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A study of the efficacy of LOGO programming on the achievement of fifth grade students

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A STUDY OF THE EFFICACY OF LOGO PROGRAMMING ON THE ACHIEVEMENT OF FIFTH GRADE STUDENTS

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Statement of the Problem

The purpose of this project was to determine the effects that LOGO programming had on the ability of fifth grade students to solve specific types of mathematical problems.

Educational Programs are often implemented with little research to determine the effectiveness of the learning intervention. There is a need for research on LOGO programming to discover if the use of this program is a viable way to broaden a student's academic growth by using a single intervention (Noss, 1987).

The research at Mary Tone Elementary School involved two groups of fifth grade students, one experimental group and one control group. Each group was pre- and posttested using the California Achievement Test (CAT) Form E, Level 15, Test 6, entitled Mathematics Computation.

Students in the control group received no instruction in LOGO programming. The students in the experimental group received eighty minutes of LOGO programming per week in a computer lab setting working in pairs. Over a period of eleven weeks students received over fourteen hours of LOGO instruction. In addition, the treatment students had access to LOGO programming in their classroom on a sign-up basis during this

same eleven weeks. Two Apple IIe computers were available to students in their regular classroom on a sign-up basis for working with LOGOwriter. Thus, students were able to access the LOGOwriter programming in two ways.

The scores were statistically analyzed to determine if the knowledge of LOGO had any significant effect on the students' academic achievement. The results of the pretest scores were used to determine the equality between groups. The posttest scores were examined to discover if there was any statistically significant difference between the control group and the treatment group. Both pre- and posttest scores were used to determine if there was a statistically significant difference in achievement of the treatment group. In all three comparisons, no significant difference was found.

A great deal more reliable research is needed in the area of LOGO programming. Educational developers and implementors need concrete evidence that LOGO will impact educational environments through improved test scores before they will invest time and money to establish LOGO programming.

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Chapter I

INTRODUCTION

Area of Concern

The use of LOGO has become a popular idea in computer education since its creation by Seymore Papert. Advocates of LOGO have encouraged computer educators to adopt this method of teaching programming. They have also influenced districts to incorporate LOGO into the computer curriculum and spend large amounts of money for hardware and software. Consequently, this has stimulated interest in the research of LOGO effectiveness as it pertains to academic achievement in all areas of the curriculum.

As a result of this interest, there exists a division in opinion relating to the practicality of teaching LOGO programming. One viewpoint regards the teaching of LOGO as an experience that will improve a child's cognitive skills. The other perspective maintains that there has not been enough unbiased research to consider LOGO as a viable learning tool for areas of cognitive development. Specifically, LOGO programming teaches LOGO and has not been significantly proven to impact cognitive skills.

Statement of the Problem

Computers are becoming a familiar tool in the classroom. They are found in kindergarten classes through subject specific high school classes as well as in classrooms for the learning handicapped. The distribution and creation of software has become big business. Consequently, computer educators are concerned about how to evaluate the plethora of computer software that is being developed.

Educators must decide which software will best meet the student's needs, meet their own requirements and the district's curricular goals. Increasingly, educators are required to add new curricular topics to the already crowded academic day. Inevitably, educators look for ways to combine two or more subjects. LOGO enthusiasts affirm that the teaching of LOGO will aid the student in areas other than just the concepts of LOGO programming. Students who participated in LOGO programming have demonstrated significant gains in the areas of creativity and reflectivity (Clements, 1987). There is a need for research in LOGO programming to discover if the use of this program is a viable way to broaden a student's academic growth by using a single intervention (Noss, 1987).

Purpose of the Study

Spatial recognition is a skill that relates to cognitive development in certain mathematical processes. More research is necessary to ascertain if there is a relationship between spatial ability and mathematical achievement.

Because LOGO, in part, teaches spatial recognition, the purpose of this study was to find out what effect, if any, the use of logo programming has on student achievement. The research at Mary Tone Elementary School involved two groups of fifth grade students, one an experimental and one a control. Each group was to be pre- and posttested using the California Achievement Test (CAT) Form E, Level 15, Test 6, entitled Mathematics Computation.

The scores were statistically analyzed to determine if the knowledge of LOGO had any significant effect on the students' academic achievement.

Definitions

While most of the terms in the area of computer programming are self-explanatory, there are some that warrant further definition. To begin, the software LOGO is a program language for communicating with a computer. It has a concise number of words and grammatical rules, but can be continually expanded to extend its vocabulary which in turn allows the user to create images on the monitor. The term 'turtle' refers to the image on the monitor which moves according to the directions it receives from the operator. CAI is the abbreviation for

Computer Assisted Instruction. Usually CAI refers to the use of software that allows the student drill and practice experience. However it can also include problem solving experiences, simulation games and specific skills related to word processing (Appendix A).

Statement of Hypotheses

The review of the research suggests that elementary school students who receive instruction in LOGO programming develop problem solving skills applicable to problems in mathematics. The following hypotheses are generated: Fifth grade students who are trained in LOGO programming will show no statistically significant difference at the .05 alpha level between pre- and posttests which measure achievement. In addition, fifth grade students who are trained in LOGO programming will show no statistically significant difference at the .05 alpha level in achievement than fifth grade students who are given no training in LOGO programming.

Limitations of the Study

This outcome of this study was restrained by the sample size of the treatment and control groups. A larger sample may have affected the results. In addition, the groups were not randomly selected but chosen for the convenience of their previously established self-contained classrooms. The test used in this study evaluated students on their computational mathematical achievement. Therefore, another restriction of this study was the teaching style and strength of the classroom teacher in the area of mathematical computation. The different teaching styles and teaching emphasis could have affected the results of this study.

Finally, this study was affected by the CTBS test itself. This test of computational skills is used to measure the students' ability in that area only. LOGO's strength is in the areas of problem solving and measurement of line and angle. These attributes are not succinctly tested by the CTBS.

Chapter II

REVIEW OF THE LITERATURE

Current Views and Research Results

One study conducted by Richard Noss investigated the geometrical concepts attained through the use of LOGO (Noss, 1983-1984). This research study involved 118 pupils between the ages of eight and eleven. The students were taken from five classrooms in five different schools. The schools were selected to represent a cross-section of cultures which would represent the student body. Two were inner-city, two suburban and one was rural. The pupils worked on programming in pairs for a median time of about seventy-five minutes per week. The programming activities were presented in two phases. The first phase introduced the students to the language and mechanics of LOGO and the second phase stressed key concepts of LOGO. Pilot tests were carefully designed and tested on pupils who had no prior experience with LOGO to insure the instrument's readability and accuracy. The final results were organized using a log-linear modeling approach. These data were then analyzed using GLIM (Generalized Linear Interactive Modeling). This method of analysis focused on the interactions between the various factors involved in the testing results. These factors were the school site, the student's gender and the treatment group.

This research was further investigated by Richard Noss (Noss, 1987). The Noss research analyzed the results of the study in order to measure the effects of a LOGO experience on a child's understanding of two geometrical concepts: the measurement of length and degree of angle. To summarize the results of the Noss research, evidence showed a trend toward the improvement of comprehension of measurement and angle in students that work with LOGO. There was a most significant trend in this mathematical growth for females. The use of LOGO showed that girls particularly benefited through LOGO programming. LOGO programming enabled them to explore and construct geometrical concepts. As a result, this study challenged mathematics educators to begin building the cognitive, social and technical components of LOGO-based learning environments within the context of the mathematics curriculum.

Another study of interest dealt with the changes that can happen to a child while involved in learning the programming language, LOGO (Mayer & Fay, 1987). Three things were looked at in this research. First, researchers examined the learning of the language pertaining to the computer program itself. Second, they looked at the change in the child's way of thinking about programming (the semantics of programming). And third, they investigated the change in the child's thinking skills in areas beyond programming. The authors propose that there is a chain of events which happens to a child when learning to program. They suggest that the learning of the programming language precedes learning to think about programming and that learning to think about programming is a prerequisite for success in learning to think outside of programming. In other words, the student learned the words and what they meant. Then the student learned how to make new ideas with the words. Finally, the student could use this creative thought in other domains.

Each of these three activities was explained in terms of what the problems the children had in experiencing the new environment. Accordingly, the researchers had to make adjustments to do an accurate study.

In response to the first question, the authors found it to be statistically significant that the language level of programming will increase as the student receives more practice. The second question of a child's thinking about programming showed either no change or the student made fewer mistakes. The third question demonstrated that some students made gains and some did not. This was dependent upon whether or not the child was able to grasp the semantics of the programming language.

As a result, the authors suggested that in order to understand whether or not programming can be helpful to students in changing the way they think, future research should look at the processes by which students learn programming languages. The research must include what was learned and what the prerequisites were for learning.

Differing from the last two research studies, Henry J. Becker questions the validity for much of the research done on LOGO programming (Becker, 1987). Becker begins his criticism of Seymore Papert's computer language "LOGO" by relating the claims Papert asserts will happen to children if they are exposed to LOGO in the proper atmosphere (Papert, 1987). For instance, Papert is confident that LOGO will enable children to improve the quality of their reasoning, their capacity to monitor their own thinking, their ability to translate vague ideas into written expression and their intellectual initiative. However, Becker explains how most elementary school teachers implement LOGO as an academic game used primarily for enrichment rather than employing it as an integral part of an effort to improve students' cognitive abilities. As a result, the optimal benefits of LOGO are not being realized.

Papert holds the view that the open classroom is essential to the effectiveness of LOGO in the classroom. But in fact, this is not what research shows is actually occurring. Classroom teachers instructing students in LOGO appear to be teaching with a traditional method rather than the "open education" mode. Becker questions Papert. "How do we know if these ideas of cognitive development are working?" In reply, Papert suggests that the population should decide on the effectiveness of LOGO programming by using a "computer criticism." This criticism would be analogous to literary criticism or social criticism but Papert suggests no method for how one might "do" computer criticism. Ultimately, Becker determined that without a scientific method of making critical judgments, most data about LOGO were subject to falsification. Therefore, much of the research emanating from computer criticism would be erroneous.

To make his point, Becker reviewed two research endeavors. These were the Pea and Kurland study (Pea & Kurland, 1984) and the Clements and Gullo study (Clements & Gullo, 1984). While both provided important data about the effects of using LOGO programming activities with elementary-age students, neither one is a strong test of Papert's theory. Both studies suffered from technical deficiencies.

To conclude, Becker suggests what might be an accurate measure of any growth experienced from the use of a computer language such as LOGO. Specifically, Becker states that the scientific method must be adapted to formulate and acquire accurate research results. These results will then allow educators to make decisions on the feasibility of incorporating computer software (specifically LOGO) into a district's curriculum plan.

Achievement

Because the question of academic achievement is of concern, the research study by Douglas H. Clements (Clements, 1986) is of particular importance. This study researched the delayed effects two types of computer implementation had on two different groups of first grade children. Each group of students was randomly selected, pretested and participated in the treatment for three months. The first group was assigned to LOGO while the second group was assigned to instruction using Computer Assisted Instruction (CAI).

Two years later researchers investigated the delayed effects of LOGO programming on the cognitive abilities and achievement of these same children. This effect was then measured against a group of students who received only drill and practice instruction in specific academic areas.

The subjects for this study were sixteen third grade children who had received either LOGO or CAI experience in the first grade as the first part of the study. The computer activities were given in two forty-minute sessions a week for twelve weeks. Children worked in groups of two or three with one of the researchers. Five months after the administration of the posttests, interviews with each child took place.

The instrument used for the pretreatment measure was the Peabody Picture Vocabulary Test-Revised Form L (PPVTR). This was given to determine the quality of the two groups. In order to evaluate the delayed effects of LOGO programming the Test of Cognitive Abilities (TCS) was given to assess the students' level of academic aptitude. This test measures abilities of a relatively abstract nature that are important to school achievement. Clements used this test to interpret data on the students' cognitive abilities. He concluded that the students who received training in LOGO outperformed the CAI students as a whole. Nevertheless, in some specific areas the CAI students performed better than the LOGO students (i.e., memory and analogies).

In order to ascertain each group's level of achievement the students were given the California Achievement Test (CAT). Again, the LOGO students' scores indicated that LOGO has a diffuse and delayed effect on certain areas of achievement. To summarize, the CAI group scored near the mean of the school district's population for most subtests, but scored somewhat above the mean on those tests which measured skills on which the students had been drilled. The LOGO group's percentile rank ranged from thirteen to twenty-two above the population's mean, with an exception in the area of reading skills where students' achievement was very strong.

Clements ended his discussion with the suggestion that these findings require replication using larger sample sizes. In addition, he suggested that future studies might utilize LOGO training in which teachers integrate LOGO into the regular mathematics curriculum.

Curriculum Direction

One research project approached the question of LOGO education by formulating and investigating a series of questions with respect to the ultimate direction of a school district's guidelines. This research by Celia Genishi suggests that while LOGO instruction should match the district's goals of critical thinking, degree of comfort with estimating numbers or openness to learning through trial and error, these accomplishments are hard to measure on achievement tests (Genishi, 1988). Schools that value quiet classrooms and a skill-based curriculum would benefit from computer software that offers drill and practice programs. A task oriented school would benefit from the advantages of a LOGO programming environment. Ultimately, software should be chosen to match the purpose of the district.

This investigation described the computer curriculum of one kindergarten class and explored the appropriateness of computers in public education. The reason LOGO programming was successful in this study was its highly task oriented nature. LOGO used in a supportive environment allows the students to view themselves as learners. This evidence has been supported by other studies. One such study found that students were able to learn a variety of mathematical concepts including estimation and proportion (Mayer & Fay, 1987). Another study found students, especially girls, gained a clearer understanding of spatial relationships (Kull, 1986). This study also supported evidence that students collaborated on problem solving activities with a great deal of eagerness.

As a final note, one study found that LOGO trained students outperformed non-LOGO students in a test of comprehension monitoring (Clements, 1987). This was attributed to the extreme care students must use to input instructions for LOGO programming to successfully take place. For example students using the programming language LOGO, must take extreme care that all commands are precisely exact. Any carelessness would result in the program not working. LOGO will then tell the student that the command was incorrect and the student will have to reenter the command for the program to continue. Students soon learn to enter accurate commands to save time and proceed with their activity.

Conclusion

In addition to the concerns viewed here, there are many other factors which affect the use of LOGO in the educational setting. Among these is the question of cost-effectiveness (Levin, Glass & Meister, 1987). While some researchers find Computer Assisted Instruction (CAI) a more viable way of increasing student achievement scores, others assert that cross-age tutoring is a more responsive intervention. The Levin, Glass and Meister study found cross-age tutoring to be more advantageous than computer activities in improving reading and mathematics achievement. There is also speculation as to the type of software students should be using for computer literacy. Increasingly, educators are also examining computers for their motivational capacities. Inevitably, the concerns for the usage of computers in the educational environment must be addressed through concrete, substantial research. The push for computers in instruction is central among the strategies for educational reform. Therefore, it is important to have information on the feasibility of teaching students LOGO programming. Information is needed not only to determine the possibility of LOGO's pertinence to academic achievement but to compare LOGO to other educational software.

Further study is needed in the area of LOGO programming to verify the various advantages or disadvantages of this software intervention. Because LOGO programming affects the learner through several modes of learning, the testing should reflect what is being learned. Adequate and appropriate testing are required to establish if LOGO can help students grow in this and other areas of cognitive development.

Research suggests that girls are particularly benefited by the spatial orientation used in LOGO. This benefit may encourage educators to initiate more research. This additional research may impress on educators the advantage of using LOGO in the computer curriculum. Furthermore, problem solving is currently receiving the attention of educators and LOGO programming may give students more practice in this area.

Chapter III

PROCEDURES

Design

The design utilized is an experimental, two group, pre-posttest design. This design is based on W. James Popham's Pretest-Posttest Control Group Design (1975). In brief, this powerful research design is best suited for use in educational research. It allows the educator to make strong inferences regarding the benefits of the treatment.

Population and Sample

The population from which the sample was drawn consisted of two fifth grade classrooms, each with twenty-six students, at Mary Tone Elementary School in Crestline, California. Complete classes were chosen in order to obtain an independent sampling unit. As a result, this avoids considerable dependence among pupils in a given classroom. The students were not informed of the experiment or that some classes were not exposed to the treatment.

The community in which the students live has a population of approximately 7,000 people. The present day breakdown of ethnic groups for the Crestline area is 89% White, 9% Hispanic, 1% Asian and 1% Black. Most of the affluent and middle-class citizens are employed in the valley and commute daily. Approximately one-fifth of Crestline's residents are recipients of welfare or unemployment benefits. Another one-half of the populace are middle-class working families, Finally, the last portion consists of retired people.

Treatment

Only the treatment group of twenty-nine students was exposed to LOGO programming. First, students were introduced to the mechanics of LOGO. This included the basic language acquisition skills necessary to talk to the computer (Appendix A). Secondly, the students were allowed time to become familiar with the turtle and then to adopt strategies in order to decrease the occurrences of failure. Then finally, the students received goal directed lessons to focus their programming skills (Appendix B). A majority of time was given to the second and third phases of this treatment allowing the students opportunities to develop the logical and spatial attributes inherent in the study of LOGO programming (Becker, 1987). At the conclusion of the treatment, both the treatment and control groups were again tested using the California Achievement Test (CAT) Form E, Level 15, Test 6, entitled Mathematics Computation.

Chapter IV

INSTRUMENTATION ANALYSIS

California Achievement Test

In order to assess academic achievement, the California Achievement Test (CAT) was used as the measurement tool. The CAT, a normed referenced test, has a long tradition of well-developed achievement tests. It has been shown to be particularly suitable for schools that emphasize the areas of reading, writing and mathematics (Keyser & Sweetland, 1985). Moreover, it has been effective in assessing the effects on groups of students because group norms are available for either class or school. However, the CAT is basically user normed and not truly representative of all the nation's students (Keyser & Sweetland, 1985).

In spite of this, the CAT can be effectively administered by classroom teachers because the test administrators do not require extensive training. Furthermore, the instructions are clearly written and easy to follow. In addition, teachers and administrators can obtain immediate results by the use of a hand-scoring option or, if the tests are sent out for machine scoring, there is only a three week waiting period. The results yield meaningful results if the test itself can be shown to relate to some meaningful aspect of instruction. This component was especially useful for the research results which analyzed LOGO programming in relation to academic improvement.

The CAT contains 180 parts for which reliability and validity may be assessed. Reliability is assessed in terms of internal consistency, error of estimate, short-term test-retest, alternate forms, and fall-spring test-retest. Validity information is presented in the form of correlations with other tests. Internal consistency reliability coefficients are reported for each level at which the level is appropriate. Therefore, the user has fall reliability, and spring reliability. Total battery reliabilities range from .89 to .98 with the vast majority at or above the .95. In the same manner, most major components of the tests yield results that are suitable for individual assessment according to Keyser & Sweetland (1985).

Foreseeably, the high validity and reliability make the CAT an adequate measure of pre- and posttest scores. Because a class summary is provided for each subtest and objective, it is possible to compare class means to other intact classrooms. These norms are more stable and more sensitive to the effects of instruction if the CAT is used as a pretest-posttest measure. This test was chosen as a measurement tool because of its flexibility, reliability and consistency.

Statistical Analysis

The review of the research suggests that there may be a difference in the study of LOGO programming and student achievement. The following hypotheses were generated: Fifth grade students who were trained in LOGO programming will show no statistically significant difference at the .05 alpha level between pre- and posttests which measure achievement. In addition fifth grade students who were trained in LOGO programming will show no statistically significant difference at the .05 alpha level in achievement than fifth grade students who are given no training in LOGO programming.

In order to ascertain any statistically significant difference, a t-test for independent samples and a t-test for related samples were used to analyze the results. Pre- and posttests were given respectively in March and June. A t-test for related samples was used because the CAT utilizes interval data.

In addition to the t-test for related samples, a t-test for independent samples was employed. This t-test analyzed the difference between posttests of the treatment group and the control group. Again, a t-test was used because the data are of interval nature.

Statistical Results

The first statistical analysis done was used to compare the treatment and control groups to insure that both groups were academically parallel. This was to establish that one group was not already outperforming the other group. This first t-test established that the two groups were equal. In this case the t-value was 1.1. Since the t-value was less than 2.06 at the .05 level, it was concluded that there was no significant difference between the CAT scores of the control group and the treatment group. The following table presents the scores of the first test.

Prestest Scores

Group 1 (treatment group)	Group 2 (control group)
Number of Correct Responses	
14	14
14	13
12	13
11	12
11	12
11	12
11	12
10	11
10	11
10	11
9	11
9	11
9	11
9	11
8	11
8	10
8	10
8	10
8	10
8	10
8	9
8	9
8	9
7	8
7	8
7	7
232	259

The following formula was used to calculate the t-value between the treatment group and the control group.

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left[\frac{\Sigma X_1^2 - \frac{(\Sigma X_1)^2}{N_1} + \Sigma X_2^2 - \frac{(\Sigma X_2)^2}{N_2}}{(N_1 + N_2) - 2}\right] \cdot \left[\frac{1}{N_1} + \frac{1}{N_2}\right]}}$$

where $\overline{X}_1$ = the mean of the first group of scores

$\overline{X}_2$ = the mean of the second group of scores

ΣX_1^2 = the sum of the squared score values of the first group

ΣX_2^2 = the sum of the squared score values of the second group

$(\Sigma X_1)^2$ = the square of the sum of the scores in the first group

$(\Sigma X_2)^2$ = the square of the sum of the scores in the second group

N_1 = the number of scores in the first group

N_2 = the number of scores in the second group

$$t = \frac{9. - 9.96}{\sqrt{\left[\frac{2367 - \frac{53824}{26} + 2897 - \frac{67081}{26}}{(26 + 26) - 2}\right] \cdot \left[\frac{1}{26} + \frac{1}{26}\right]}}$$

$$t = 1.1$$

After the treatment, a posttest was given. The subsequent results were analyzed. This comparison of test scores produced a t-value of 1.86. Because the t-value was less than 2.056 at the .05 level, it was determined that there was no significant difference between the performance of either group. The following table lists the posttest scores for both groups.

Prestest Scores

Group 1 (treatment group)	Group 2 (control group)
Number of Correct Responses	
14	14
13	14
12	14
12	14
11	13
11	12
11	12
11	12
11	12
11	11
10	11
10	11
10	11
10	10
10	10
9	10
9	10
9	9
9	9
9	9
8	9
8	9
8	9
7	8
4	8
4	4
251	275

The following formula was used to calculate the t-value between the treatment group and the control group.

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left[\frac{\Sigma X_1^2 - \frac{(\Sigma X_1)^2}{N_1} + \Sigma X_2^2 - \frac{(\Sigma X_2)^2}{N_2}}{(N_1 + N_2) - 2}\right] \cdot \left[\frac{1}{N_1} + \frac{1}{N_2}\right]}}$$

where $\overline{X}_1$ = the mean of the first group of scores

$\overline{X}_2$ = the mean of the second group of scores

ΣX_1^2 = the sum of the squared score values of the first group

ΣX_2^2 = the sum of the squared score values of the second group

$(\Sigma X_1)^2$ = the square of the sum of the scores in the first group

$(\Sigma X_2)^2$ = the square of the sum of the scores in the second group

N_1 = the number of scores in the first group

N_2 = the number of scores in the second group

$$t = \frac{9.7 - 10.6}{\sqrt{\left[\frac{2557 - \frac{63001}{26} + 3043 - \frac{75625}{26}}{(26 + 26) - 2}\right] \cdot \left[\frac{1}{26} + \frac{1}{26}\right]}}$$

$$t = 1.86$$

A third t-test was done to determine the significance of a difference between two correlated means. Pre- and posttest scores for individuals in the treatment group were used to determine if there was any improvement. The resulting t-value was .35. Since the obtained t-value was smaller than 2.060 at the .05 level, it was concluded that training in LOGO programming had no statistically significant difference as reflected by selected mathematics computation of the CAT. The table below represents the pre- and posttest scores of the treatment group.

Student	Pretest Scores	Posttest Scores	Difference
1	10	13	+3
2	11	11	0
3	7	10	+3
4	8	11	+3
5	7	10	+4
6	11	11	0
7	14	8	-6
8	11	10	-1
9	7	11	+3
10	8	11	+3
11	10	8	-2
12	9	9	0
13	10	4	-6
14	12	12	0
15	11	14	+3
16	8	10	+2
17	8	9	+1
18	8	9	+1
19	14	9	-5
20	8	10	+2
21	9	9	0
22	9	7	-2
23	8	4	-4
24	8	8	0
25	8	10	+2
total	234	238	4

The following formula was used to find the t-value for related measures.

$$t = \frac{\overline{X} - \overline{Y}}{\sqrt{\dfrac{\Sigma D^2 - \dfrac{(\Sigma D)^2}{N}}{N(N-1)}}}$$

where D = difference score between each X and Y pair
N = number of pairs of scores

$$t = \frac{9.36 - 9.56}{\sqrt{\dfrac{198 - \dfrac{16}{25}}{25\ (25 - 1)}}}$$

$$t = .35$$

Conclusions and Implications

The results of this study found that using LOGO programming in the classroom and in the lab setting did not significantly improve mathematics achievement. This supports the findings of other research endeavors (Levin, Glass & Meister, 1987). The limited scope of the mathematics computation of the CAT was too narrow to address the particular strengths of LOGO programming. Until reliable testing can be developed, LOGO programming escapes the criteria of standard achievement tests. It is evident that more research is needed in the area, although an adequate test has not been established.

Seymore Papert (1987) strongly recommends the implementation of LOGO programming in an "open classroom" situation. This study did not have students in the treatment group working in an open classroom. Possibly, the free exploration of an open classroom allows for more leaning about the programming and more room for that to transfer into other areas of the curriculum. Other researchers who worked within regular classrooms likewise found little change in student achievement (Clements, 1986). Further research should continue in the open classroom situation, thereby allowing researchers the best conditions to conduct treatment. Similarly, this would allow for replication.

LOGO programming is exciting to students. They learn to talk to each other about geometric and spatial ideas. In addition, they calculate distances, plot locations and design graphics. Children are challenged when they work with LOGO in a way that other computer programs cannot offer. LOGO is motivational to students. Furthermore, LOGO has the extraordinary potential to cover more than one curriculum area. This is valuable as the demands of teaching additional subjects require educators to search for ways to integrate the curriculum. If LOGO is to be found to make a statistically significant difference in achievement, it can additionally enhance a student's learning experience by offering this integration of math and language. Furthermore, the motivational qualities of LOGO are an added incentive for both educators and students.

As a final note, it is important to remember in this technological age that it is ultimately the quality of teaching that reaches students. LOGO programming can expose students to new and powerful ideas yet it is the clear presentation and an exciting introduction that will stimulate the student's mind. The subject, the facilitator, the environment and the materials all combine to sharpen the child's achievement.

Chapter V

LIMITATIONS OF THE PROPOSED STUDY

Bias

Current LOGO theories must be first tested in a variety of systematic settings before they are implemented. As Becker (1987) states, many of the studies done do not represent accurate scientific investigations. One bias of research based on prior research is the falsifiability in the methodology. The review of literature indicated a weakness of the investigations in much of the research. This was due to the difficulty in securing tests which will accurately assess the cognitive advantages of learning LOGO. The basis of any new research is susceptible to the foundations of prior research. Moreover, different researchers employ different theories about LOGO. It is necessary for researchers to make concrete predictions and then be able to reproduce those conditions in any classroom in the country. More accurate, scientific research was needed in the area of LOGO programming to effectively assess the benefits and therefore reliably base further research (Mayer & Fay, 1987, Clements, 1987).

Another bias was the small sample size and no randomization. Six classrooms, rather than two would be a more reliable sample of the population. In addition, there were underlying effects that could also challenge the reliability. Among these were the Rosenthal effect in which the regular classroom teacher could have implemented teaching strategies that could have influenced a group's behavior either positively or negatively. Another bias which could have affected this research project was that students in the control group could have had LOGO programming at some other time in another institution. Also, it is possible that the control class could have found out about the LOGO programming experiment and therefore worked harder to compensate for this unbalance.

Equally important, the quality of the regular classroom teacher may have affected the outcome of this research. The amount of time spent in computational problem solving under the direction and strength of the teacher could have been significant for these findings. In addition, because the students were chosen for being in a particular classroom rather than randomly chosen could have affected the outcome of this study.

Possibly, the most influential limitation of this study was the discrepancy between what LOGO teaches and the criteria of the CAT. LOGO's strength revolves around the students learning about measurement and angle through problem solving experiences. The testing instrument used in this study does not reflect these abilities. To date, there is no reliable test that measures the amount of academic achievement students receive from LOGO enriched activities. Becker (1987).

Appendix B

List of LOGOwriter commands

bk	backspace
cg	clear graphics
end	
fill	
fd	forward
gp	getpage
home	
ht	hide turtle
lt	left
list	
load	
np	namepage
pd	pen down
pe	pen erase
printscreen	
printtext	
pu	pen up
repeat	
rt	right
setc	set color
setsh	set shape
square	
stamp	
triangle	

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