has become increasingly popular, mathematics teachers are often reluctant to integrate writing activities into regular classroom instruction (Burton, 1985). In recent years, however, this view has been changing and researchers have recommended increased writing as a means of improving students' mathematics proficiency (Altieri, 1991; Jamar & Marrow, 1990; Moore, 1991; Winograd, 1992).

Greenes, Schulman, and Spungin (1992) purport that in order for students to acquire a better grasp of mathematics they must be given the opportunity to share their thoughts with others, to brainstorm and wrestle with ideas, and to get feedback and make revisions to their initial thoughts. It is the opinion of these researchers that understanding is enhanced by communication and communication is enhanced by understanding. They are, therefore, convinced that any activity in the mathematics classroom which requires communication will help students to clarify, refine, and organize their thoughts and inevitably lead them to consider alternative approaches and solutions to mathematics problems. Such activities, the authors feel, will also help students develop facility with the language of mathematics. Greenes et al. (1992)

advocate writing as one of the means of communication by which the above can be accomplished.

Sharma (1990) too, believes that communication is important if one is to become proficient in mathematics. She explains that for a child to master a concept at its fullest, the child needs to understand it at all its levels of manifestations and at all its levels of difficulty. She further expounds that the mastery of a given mathematical concept passes from intuitive levels of understanding to the level where the child can explain how he or she has arrived at a particular result and can explain the intricacies of the concepts. Being able to write down this explanation is sound proof for the student and teacher that a given concept has been mastered.

Hosmer (1986) feels that in order for young children to develop the skills needed for clear, concise explanations, they must have a wide variety of experiences in writing. She notes that the skills developed while writing in mathematics often transfer to other disciplines.

Lauritzen (1991) agrees with this benefit of writing in mathematics. She feels that such activities pervade all aspects of learning. She further believes that stories are the most effective tools by which children can make their content meaningful and that all children benefit from the use of writing in their learning of mathematics.

Jamar and Marrow (1990) found that the inclusion of writing in the mathematics classroom provides a learning atmosphere that promotes risk taking as a natural part of learning. Miller (1991) contends that researchers have successfully used journal writing to get students to express their anxieties about mathematics and the problems they encounter in the learning process. She cites Bell and Bell (1985) who found expository writing to be an effective and practical tool for teaching problem solving. They also found that impromptu writing has been used successfully in secondary school mathematics classes.

Fennell and Ammon (1985) discovered that students solved word problems with much success when they wrote their own story problems. Winograd (1992) agrees with this finding. His study showed that fifth graders succeeded in writing math problems on a regular basis, solving their own and peers' problems, using math-related writing as an important medium of social discourse, and making connections between school math and everyday experiences.

Altieri (1992) also supports this premise. She learned that giving students the opportunity to write and solve their own math problems helped them learn to interpret problems. The author feels that this activity improves mathematics skills and helps build self-confident readers and writers.

In further agreement, Kliman and Richards (1992) explain that as students incorporate mathematics information and relationships into stories that are meaningful to them, they learn that mathematics can be used to model familiar situations and that it can help them make sense of the world around them. Most important, say the authors, these students learn that in mathematics solving problems involves alot more than performing calculations. Kliman and Richards (1992) are certain that writing helps students to focus on the meaning of the problem involved, rather than on such dilettante aspects as clue or key words.

Moore (1991) contends that math journals allow students to proceed at their own rate and coverge on an understanding of mathematics concepts using their own experiences. She believes journals can be used as diagnostic tools, both for student understanding and for teacher effectiveness. In her study, Wason-Ellam (1987) found that journal writing allowed students to reflect and generalize about experiences, thus activating prior knowledge, which is an appropriate way to begin any form of learning. She avows that journals add an alternate dimension to the learning process in content areas by allowing students to record their personal thoughts as they explore new concepts.

Wadlington, Bitner, Partridge, and Austin (1992) proclaim that when students write and share activities on a regular basis, they are motivated to be creatively and enthusiatically involved. They believe that writing about mathematical concepts help students clarify their own ideas and give teachers valuable insights into their students' thought processes. The authors are convinced that as students write in their journals they become more reflective, expressive mathematicians.

Countryman (1993), too, advocates writing in the mathematics classroom. She claims that writing helps students focus on their own learning styles, and forces them to think about what works and does not work for them. The author also feels that writing enables many students to become more responsible in class, for as they write about doing mathematics, they come to see themselves as central to the learning process.

Even in institutions of higher learning writing, is being exhorted as a valuable strategy to improve mathematics. Jack Lockhead, Assistant Dean of Natural Sciences and Mathematics at the University of Masschusetts, finds that giving writing to math students "helps clarify fuzzy thoughts" (McMillen, 1986, p. 19). According to McMillen (1986), other faculty members say that since students have engaged in writing they are more organized and logical when they answer exam questions. Still others have found that students no longer freeze up with exam phobia. McMillen (1986) concludes that writing helps students become autonomous learners, rather than waiting dependently on the teacher to give them the rule that applies.

Kober (1991) concluded from her study that writing is an especially effective way to develop conceptual and higher order thinking skills. She feels that prose writing about content information has an essential instructional role in the mathematics classroom.

Not all researchers are enthusiastic about the invasion of writing in a symbol centered classroom. Ford (1990) believes that the inclusion of this strategy in mathematics is absurd. She cannot conceive how students can learn about something as difficult as problem solving by doing something equally as difficult - writing.

Archambeault (1991) reports that some teachers have suggested that writing activities have limited application in the mathematics classroom because of the highly symbolic nature of the subject. Also, mathematics does not rely on lengthy text passages to communicate information.

Other opponents argue that allowing students the time to write in class prevents the full coverage of the prescribed math curriculum (Miller, 1991). They feel such practice certainly does more harm than good, since students would now be exposed to less mathematics content than previously. These researchers are also concerned that the evaluation of this type of writing will present much confusion since there are no set standards of evaluating writing. Finally, in rebuttal, researchers argue that writing in mathematics will unreasonably increase the work load of already overworked professionals (McMillen, 1986).

The research strongly supports the view that writing in the mathematics classroom can have great positive effects. This study has investigated the effect of daily writing on mathematics achievement. It is hoped that the results of this study will stimulate interest in this topic and will bring about changes in children's instructional programs in regard to writing and mathematics.

CHAPTER THREE

PROCEDURE

It was the purpose of this study to investigate the effect of daily writing in mathematics on the mathematics achievement of fourth grade students at the Pearl Byrd Larsen Elementary School on St. Croix.

Sampling

The population sample consisted of 50 fourth grade students from the Pearl Byrd Larsen Elementary School on St. Croix. Two groups of 25 subjects each were selected using convenience sampling. These two classes were chosen from the four fourth grade classes already established at that school.

The treatment group consisted of 14 boys and 11 girls. Four percent of the subjects were 8 years old, 56% were 9, 16% were 10, 20% were 11, and 4% were 12. The mean age of this group was 9.6 years. The mean reading level was eight, but 12% of the subjects were reading on level nine.

The control group consisted of 11 boys and 14 girls. Forty-four percent of the subjects were 9 years old, 44% were 10, and 12% were 11. The mean age is 9.7 years. The reading level of all subjects in this group was 9. Both the experimental and non-treatment groups used the same reading program - <u>Silver Burdett/Ginn World of Reading.</u>

Methodology

This experiment was a nonequivalent control group quasi-experimental design. Two existing groups were pretested, one was administered a treatment, and finally both were posttested.

The pretest was administered to check for initial equivalence of groups and to determine students' level of proficiency in each of the following objectives before the experiment began:

1. Measure and draw segments in centimeters.
2. Measure and draw segments in inches.
3. Find the perimeter of any polygon.
4. Find the area of a region.
5. Find the volume of a rectangular prism.
6. Identify cube, rectangular prism, sphere, cylinder, cone, and pyramid.
7. Identify plane figures: square, circle, rectangle, and triangle.
8. Identify and draw segments.
9. Identify parallel and intersecting lines
10. Identify rays, angles, and right angles.
11. Tell whether two geometric figures are congruent or similar.
12. Identify and draw lines of symmetry.
13. Locate a point on a grid by using a number pair.
14. Name a number pair for a given point.

For seven weeks the above objectives that students had not mastered were taught to the experimental group through the use of textbooks, worksheets, lectures by the teacher, and manipulatives.

In addition the subjects participated in a number of writing activities.

Throughout the seven weeks of this study the treatment group reflected on each day's lesson in math journals. Each subject responded in writing to the following questions for 5 to 10 minutes:

1. What were the important points in today's lesson?
2. What did I understand from the lesson?
3. What did I not understand?
4. What questions would I like to ask (the teacher) about the lesson?

After the first week, in addition to journals, the subjects were involved in other types of writing activities. For example, they:

-wrote definitions of math terms;

-analyzed the errors they made in solving their problems and wrote about their errors;

-wrote to a friend offering advice on solving a certain problem;

-wrote a short story or word problem for practice problems on given worksheets; and

-wrote the procedure for solving a given problem.

The same objectives taught to the treatment group were also taught to the non-treatment group through the use of textbook, worksheets, lectures by the teacher, and manipulatives. However, the subjects in the non-treatment group did not participate in any writing activities as described for the treatment group. In both the experimental and non-treatment groups, mathematics was taught for one hour per day for each of the seven weeks.

After the seven week period, a posttest was administered to both groups. This test was used to compare the gains of the two groups. The pretest and posttest were both teacher-made tests adapted from chapters 8 and 10 pre- and posttests of D.C. Heath Mathematics Test, Level 4. Each item on both tests were weighted the same and results were scored on a percentage basis. All tests were administered and scored by the researcher and reviewed by a second scorer.

Statistical Procedure

Analysis of Covariance (ANCOVA) was used to determine the significance of difference between group means. The level of significance was set at .05. The independent variable of this study was type of math program and the dependent variable was mathematics achievement. The covariate was the pretest. This score helped to adjust the groups' mean scores.

Control of Extraneous Variances

The pretest and posttest used in this study were of the equivalent-forms method in an effort to control pretest sensitization. Because of the duration of the study, it was not likely that maturation will affect the subjects' performance on the measure of the dependent variable. In addition, the use of the constant variables grade level, time, discipline, objectives to be taught, and number of subjects also provided control for the study. Finally, Analysis of Covariance was used to help equate initial differences in groups.

Limitations

There were limitations to this study since its participants were conveniently selected. As a result, the effectiveness that randomization has in controlling extraneous variables was absent. Further, the designer of the study also administered the treatment and only 14 specific mathematics objectives were examined. In addition, the ecological validity of the study may be low since all the subjects were associated with the fourth grade at one school. Thus, the findings may not be generalizable to other grades and schools.

Significance of the Study

It was the purpose of the study to investigate the effect of daily writing in mathematics on the mathematics achievement of fourth grade students at the Pearl Byrd Larsen Elementary School on St. Criox. It is hoped that this study will be replicated in other schools, since the collection of data on this issue is so limited in the Virgin Islands. It is also hoped that the findings of this investigation will help to dispel any misconceptions associated with writing in the mathematics classroom. Further, it is hoped that teachers and curriculum developers can use the outcomes of this study to reassess how math is taught in elementary schools. Finally, it is hoped that teachers would be encouraged to use writing as one of the strategies they employ to increase their students' mathematics achievement.

CHAPTER FOUR

ANALYSIS OF DATA

The purpose of this study was to investigate the effect of daily writing in mathematics on the mathematics achievement of fourth grade students. To this end, two groups of twenty-five subjects each were conveniently selected at the Pearl Byrd Larsen Elementary School on St. Croix. One group was administered a treatment, while the other was used as a control.

For seven weeks, one hour per day, both the experimental and non-treatment groups were taught fourteen mathematical objectives through the use of textbooks, worksheets, lectures by the teacher, and manipulatives. However, in addition to this, the subjects of the experimental group were engaged in a number of writing activities.

Prior to the commencement of the experiment, both groups were given a teacher-made pretest to check for initial equivalence of groups and to determine the level of proficiency in each objective to be taught. This covariate revealed that the non-treatment group had a higher mean score than the experimental group. Table I documents the statistical data.

Table 1

<u>Pretest Mathematics Achievement Scores</u>

GROUPS	MEAN	STANDARD DEVIATION
Experimental	10.84	5.778
Control	20.32	11.792

At the end of the seven week period a teacher-made posttest adapted from chapters 8 and 10 posttest of D.C. Heath Mathematics Test, Level 4 was administered to both groups. The pretest and posttest were of the equivalent-forms method in an attempt to control pretest sensitization. Both tests were administered and scored by the researcher and reviewed by a second scorer. The scoring was done on a percentage basis. The results of the posttest showed that there was a marked difference in the performance of the two groups. The mean score of the experimental group was higher than that of the control group (See Table 2).

Table 2

<u>Post-test Mathematics Achievement Scores</u>

GROUP	MEAN	STANDARD DEVIATION
Experimental	90.2	7.681
Control	69.76	13.132

Table 2 shows the mean score of the posttest for the experimental group was 90.2 and that of the non-treatment group was 69.76. It must be noted that although the experimental group started with a lower mean (10.84) than the non-treatment group (20.32), at the conclusion of the experiment the experimental group showed a much higher mean. The gain in mean from pretest to posttest for the experimental group was 79.36. The gain for the control group was only 49.44. This was a difference of 29.92.

An analysis of the pretest and posttest standard deviations also revealed differences in the two groups. The standard deviation for both groups increased by about the same amount from pretest to posttest (experimental- 1.903, non-treatment- 1.340). However, the experimental group, in both cases, had a smaller standard deviation implying that it was a more cohesive group in terms of mathematical achievement than the non-treatment group.

Additional differences were disclosed when the posttest was analyzed in terms of the number of subjects who received given scores. Sixteen students in the experimental group received scores 90-100, as compared to one student in the non-treatment group. Both groups had the same number (six) of students with scores 80-89. The experimental group however, had two subjects with scores 70-79, while the non-treatment group had seven. One person in the experimental group scored 60-69, versus four of the non-treatment group. None of the students in the experimental group scored 0-59, but seven from the comparative group did. Table 3 records this data.

Table 3

Distribution of Posttest Scores For Experimental and Control Groups

Scores	Experimental	Control
90-100	16	1
80-89	6	6
70-79	2	7
60-69	1	4
0-59	0	7

The Analysis of Covariance (ANCOVA) was applied to determine the significance of difference between group means. The level of significance was set at .05. A summary of the Analysis of Covariance is displayed in Table 4.

Table 4

Analysis of Covariance

SOURCE	SS	DF	MS	F
Total	10661.238	48		
Error	4903.346	47	104.327	
Treatments	5757.892	1	5757.892	55.191

The critical valve for a .05 level test with degrees of freedom (1,47) is 4.052. For significant differences to be obtained in this study the F statistic must exceed this critical value. As can be observed, the F statistic (F= 55.191) is greater than the critical value. It also exceeds the critical values at the .01 (7.31) and the .001 (12.61) levels. The researcher, therefore, concluded that there are statistically significant differences between the mathematics achievement of fourth grade students at the Pearl Byrd Larsen Elementary School on St. Croix who engaged in daily writing in mathematics and those who did not. As a result, the null hypothesis of this study was rejected.

CHAPTER FIVE

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Conclusions

Writing in the mathematics classroom has been a rarity for many decades. Recently, however, with the continued decline of our students' mathematics proficiency and the United States' increased difficulty in maintaining its competitive edge in the global marketplace, many researchers have been advocating writing as an effective strategy to improve our students' mathematics shortcomings (Jamar & Marrow, 1990; Moore, 1991; & Winograd, 1992). In fact, the Curriculum and Evaluation Standards for School Mathematics urge all teachers of mathematics, at all levels, to increase the amount of writing that students do in the classroom. This study investigated the effect of daily writing in mathematics on the mathematics achievement of fourth graders. The null hypothesis stated that the inclusion of daily writing in mathematics would make no significant differences between the mathematics achievement of students who wrote and those who did not.

The participants of this study were conveniently chosen from one school, the Pearl Byrd Larsen Elementary School on St. Croix. There were two groups of twenty-five subjects each. One group was administered a treatment; the other was used as a control. For a period of seven weeks both groups were taught fourteen mathematics objectives through the use of textbooks, worksheets, lectures by the teacher, and manipulatives. Additionally, the experimental group was engaged in a variety of writing activities.

Before the experiment commenced, both groups were given a teacher-made pretest to check for initial equivalence of the groups and to determine students' level of proficiency in each of the objectives to be taught. After the seven week treatment, both groups received a teacher-made posttest. This test and the pretest were both adapted from chapters 8 and 10 pre- and posttests of D.C. Heath Mathematics Tests, Level 4. These teacher-made tests were of the equivalence-forms method so that pretest sensitization could be controlled. An Analysis of Covariance was used to determine whether or not the results of the two groups were significantly different.

Analysis of the results revealed that there were statistically significant differences between the mathematics achievement of the participants of the experimental group and those of the non-treatment group. The mean score of the experimental group was 90.2, and that of the non-treatment group was 69.76. In isolation, this difference was quite remarkable, but when compared to the mean scores for the pretests (experimental group, 10.84; non-treatment group, 20.32) it was even more significant. This result indicated that the experimental group had increased its mean score by 79.36 points, while the non-treatment group had increased by only 49.44 points. The F statistic of this study ($F=55.191$) exceeded the critical values at the .05 (4.052), the .01 (7.31), and the .001 (12.61) levels.

Based on the results of this study, the null hypothesis was rejected. The experimental group not only substantially increased its mean score, its standard deviation also remained small. In seven weeks these students were able to make mean gains beyond that of the non-treatment group although the non-treatment group started with a higher mean score. Since the primary difference in the teaching of the objectives was daily writing, the gains of the experimental group can only be attributed to this treatment.

The results of this study exemplify the claim of Davison and Pearce (1988) who reported that when students use writing to practice mathematics tasks their comprehension of concepts is enhanced. The results also support the belief of Wadlington et al. (1992) who claim that as students write in their math journals they become more reflective, expressive mathematicians. Although the early writings of the experimental group were vague and unpretentious, the latter writings were more detailed and mathematically sophisticated (See Appendix F).

Miller (1991) supports journal writing in the mathematics classroom because it provides the teacher with an opportunity to interact with students on a regular basis. Moore (1991) contends that such writings can be used as diagnostic tools, both for student understanding and for teacher effectiveness. The researcher of this study proved both claims to be true. As the daily responses were read, the researcher was able to analyze students' thought processes and make needed corrections on a regular basis. The students were able to correct their misconception about the mathematics skills in the early stages of their learning. Thus, these students of the experimental group had little or no opportunity to transfer a misunderstood concept to their long term memory. This type of daily diagnosis undoubtedly contributed to the favorable results of this study.

The findings of this study also concur with the report of Sharma (1990) that a child's native and mathematical language play an important role in the conceptualization of mathematical information. The author explained that if a child has difficulty in translating mathematical concepts into his/her native language, he/she may have difficulty seeing the meaning of the mathematics concept. The researcher found that the subjects who had the most difficulty putting their mathematical thoughts into words were also the subjects who had the least gains in mathematical achievement from pretest to posttest.

Miller (1991) reported that some researchers are concerned that writing in the mathematics classroom would do more harm than good, since, as a result of the time spent writing, students would be exposed to less mathemaics content than previously. The results of the study weaken this argument. In seven short weeks most students of the experimental group were able to master fourteen objectives. Even students who did not master all the objectives made major gains from pretest to posttest (See Appendix A). This supports the assumption that writing in mathematics greatly enhances students' comprehension of mathematics concepts. Therefore, students who write would be able to proceed more quickly and successfully through their prescribed tests, thereby increasing their coverage of the curriculum, not decreasing it.

Finally, the results of this study allay the fear of Ford (1990) that students cannot learn a difficult task by doing something equally as difficult - writing. It must be noted that writing in mathematics is usually for personal learning. This type of writing helps the writer reflect, clarify information, discover his or her knowledge and opinions, and learn specific information (Wason-Ellam, 1987). Writing in mathematics is not frequently shared with an audience. Therefore, the mechanics of good writing need not be stressed when this writing for personal understanding is being done.

With the significant differences obtained in this study, the researcher can reasonably conclude that the integration of daily writing in mathematics will improve students mathematics achievement. Educators, however, must be careful not to confuse writing for personal learning with writing for an audience. The mechanics of good writing do not have to be heavily emphasized during every occurrence of writing for personal learning. Writing in mathematics, an example of personal learning, is a viable, cost effective strategy that can be utilized to help increase students' comprehension of mathematics.

Implications

According to Mullis et al. (1991), the mathematics skills of our nation's children are generally insufficient to cope with either on-the-job demands for problem solving or college expectations for mathematics literacy. Even our most astute mathematics students compare poorly with students internationally (Medrich & Giffith, 1992). In the United States Virgin Islands, students are scoring on the 200 level of the NAEP tests which indicates that the students' skills are substantially below those needed for the study of advanced mathematics.

In an effort to combat this escalating problem, educators are investigating new strategies for the teaching of mathematics. Recently, writing has been proposed as one of the successful strategies for the improvement of math skills. The researcher felt it was necessary to find out what effect writing in the mathematics classroom would have on our students' mathematics achievement. Fourth graders were used in this study. The results indicated that writing in the mathematics classroom can be a viable, cost-effective method that can be utilized to help increase students' comprehension of mathematics.

This study may prove beneficial to teachers and administrators in several ways:

1. They may be made aware of the positive effects of writing in mathematics that may dispel misconceptions associated with writing and mathematics.
2. Teachers may be motivated to utilize writing in their teaching of mathematics.
3. Administrators may wish to offer in-service training for teachers to improve their ability to effectively use writing in the mathematics classroom.
4. Administrators may also be motivated to effect new standards for the teaching of mathematics that may stimulate the search for new strategies, including writing.

5. This study may be used as a guide for implementing writing in the mathematics classroom.

Professors who teach mathematics courses at the University of the Virgin Islands may want to include writing in their syllabuses, so that persons being trained as teachers can become aware of the positive effects of this strategy and how it can be successfully implemented in their classrooms. Those who are involved in curriculum planning can use the outcomes of this study to reassess how math is taught in elementary schools. Finally, this study may provide incentive for similar studies to be conducted since the collection of data on this issue is so limited.

Recommendations

We are living in an era of change, and as educators, we need to know when our instructional strategies are working. The results of this study have proven that writing in mathematics should no longer be feared, but should be considered a viable option in helping students understand mathematics concepts.

Based on these results, the researcher makes the following recommendations to educators, particularly to policy makers whose decisions affect the mathematics education of students in the United States Virgin Islands:

1. Conduct further studies on the effect of daily writing in mathematics, under more controlled circumstances and with a wider population sample in terms of grade level.
2. Hold workshops for teachers in order to better prepare them to integrate writing in their teaching of mathematics.

3. Upgrade the skills of master teachers who will facilitate classroom teachers (in individual schools) in their efforts to integrate writing in the mathematics curriculum.
4. Have workshops for parents and guardians, so that they too can improve their math skills and, thus, be able to help their children with writing in mathematics.
5. Use the results of this study to make short and long range plans to improve the math curriculum.
6. Consider the results of this study when decisions are being made to purchase the new mathematics series for public schools in the United States Virgin Islands.

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APPENDIX A

TABLE 1

Experimental Group

Mathematics Achievement Test Scores in Percentages

Subjects	Pretest	Posttest
A	17	94
B	17	94
C	11	92
D	11	94
E	23	94
F	9	78
G	14	100
H	3	92
I	11	97
J	9	83
K	11	97
L	0	89
M	14	83
N	14	83
0	14	97
P	14	97
Q	11	89
R	11	97
S	0	92
T	9	92
U	6	83
V	14	94
W	0	69
X	9	79
Y	19	97

APPENDIX B

TABLE 2

Non-treatment Group

Mathematics Achievement Test Scores in Percentages

Subjects	Pretest	Posttest
A	26	55
B	26	83
C	0	64
D	26	78
E	29	47
F	25	58
G	6	56
H	20	83
I	20	78
J	20	44
K	29	83
L	54	92
M	14	58
N	9	67
O	26	78
P	26	61
Q	29	72
R	17	50
S	11	72
T	11	81
U	40	81
V	20	78
W	6	67
X	14	83
Y	6	75

APPENDIX C

PRETEST

SCHOOL: PEARL BYRD LARSEN **NAME:** ____________

SUBJECT: MATHEMATICS **DATE:** ____________

GRADE: ____________

Read each question carefully, then supply the best answer.

I. Measure each line in inches, then in centimeters. Write the answers on the blanks provided.

1. ______________________________

_____ inches _______ centimeters

2. ___________________________________

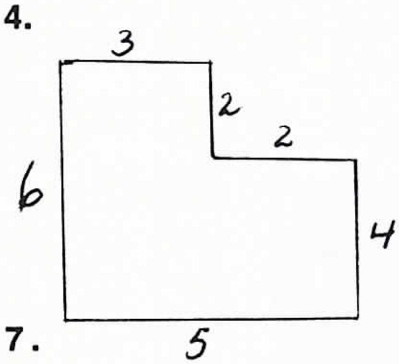
_____ inches _______ centimeters

3. ____

_____ inches _______ centimeters

II. Give the perimeter of each figure below:

4.



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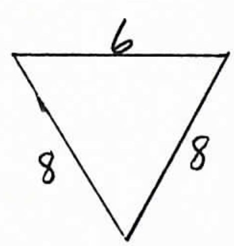

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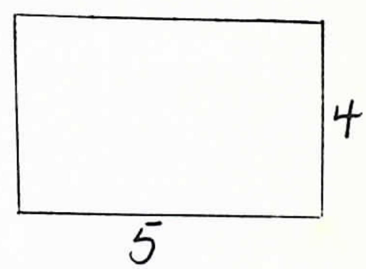

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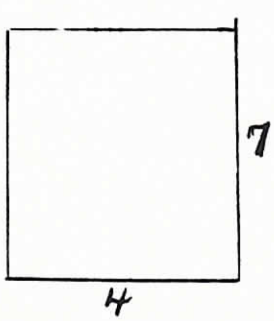


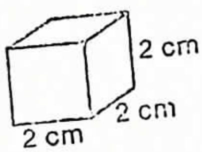
III. Give the area of **6 and 7.**

8. Area of number **6:** ______ square inches.

9. Area of number **7:** _______ square feet.

IV. Give the volume of each prism.

10.



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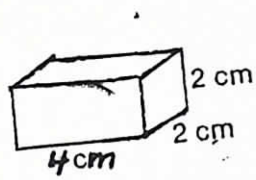

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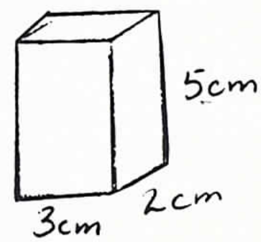

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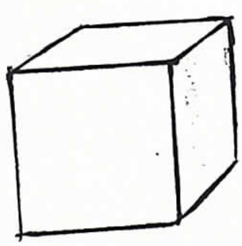
V. Write the appropriate name on the line below each figure:

cube, sphere, cylinder, or cone.

13.



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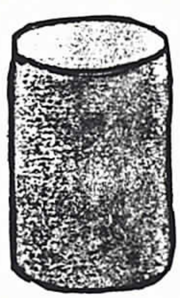

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15.

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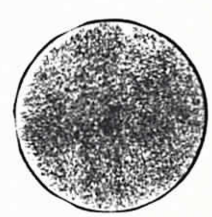
16.



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VI. Read each statement. Determine whether each is **true** or **false.** Write your answer on the line provided.

17. ________ A segment has two endpoints.

18. ________ A ray has zero endpoints.

19. ________ Two parallel lines cross at exactly one point.

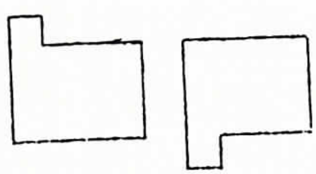
20. ________ A triangle has three vertices.

21. ________ A square has four right angles.

22. ________ A rectangle has only three sides.

VI. Determine whether each of the following is **congruent** or **similar**. write the appropriate answer on the line provided.

23.



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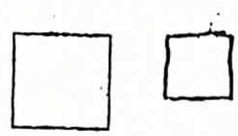
23.



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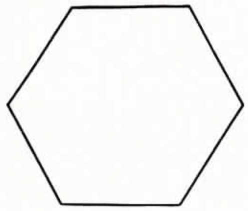
24.

____

VII. How many lines of **symmetry** does each figure have? Draw them.

25.



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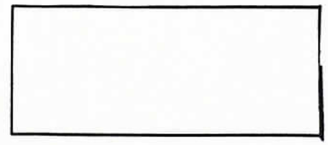

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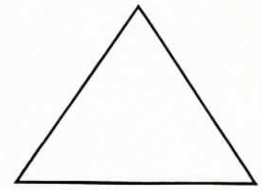
27.



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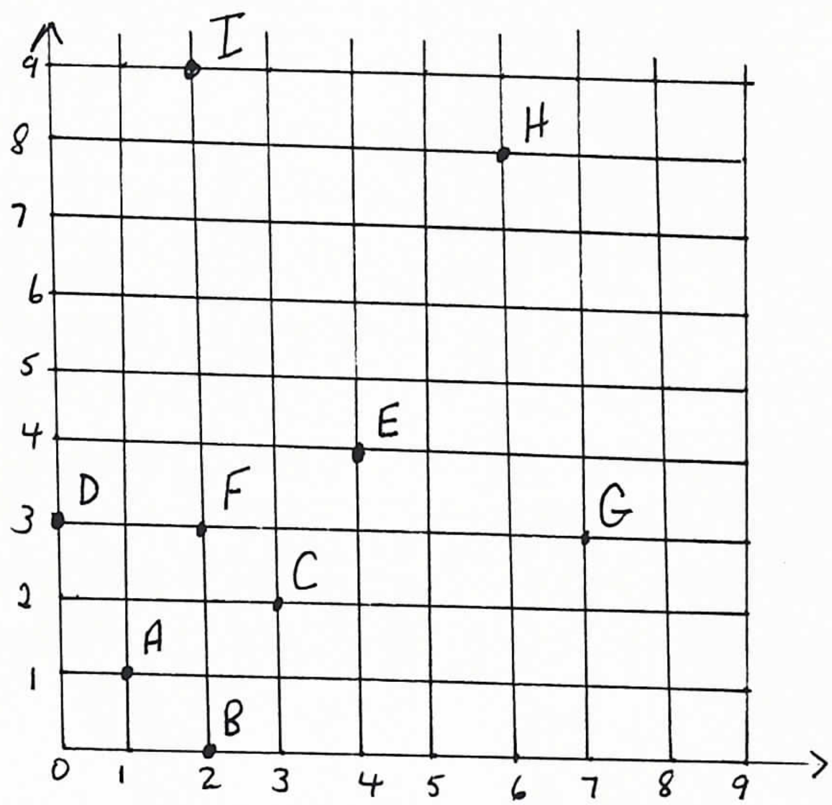
VIII. Use the information on the grid provided to name a given point or an ordered pair.

	Letter	Ordered Pair
27.	D	
28.		(3, 2)
29.		(1, 1)
30.	E	
31.	B	



APPENDIX D

POST-TEST

SCHOOL: PEARL BYRD LARSEN **NAME:** ______________

SUBJECT: MATHEMATICS **DATE:** ______________

GRADE: ______________

Read each question carefully, then supply the best answer.

I. Measure each line in inches, then in centimeters. Write the answers on the blanks provided.

1. ____

______ inches ______ centimeters

2. ______________________________

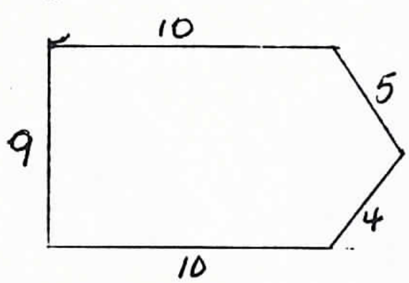
______ inches ______ centimeters

3. ____

_____ inches ______ centimeters

II. Give the perimeter of each figure below:

4.



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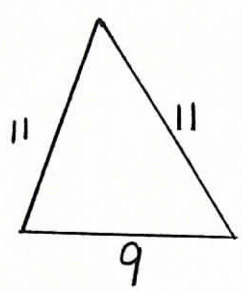

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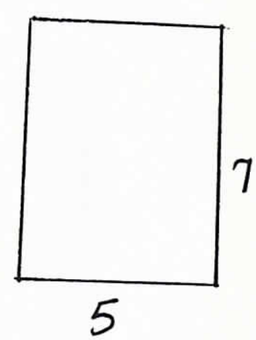

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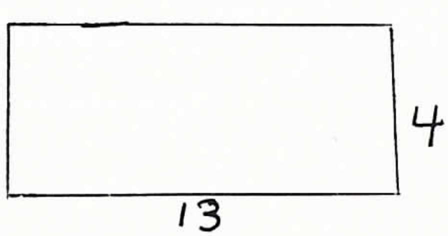


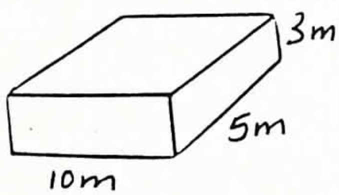
III. Give the area of **6 and 7.**

8. Area of number **6:** ______ square inches.

9. Area of number **7:** _______ square feet.

IV. Give the volume of each prism.

10.



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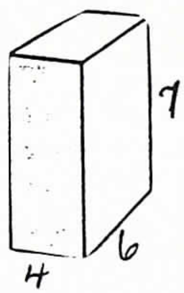

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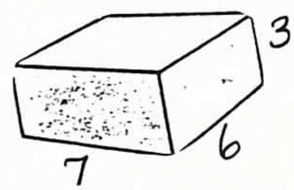
12.



____

V. Write the appropriate name on the line below each figure:

cube, sphere, cylinder, or cone.

13.

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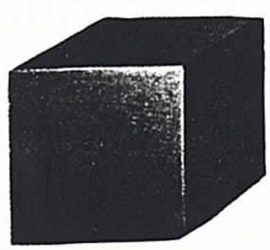
14.



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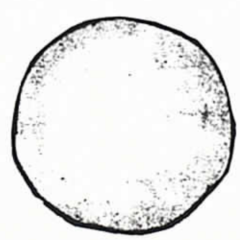

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16.

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VI. Read each statement. Determine whether each is **true** or **false.** Write your answer on the line provided.

17. ________ Parallel lines cross each other at a point.

18. ________ A ray has two endpoints.

19. ________ A sphere has three vertices.

20. ________ A square has four sides that are different lengths.

21. ________ A rectangle has four right angles.

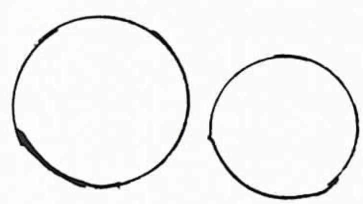
22. ________ A line never comes to an end.

VI. Determine whether each of the following is **congruent** or **similar**. write the appropriate answer on the line provided.

23.

____

24.



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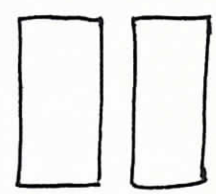

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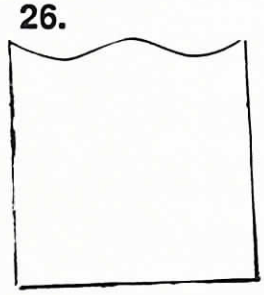
VII. How many lines of **symmetry** does each figure have? Draw them.

26.



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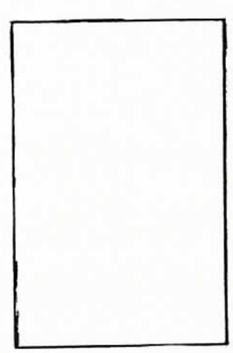

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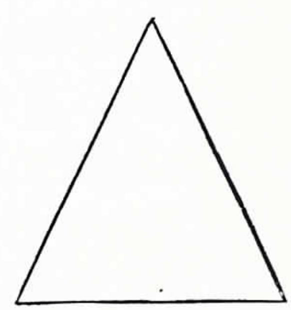

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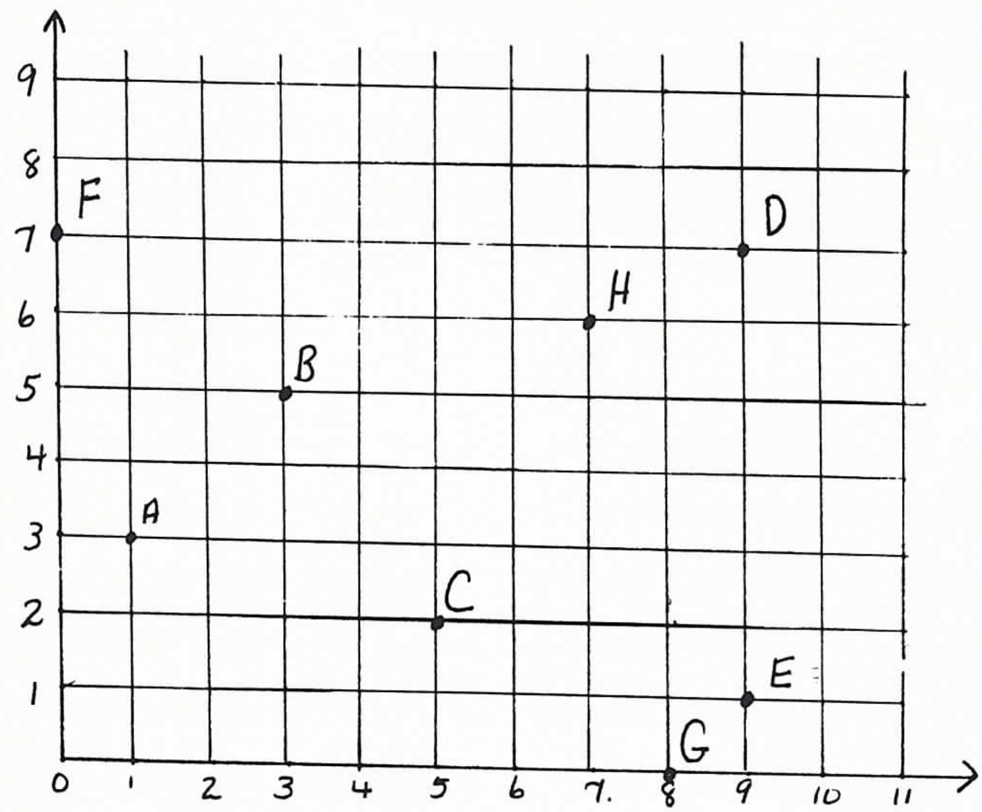
VIII. Use the information on the grid provided to name a given point or an ordered pair.

	Letter	Ordered Pair
28.	E	
29.	H	
30.	B	
31.		(0, 7)
32.		(5, 2)



APPENDIX E

Writing Activities In Which the Experimental Group Engaged

I JOURNAL WRITING

After each new lesson, students were asked to reflect on the day's lesson by answering the following questions in their journals:

1. What were the important points of today's lesson?
2. What did I understand from the lesson?
3. What did I not understand?
4. What questions would I like to ask the teacher about the lesson?

II OTHER WRITING ACTIVITIES

1. Explain the difference between inch and centimeter. List three things you would use each to measure.
2. Explain the relationship between inches, feet, and yard.
3. Measure the sides of your note book and then write how you went about measuring it.
4. Mrs. Smith's sixth grade students do not understand how to find the perimeter of a polygon. You have been invited to teach the class. Write what you will say to the students to help them understand the concept. You may use examples.
5. The following students have made errors in working out the perimeter of given polygons. Analyze their errors and then give reasons why each problem was incorrect.
6. For your home assignment this evening, write the steps for finding the perimeter of a polygon. Also have an adult member of your family write the steps for finding the

perimeter of a polygon. Compare and contrast the two listings.

7. If you are asked what is the area of something, what would your answer be? Write your response.
8. My daughter Nahvia does not understand how to find the area of a given polygon. Write a note to her explaining what to do.
9. Analyze the errors you made on Quiz I. Write the reasons you got a given problem incorrect.
10. What do you understand by the term volume? Give examples of things you can find the volume of.
11. One of your classmates said that a person cannot find the volume of a two dimensional object. Do you agree? Why?
12. Explain how you would go about finding the volume of a rectangular prism.
13. Which of the following is your favorite figure: cone, cube, cylinder, pyramid, rectangular prism, or sphere? Write all you know about the figure and tell why you like it.
14. Compare and contrast two of the following figures: cone, cube, cylinder, pyramid, rectangular prism, and sphere.
15. Look around the classroom and find objects with the following shapes: square, rectangle, triangle, and circle. Explain why each object would be given the shape you chose.
16. Describe the features of any two of the following figures: square, rectangle, triangle, and circle.
17. Explain the difference among lines, segments, and rays.
18. Complete the following story with the most suitable words:

Today we reviewed lines, segments, and rays. I now know that a ___ goes on and on in ___ directions. I also know that a line does not have any ___. A ray, however, has ___ endpoint(s), while a ___ has two endpoints. I also know that a ___ goes on and on in one direction. Lines that touch each other are called ___. Lines which do not touch each other are called ___.

19. Name a pair of streets in Christiansted that you consider to be parallel. Name a pair of streets in Christiansted that intersect.

20. Explain as clearly as you can what you understand by the term angle.

21. How would you describe a right angle? Which of the figures we have studied contained right angles?

22. Distinguish between the concepts congruent and similar.

23. One of your classmates was absent when we studied symmetry. Explain to him or her what this concept is about.

24. Explain the steps you take to find the ordered pairs of a given letter on an ordered pair grid.

25. Create story problems for two of the practice problems on the worksheet provided.

APPENDIX F

Samples of Writing From the Experimental Group: Week I, Week III, and Week VII

Week I

Question: Answer the following questions in your journal.

1. What were the important points of today's lesson?
2. What did you understand from the lesson?
3. What did you not understand?
4. What questions would you like to ask (the teacher) about the lesson?

Answer: 1. We had studied how to measure an inch and how long is a foot.

2. I understand a foot is twelve inches long. You start from the begining of the ruler.

3. I did not understand when we had just start how long was a foot and an inch.

4. How long is a foot? How long is an inch?

Question: **Explain the relationship between inches, feet, and yards.**

Answer:

I understand that the yard is the biggest and the inch is the smallest and the foot is the second biggest.

Shenique

Week III

Question: Answer the following questions in your journal.

1. What were the important points of today's lesson?
2. What did you understand from the lesson?
3. What did you not understand?
4. What questions would you like to ask (the teacher) about the lesson?

1. The important points in the lesson are about rays, segments, an lines.

2. I understand a segment has two endpoints. I understand a ray has one endpoint and one of the sides keep going on. I understand a line has no endpoint but it keeps going on and on. Intersecting lines are touching each other. Parallel lines does not touch each other.

3. I understand everthing today.

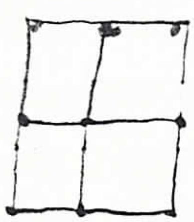
Carlyle

Question: My daughter Nahvia does not understand how to find the area of a given figure. Write a note to her explaining what to do.

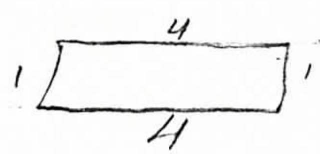
Answer:

First Nahvia you have to draw a box then put in squares. Then you count the boxes. You can also multiply and you will get your answer. This is how it is suppose to look.

4 square cm.



4 square cm.



Shenique

Question: One of your classmates said that a person cannot find the volume of a two dimensional figure. Do you agree? Why?

Answer:

Yes, I agree. You cannot find the volume of a flat thing because it do not have 3 dimensional

A volume is how many things can fit in something, Like a cup of juice. It can take a certain amount of juice.

Kaleem

Week VII

Question: Answer the following questions in your journal.

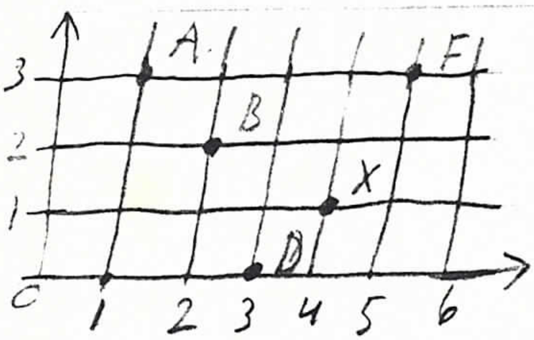
1. What were the important points in today's lesson?
2. What did you understand from the lesson?
3. What did you not understand?
4. What questions would you like to ask (the teacher) about the lesson?

1. We learned about orderpairs. We learned that that the x-axis is the line that is going a cross and the y-axis is the line that is going up. The whole thing is call an Ordered pair grid.

2. I understand there are points on the grid. The points have names like letters. To name a point I have to look for numbers. I must look on the x-axis first then on the y-axis. I could use these numbers to name the points.

3. I understand every-thing.

4. I have no questions to ask the teacher.



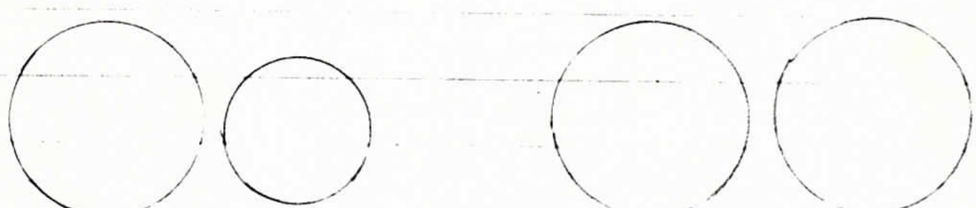
A=(1,3)
B=(2,2)
D=3,0)
X=(4,1)
F=(5,3)

Carlyle

Question: Distinguish between the concepts congruent and similar.

I can tell the difference between similar and congruent. Don't forget that I am talking to you Mrs. Henry. Lets go on. As I was saying that I learned similar and congruent. Similar means that when you have two covers, one will be bigger then the other. One thing you must remember that it must have the same shape.
Now lets talk about congruent. Congruent means if you have two covers they will be the same shape and the same size.
This is how it is going to look.

Similar | Congruent



Sheri

Question: One of your classmates was absent when we studied symmetry . Explain to him or her what this concept is about.

Answer:

A line of symmetry is a line that come straight through a figure like a paper. If you put a line straight down the middle that would be one. If you put a line straight across the middle that would be two. When you fold the paper on the line of symmetry the two sides must fit on each other perfectly.

Kaleem

this is an example