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THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

AN INVESTIGATION OF THE EFFECT OF THE SCIENCE CURRICULUM IMPROVEMENT STUDY'S FIRST YEAR UNIT, MATERIAL OBJECTS, ON GAINS IN READING READINESS

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SUBMITTED TO THE GRADUATE FACULTY

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AN INVESTIGATION OF THE EFFECT OF THE SCIENCE CURRICULUM IMPROVEMENT STUDY'S FIRST YEAR UNIT, MATERIAL OBJECTS, ON GAINS IN READING READINESS

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CHAPTER I

AN INVESTIGATION OF THE EFFECT OF THE SCIENCE CURRICULUM IMPROVEMENTS STUDY'S FIRST YEAR UNIT, MATERIAL OBJECTS, ON GAINS IN READING READINESS

When in 1649, the general court of the New England colonies decreed that each town of fifty householders was to insure each child training in the skills of reading and writing, the stage was set for a pattern in education which exists even today. "It was," observed the court, "the one chief project of the old deluder Satan to keep men from the knowledge of the scriptures."[1] The schools were developed to teach children to read for the primary purpose of reading the Bible and thereby frustrate "the old deluder" in his avowed objectives. Since that time elementary schools have held as a primary purpose (perhaps even the primary purpose) the development of a reading ability.

In 1931 Davidson found that first grade teachers spent an average of thirty percent of their time on teaching reading, while many teachers spent as much as fifty percent.[2] According to O'Brien in 1921, the

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[1]Adolphe E. Meyer, An Educational History of the Western World (New York: McGraw-Hill Book Company, 1965), pp. 188-189.

[2]Helen P. Davidson, "An Experimental Study of Bright, Average, and Dull Children at the Four Year Mental Level", Genetic Psychology Monographs, Vol. 9 (1931), No. 3, 4.

cost of reading in the first six grades was more than the combined cost of any two other subjects.[3]

The expenditure in time and money is, of course, an important item to any school system, but of more lasting importance is the effect of reading on the child. That brilliant though often eccentric Frenchman, Rousseau, said of reading: "It is the scourge of childhood."[4] Rousseau may have been right, because the primary cause of failure in the first grade is due to reading problems while even in the higher grades as many as twenty percent of failures are a direct result of poor reading.[5] Any innovation and/or methodology which could improve this situation would surely be a boon to education, and particularly to children.

In the past several years a great deal of attention has been directed toward reading readiness. Most authorities have agreed that in order for the child to be successful in beginning reading he must first have experiences which will lead to the development of skills such as left to right progression and shape recognition.[6] These abilities are

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[3]John A. O'Brien, Reading: Its Psychology and Pedagogy (New York: Appleton Century Co., 1921), p. 20.

[4]Meyer, op. cit., p. 336.

[5]Albert J. Harris, How to Increase Reading Ability (New York: Longmans Green & Co., 1940), pp. 2-3.

[6]James A. Smith, Creative Teaching of Reading and Literature in Elementary School (Boston, Mass.: Allyn and Bacon Inc., 1967) p. 114.

essential prerequisites of readiness for the actual reading program Austin and Morrison described some essential ingredients of a good prereading program when they said it should be: ". . . activities to help children associate and classify data, to observe and remember details. . ."[7]

In a study completed in 1965, Almy found that the child's success in beginning reading was related to his ability to conserve.[8] This ability to conserve was measured by a series of tasks related to number, liquid, volume, length, solid amount and others all of which are described in her report. Almy says ". . . the findings in our studies of a rather substantial correlation between performance in conservation tasks and progress in beginning reading suggest that to some extent similar abilities are involved. A program designed to nurture logical thinking should contribute positively to readiness for reading."[9]

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[7]Mary C. Austin and Coleman Morrison, "The First R": The Howard Report, Reading in the Elementary Schools (New York: MacMillan Co., 1963), p. 15.

[8]Within the context of this dissertation conservation is taken to mean the ability to recognize certain physical constants of an object such as volume, weight, number or length even when that object is undergoing or has undergone a physical change such as deformation or subdivision.

[9]Millie Almy, Young Children's Thinking (New York: Teachers College Press, Columbia University, 1967), pp. 139-140.

In 1968 - 1969 Stafford, working with first grade children, showed that the use of the Material Objects[10] unit from the Science Curriculum Improvement Study would significantly accelerate the attainment of conservation abilities.[11] In that research Stafford used the same tasks with the children which were used by Almy. The inference, therefore, is that children's reading abilities should be assisted by studying Material Objects.

The Science Curriculum Improvement Study (SCIS), was inaugurated in 1965 by Robert Karplus with the aid of a National Science Foundation Grant. The SCIS has as its purpose ". . . to develop a teaching program to increase the scientific literacy in the school and adult population."[12]

Material Objects is the first year physical science unit in the SCIS program. This unit consists of a series of activities which cause the child to make observations. The following quotation expresses the SCIS viewpoint.

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[10]Material Objects is the title of the first level unit in physical science, developed by the Science Curriculum Improvement Study at the University of California in Berkeley, California. This project is directed by Dr. Robert Karplus.

[11]Donald G. Stafford, "The Influence of the First Grade Program of the Science Curriculum Improvement Study on the Rate of Attainment of Conservation", (unpublished Ph.D. dissertation, University of Oklahoma, 1969).

[12]Herbert Thier and Robert Karplus, "Science Teaching is . . . Becoming Literate!", Education Age (Jan. - Feb., 1966), pp. 40-45.

> "The objects themselves are to be distinguished from their properties (shape, color, texture, size, etc.), from the influence or effect they have on one another, from the patterns in which they may be arranged, and from the emotions they arouse . . . we shall concentrate on the properties of objects."[13]

Statement of the Problem

This study investigates whether or not a relationship exists between the use of Material Objects as a pre-reading program and the child's gains in Reading Readiness. The study ties together the findings of Almy (success in beginning reading is rather substantially related to conservation abilities), and Stafford (the use of Material Objects significantly accelerates the attainment of conservation abilities).

The Hypothesis

The Material Objects unit when used as a pre-reading program will enhance success in beginning reading by accelerating attainment of conservation.[14] In order to test that specific hypothesis the following statistical hypothesis was tested:

> There is no difference at the 0.20 level of significance in gain in reading readiness, as measured by gain in mean scores on the Metropolitan Reading Readiness Test, between students who

---

[13]Science Curriculum Improvement Study, Material Objects Teacher's Guide, Preliminary Ed., (Boston: D. C. Heath Co., 1966), p. 6.

[14]Stafford. Op. Cit.

have experienced the Material Objects unit as a reading readiness program as compared to students who have experienced a conventional reading readiness program.

The Research Design

In order to implement testing of the hypothesis, the cooperation of the Ada, Oklahoma, Public School System was obtained. Ada, a community of approximately 13,000 population, is located in southeastern Oklahoma. The city acts as a service area for a rather extensive surrounding rural area. The population is composed of primarily merchants, service personnel, small industry employees and ranchers. In addition to five elementary schools, a junior high school and a senior high school, Ada is the home of East Central State College. Four first grade classrooms were selected to participate in this project. Two classrooms (Groups I-A and I-B) used the Material Objects unit as a reading readiness program and received no instruction in beginning reading until the unit was completed, which required about six weeks. The remaining classrooms (Groups II-A and II-B) used the reading readiness program currently employed in the Ada School System. Both groups completed the Metropolitan reading readiness tests at the beginning of the school year and again at the time Group I completed the Material Objects unit.

The Teachers Involved in the Research

During the spring of 1968 a Cooperative College School Science Grant was issued to East Central State College by the National Science Foundation. During the preparation for the summer phase of this program the director, the investigator, in consultation with John W. Renner of the University of Oklahoma, first conceived the idea for this research. In order to carry out the research, highly competent teachers, trained in the techniques of inquiry teaching, would have to be located for both the experimental and control classrooms.

Throughout the two three week summer workshops in 1968, while preparing 45 Ada Elementary teachers to implement the SCIS program in their classes in the fall, the investigator watched first grade teachers quite carefully in order to select those who would be available to participate in this research at a later date.

The academic year 1968 - 1969 were spent visiting Ada classrooms as a consultant to aid in the implementation of the inquiry science program by the SCIS. During this year, eight first grade teachers were observed almost weekly and special consideration was given to their ability to teach by the inquiry method which the SCIS program requires. At the end of that school year, four were selected and all agreed to participate in this research. Each had

demonstrated not only command of the program (Material Objects) but in addition an ability to help children learn to do their own thinking.

The Teacher Variable

At present no acceptable instrument is available to evaluate a teacher's ability to teach reading or science, or, for that matter, any other subject. In order to minimize the teacher variable as much as possible, teachers for both the control and the experimental group were selected who possess the following:

1. Outstanding performance in a three-week summer workshop in inquiry science using SCIS materials.
2. One year of experience with the Material Objects unit.
3. An expressed willingness to participate in the research project.

The Student Variable

In this particular research design the factor of particular concern is that the two groups be as much alike as possible. Since no intelligence tests are given in the Ada School System to first grade children, common criteria (in addition to the teacher) had to be established to select the classrooms used. In selecting the classrooms for this study, the following criteria have been considered:

1. Similar socio-economic background of the patrons.

2. Equality of previous classes on I.Q. scores obtained at the second grade level as indicated by t-tests on mean I.Q. scores for the previous three years.

3. Comparable percentage of previous students who have completed highschool and entered college.

The Statistics

In order to test Hypothesis 1, the following procedure was used. The Metropolitan Reading Readiness Test was given to each class at the beginning of the school year before the Material Objects unit or conventional reading readiness programs were begun. The means of these tests were evaluated by the t-test to determine if there were any statistical differences among the groups in regard to reading readiness at the beginning of the school year.

The t-values were obtained by means of the relationships:

$$t = \frac{X_1 - X_2}{Sd}$$

where X_1 and X_2 are the mean scores on the Metropolitan Reading Readiness Test for both the control and the experimental groups and

$$Sd = \sqrt{\frac{(N_1 - 1)S_1^2 + (N_1 - 1)S_2^2}{N_1 + N_2 - 2}} \cdot \sqrt{\frac{1}{N_1} - \frac{1}{N_2}}$$

[15] where

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[15] G.H. Weinberg and J.A. Schumaker, Statistics An Intuitive Approach (Belmont, California: Wadsworth Publishing Company, Inc., 1965), 201.

N_1 and N_2 are the numbers of individuals taking the test in each group and S_1 and S_2 are the standard deviations for each group and are given by:[16]

$$S = \frac{(\Sigma X)^2}{N - 1} - \frac{\Sigma (X)^2}{N(N - 1)}$$

When Group I completed the Material Objects unit the Metropolitan Reading Readiness test was again given to each group. The t-tests were again employed to determine differences among groups in the following manner.

Group I $\Leftrightarrow$[17] Group II $\Rightarrow$[18] t (Pre test)

Group I $\Leftrightarrow$ Group II $\Rightarrow$ t (Post test)

Group I $\Leftrightarrow$ Group II $\Rightarrow$ t (Gains)

In order to reject the hypothesis previously stated, the gains in reading readiness scores should be significant in favor of Group I-A and I-B.

The level of significance (0.20) used to test the hypothesis was chosen in order to make the statistics more prone to produce a type - I error, i.e., rejecting a true hypothesis. The reasoning behind this decision was deliberate and should be fully understood. Assume

---

[16] Ibid, 185.

[17] The symbol $\Leftrightarrow$ has the meaning "is compared to".

[18] The symbol $\Rightarrow$ has the meaning "to obtain".

for a moment that the hypothesis is true (there is no difference in gains between groups in reading readiness). It seems reasonable to infer in this case that Material Objects has then functioned not only in its role as a science program, but at the same time has caused gains in reading readiness equal to a conventional program. It has then served a dual purpose at a cost which would be less than the cost of two programs (reading readiness and science). A type I error has then produced no undesired results either educationally or financially.

If, on the other hand a type II error should be committed (a false hypothesis accepted) when in fact the experimental group gained as well or better than the control group, the value of the Material Objects unit might not come to light. Most schools are reluctant to spend money for science in the primary grades, choosing instead to use the greater part of their funds for reading readiness and reading. If a type II error were committed the child might be deprived of a set of experiences, (Material Objects) which would serve the dual purpose of science education and reading readiness. Such an event would be educationally harmful. This, then, displays the investigator's willingness to tend toward the type I error.

Related Research

The researches by Stafford and Almy referred to earlier represent the inspiration for this study. Almy, by indicating the relationship between ability to conserve and success in beginning reading, has isolated a set of easily measured characteristics which can be used as indicators of reading readiness. Prior to this work, attempts had been made to identify reading readiness through such items as the "Draw A Man Test," recognition of geometric shapes, and letter matching. In addition, several studies (Drukin[19], Gates[20], and Roslow[21]) showed that the use of intelligence tests as indicators of success in beginning reading was less than adequate. All factors considered, the work of Almy is likely to become a most accurate and convenient method for determining reading readiness. The work of Stafford which was previously mentioned showed that the use of the Material Objects unit can significantly enhance the attainment of conservation abilities.

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[19]Delores Durkin, "Children Who Read Before Grade One," The Reading Teacher, Vol. 14, (Jan., 1961), pp. 163-166.

[20]Arthur Gates, "The Necessary Mental Age for Beginning Reading," Elementary School Journal, Vol. 37, (March 1937) pp. 397-408.

[21]Sidney Raslow, "Reading Readiness and Reading Achievement in the First Grade," Journal of Experimental Education, Vol. 9 (Dec., 1940) pp. 154-159.

No instance of research related to the effectiveness of a specific curriculum program, not originally designed for reading readiness in beginning reading, has been found by this investigator.

CHAPTER II

PRESENTATION AND DISCUSSION OF THE DATA

The data collected in order to evaluate the research hypothesis are presented in this chapter with minimum discussion except for points needed to clarify them.

> Hypothesis: There is no difference at the 0.20 level of significance in gain in reading readiness, as measured by gains in mean score on the Metropolitan Reading Readiness Test, between students who have experienced the Material Objects unit as a pre-reading activity as compared to students who had not had these experiences but have had experience with the Harper & Row Reading Readiness Program.

Table I displays the total and subtest scores on the Metropolitan Reading Readiness Test for the pre- and post-tests as well as the gains in each area. This table clearly shows that the experimental group achieved a greater total gain in reading readiness than did the control and also outgained the control in five of the six sub-test areas. Only in the copying sub-test was the control able to

Table I

Metropolitan Reading Readiness Scores (Pre- Post- Gain)

	Control			Experimental		
	Pre	Post	Gain	Pre	Post	Gain
Word Meaning	11.09	11.53	0.43	9.54	11.16	1.62
Listening	11.56	12.90	1.34	11.45	12.89	1.43
Matching	10.56	12.28	1.71	9.67	12.48	2.81
Alphabet	11.56	15.50	3.84	10.86	15.16	4.29
Numbers	15.96	19.68	3.71	15.27	20.21	4.94
Copying	10.68	12.12	1.43	10.56	11.86	1.29
Total	71.21	84.03	12.81	67.27	83.62	16.53

outgain the experimental. It may also be noted that on the pre-test the control group outscored the experimental in all six of the sub-test items.

Table II displays the t values and levels of significance for the changes in scores both on the sub-tests and on the total score.

Table II

Gains in Scores, Levels of Significance

Sub Test	Change Control	Change Experimental	t value	Level of Significance
Word Meaning	0.43	1.62	-1.9041	.1 → .05
Listening	1.34	1.43	-0.1377	not significant
Matching	1.71	2.81	-1.5426	.2 → .1
Alphabet	3.84	4.29	-0.5010	not significant
Numbers	3.71	4.94	-1.4599	.2 → .1
Copying	1.43	1.29	0.2202	not significant
Total	12.81	16.35	-1.4511	.2 → .1

N for Control = 32 N for Experiment = 37 Degrees of freedon = 67

The levels of significance show a marked superiority in gains for the experimental over the control with reasonable certainty that these results are not simply chance variations. Note particularly the t values for matching and numbers and remember the essentials of a good reading program: ". . . activities to help the child associate and classify data, to observe and remember details . . ."[22]

The graphs on pages 17 - 24 display the data from Table I. The superiority of the experimental group over the control in total gain is most clearly shown by Graph I to be composed primarily of the gains in word meaning, matching and numbers. This should be expected since these factors are essential ingredients of scientific inquiry. Notice should be taken that of those areas usually associated with the language skills, i.e., listening, alphabet and copying, the experimental group had superior gains in two of those three. Graphs III and IV show that the essence of the significance of these changes lies in the fact that the experimental group started at a lower level of reading readiness than did the control and caught up. Graphs V and VI display the data by sex and indicate that the greatest gains came about in the girls experimental group.

A listing of the raw data may be found in the appendix to this dissertation.

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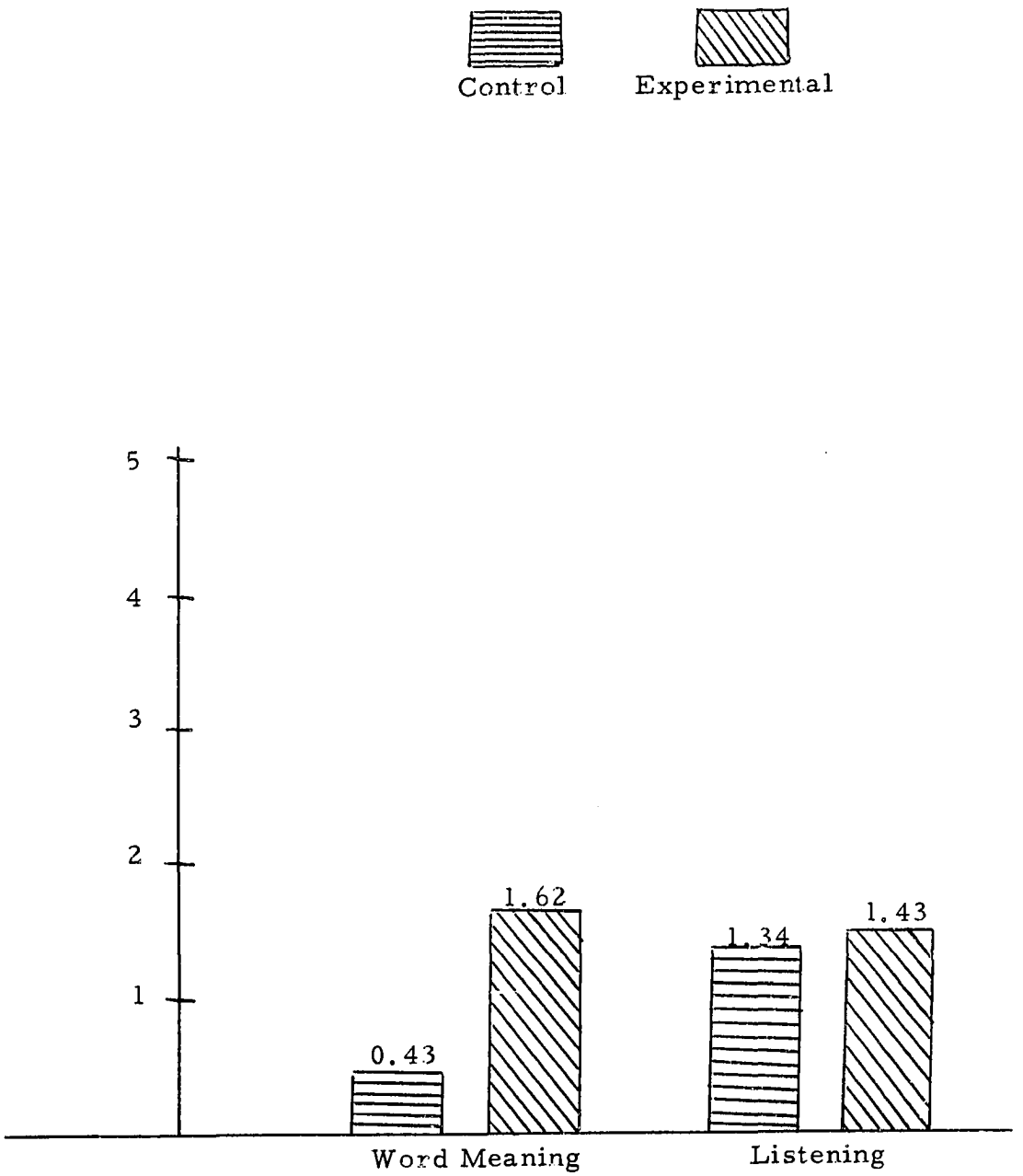
[22] Op. cit., Austin and Morrison, p. 15.

Graph I

Average Gain in Metropolitan Sub test Scores



Graph I (con't.)

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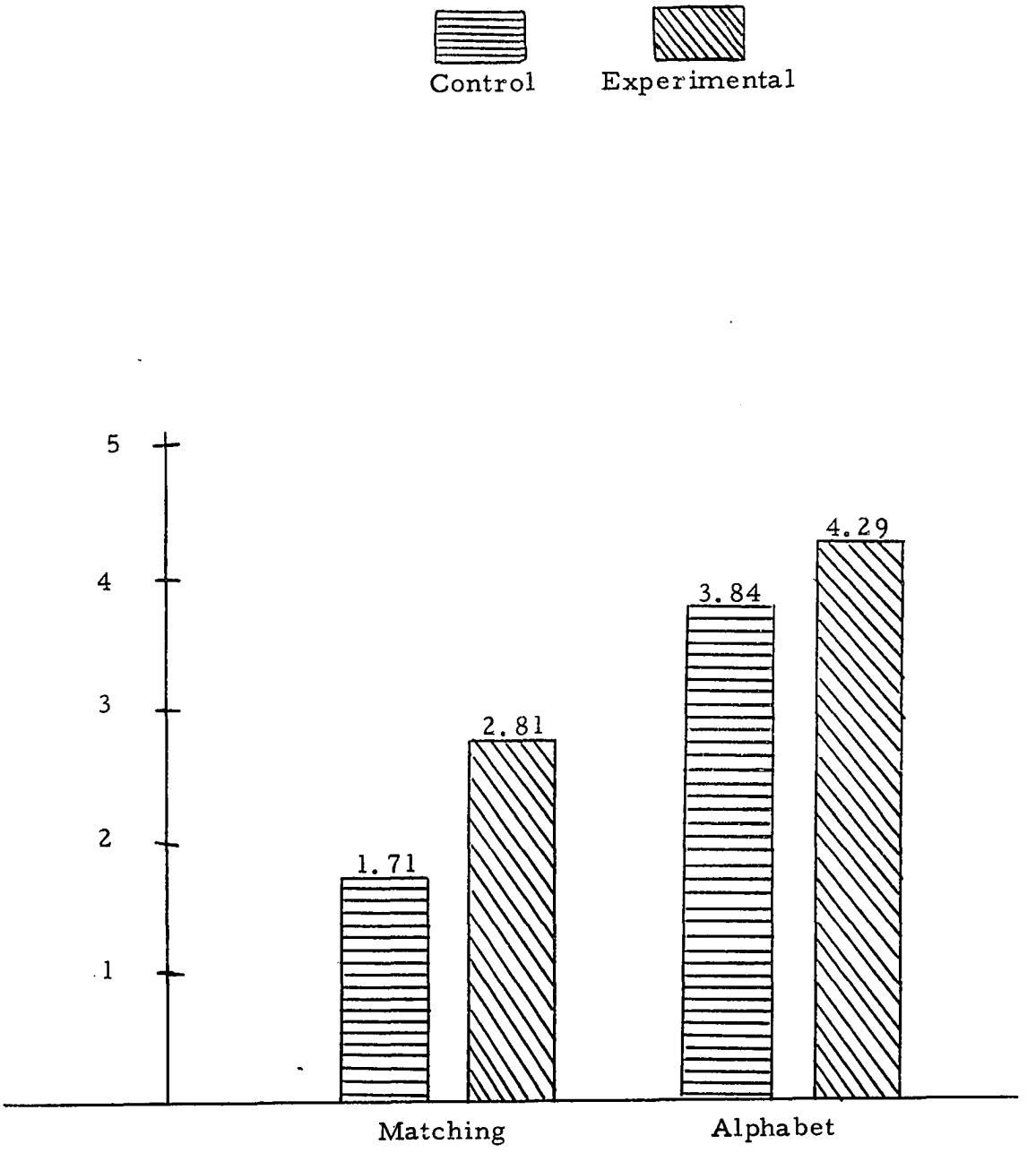

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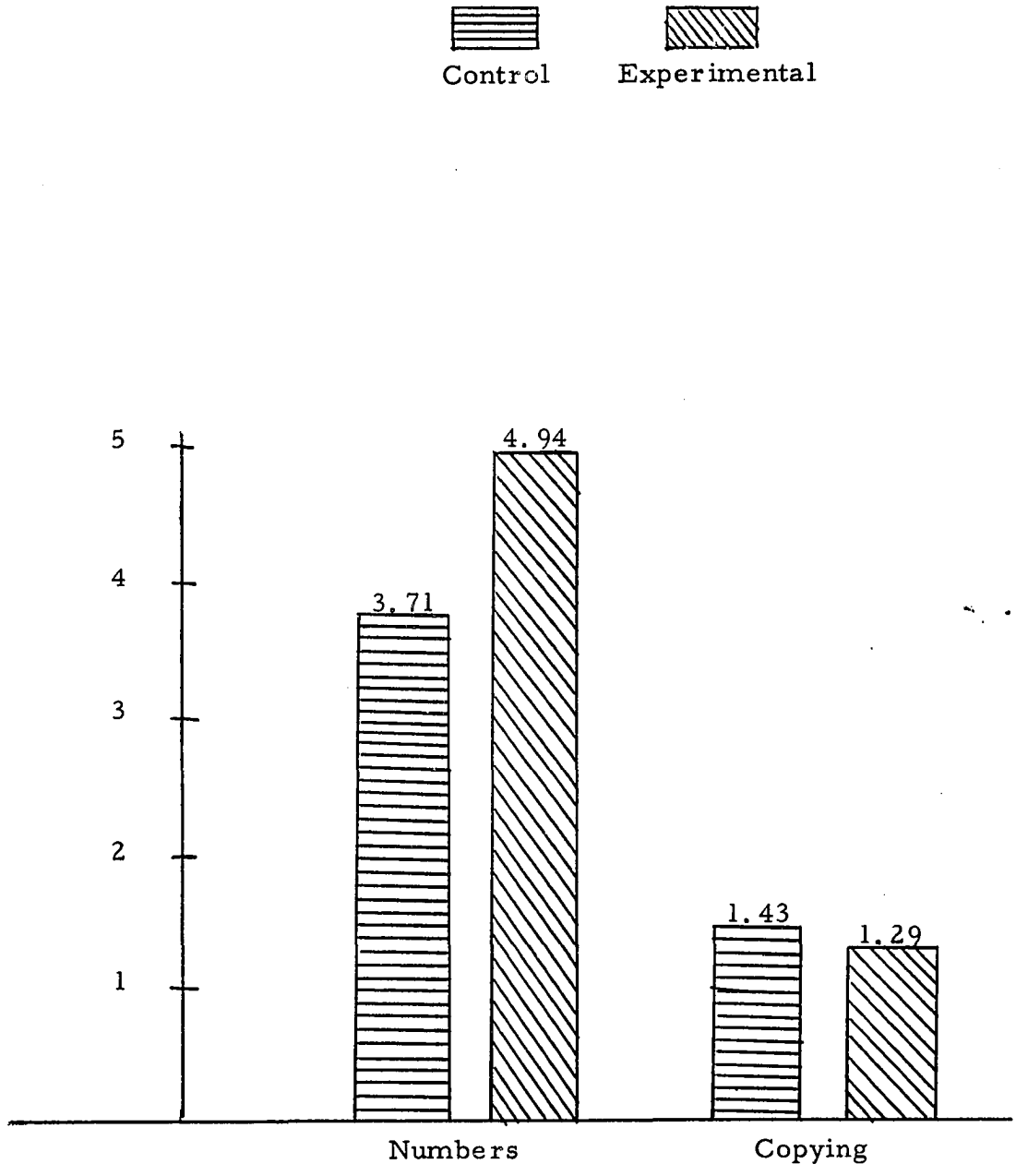
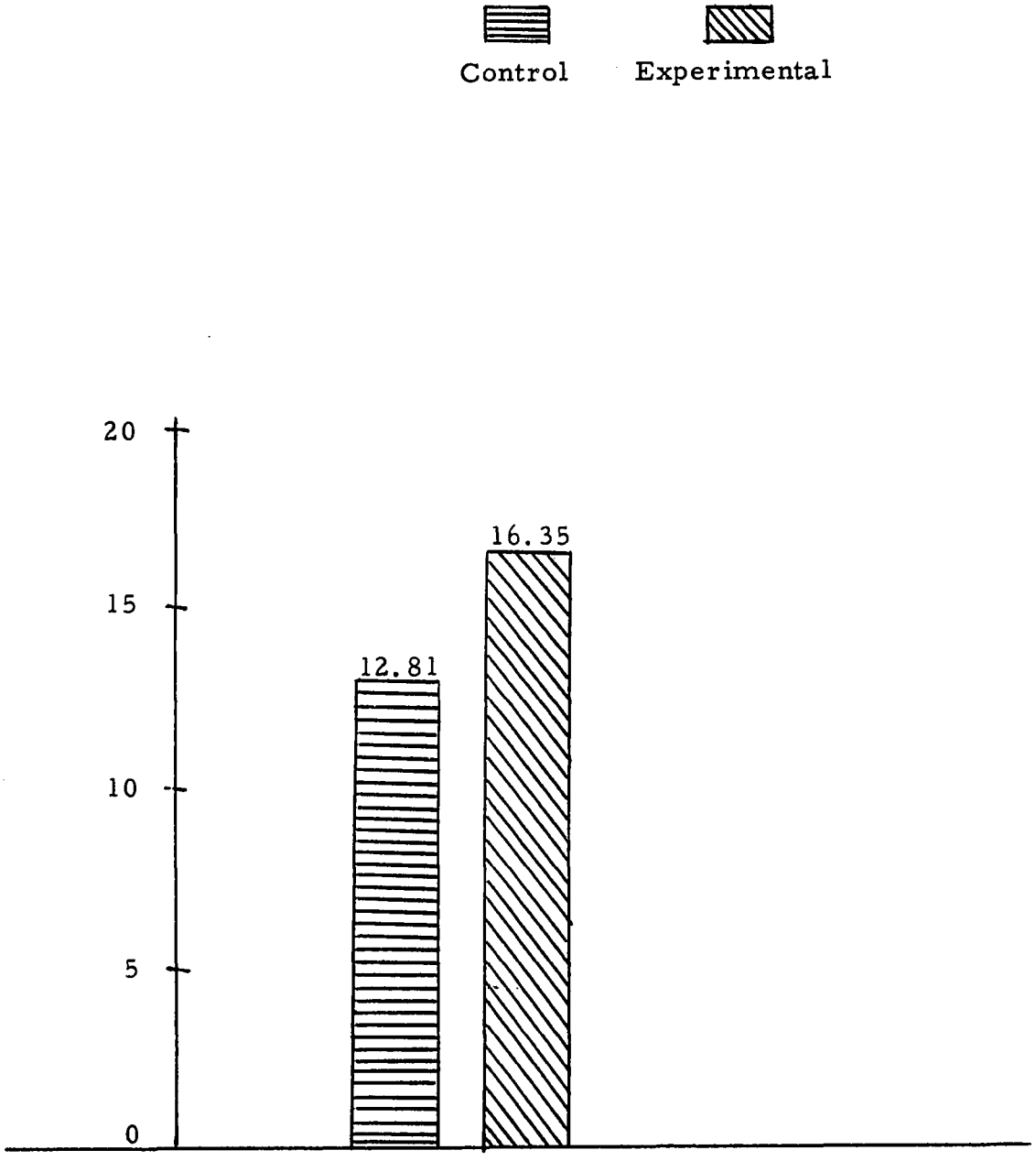
Average Gain in Metropolitan Sub test Scores



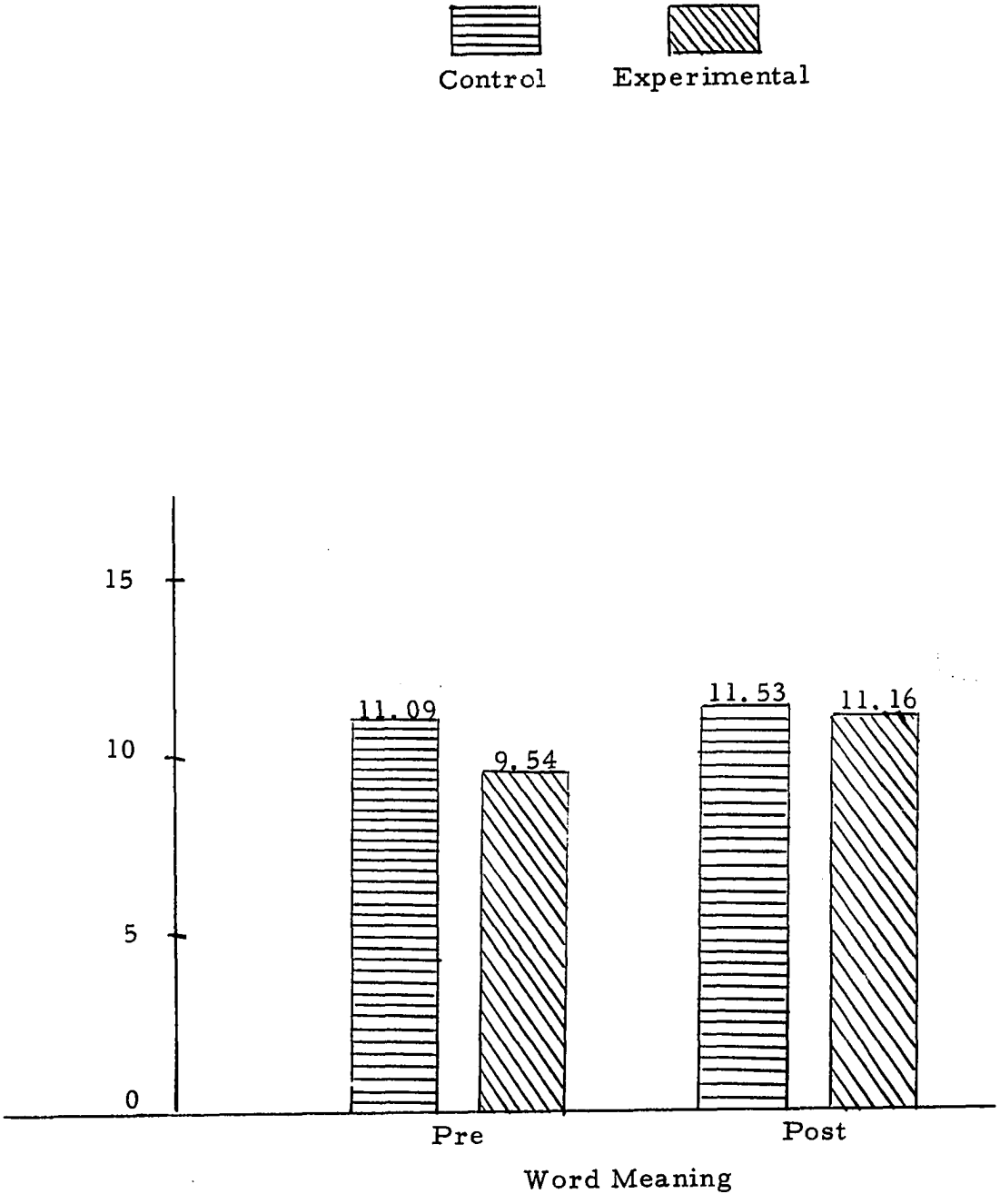
Graph II

Average Gain in Total Metropolitan Score



Graph III

Average Scores on Metropolitan Sub-tests Pre and Post



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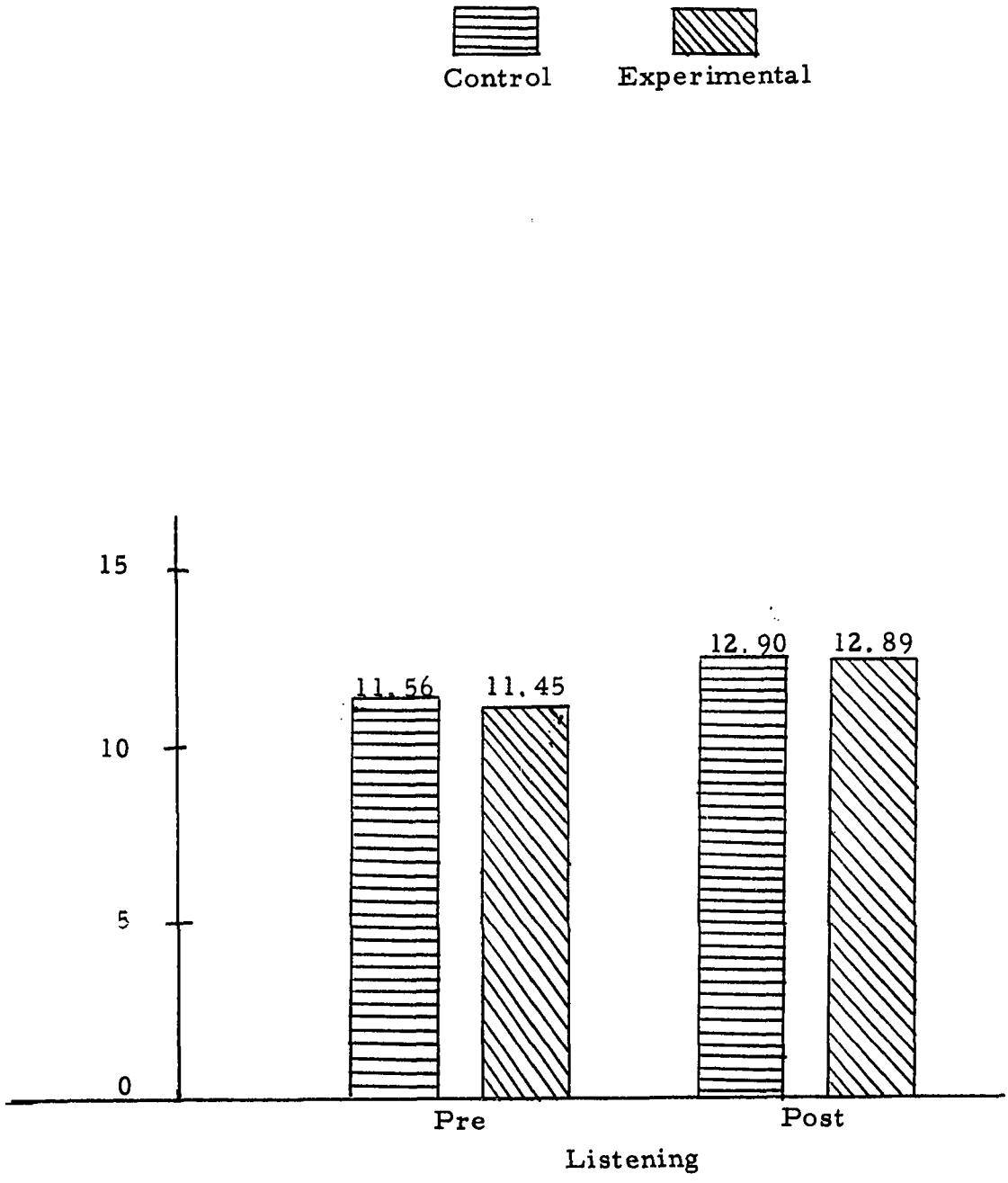

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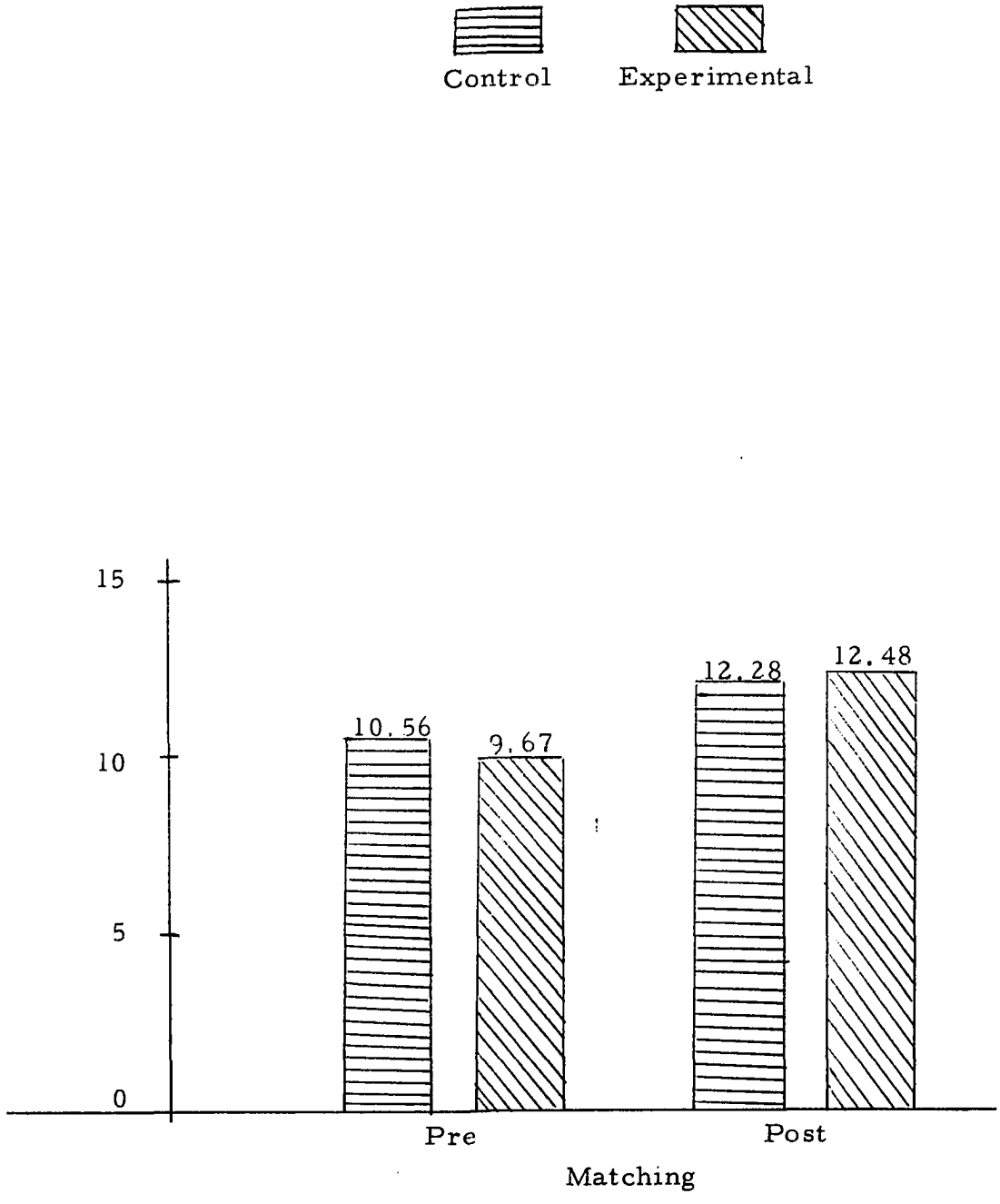
Average Scores on Metropolitan Sub-tests Pre and Post



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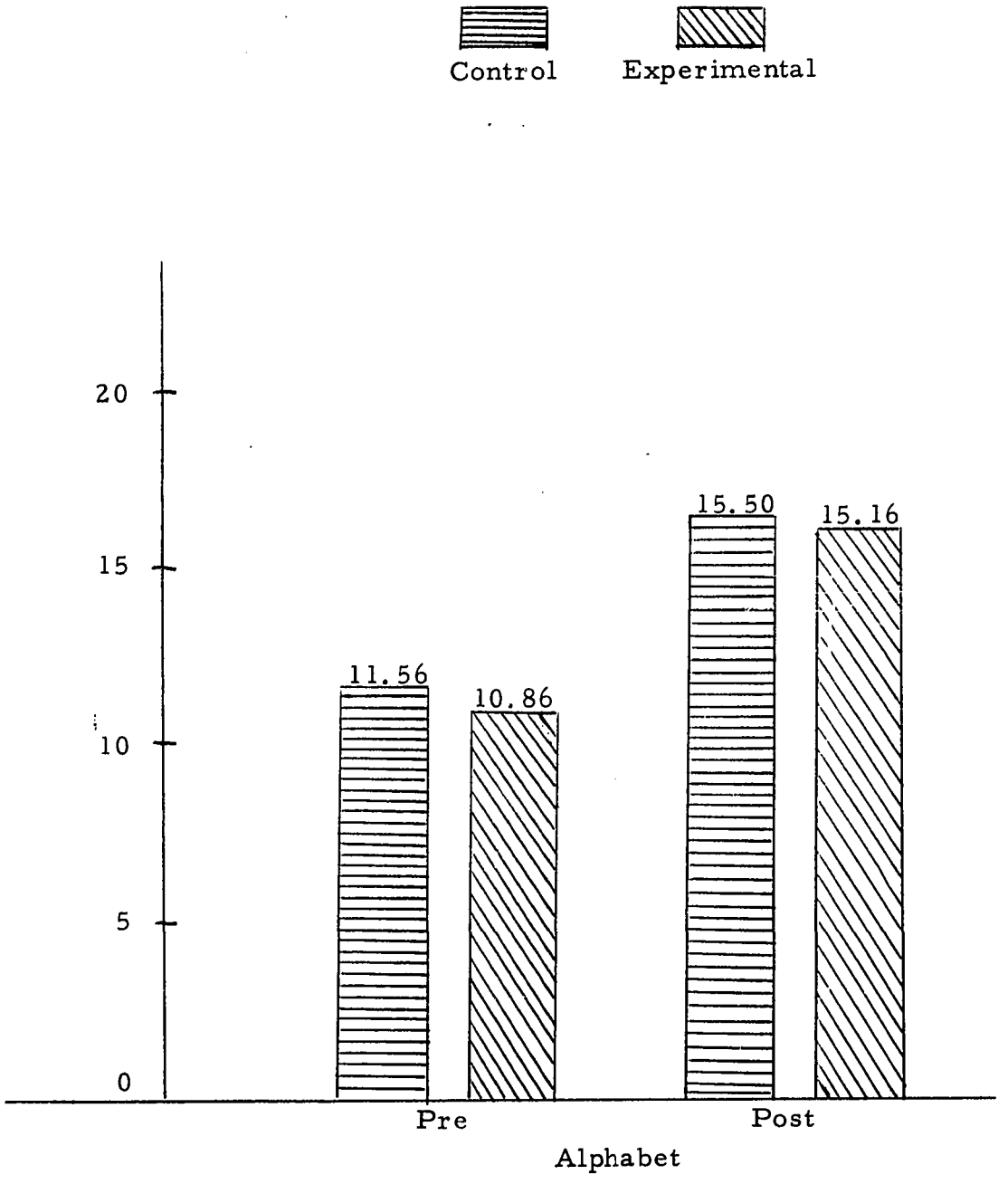
Average Scores on Metropolitan Sub-tests Pre and Post



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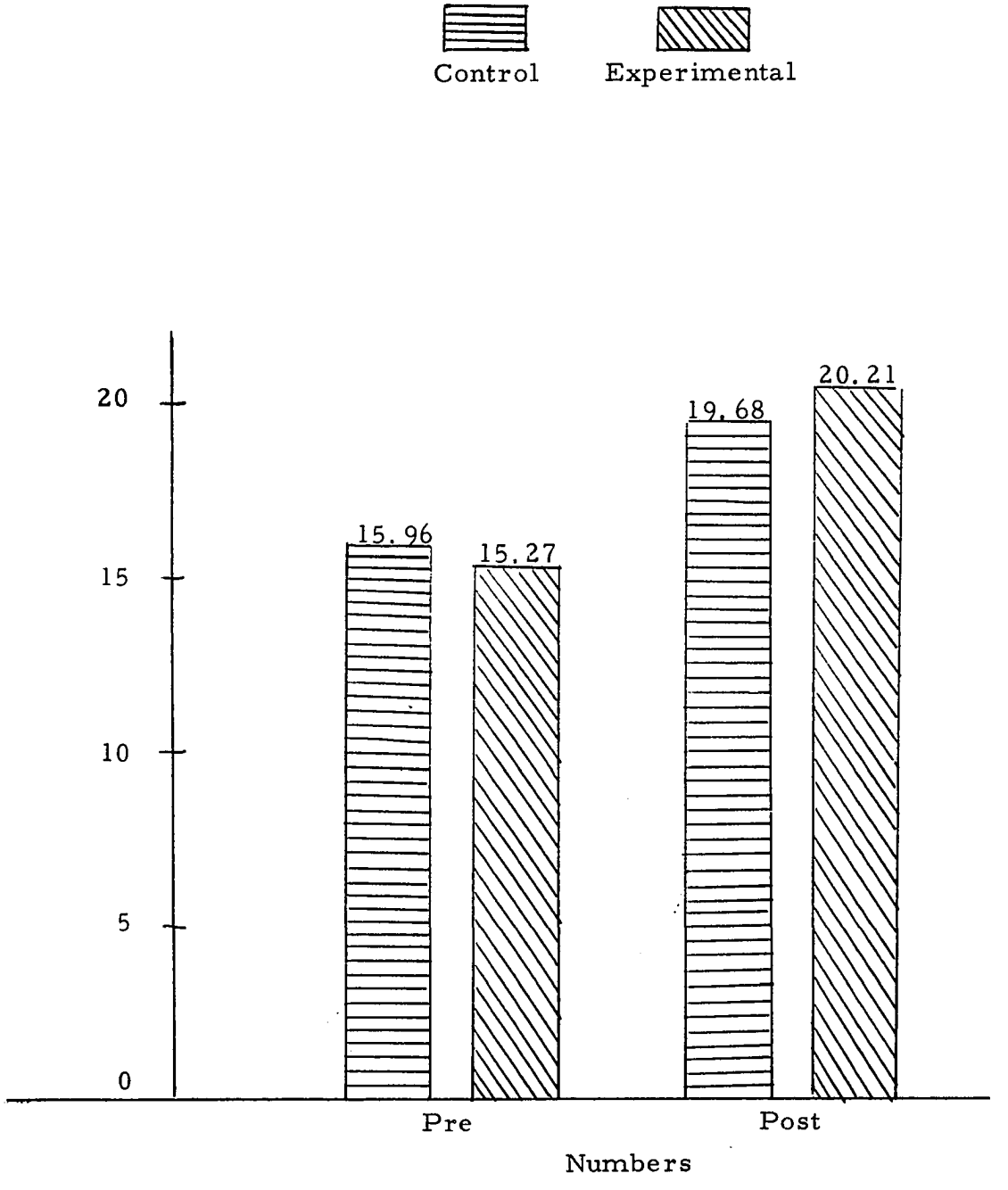
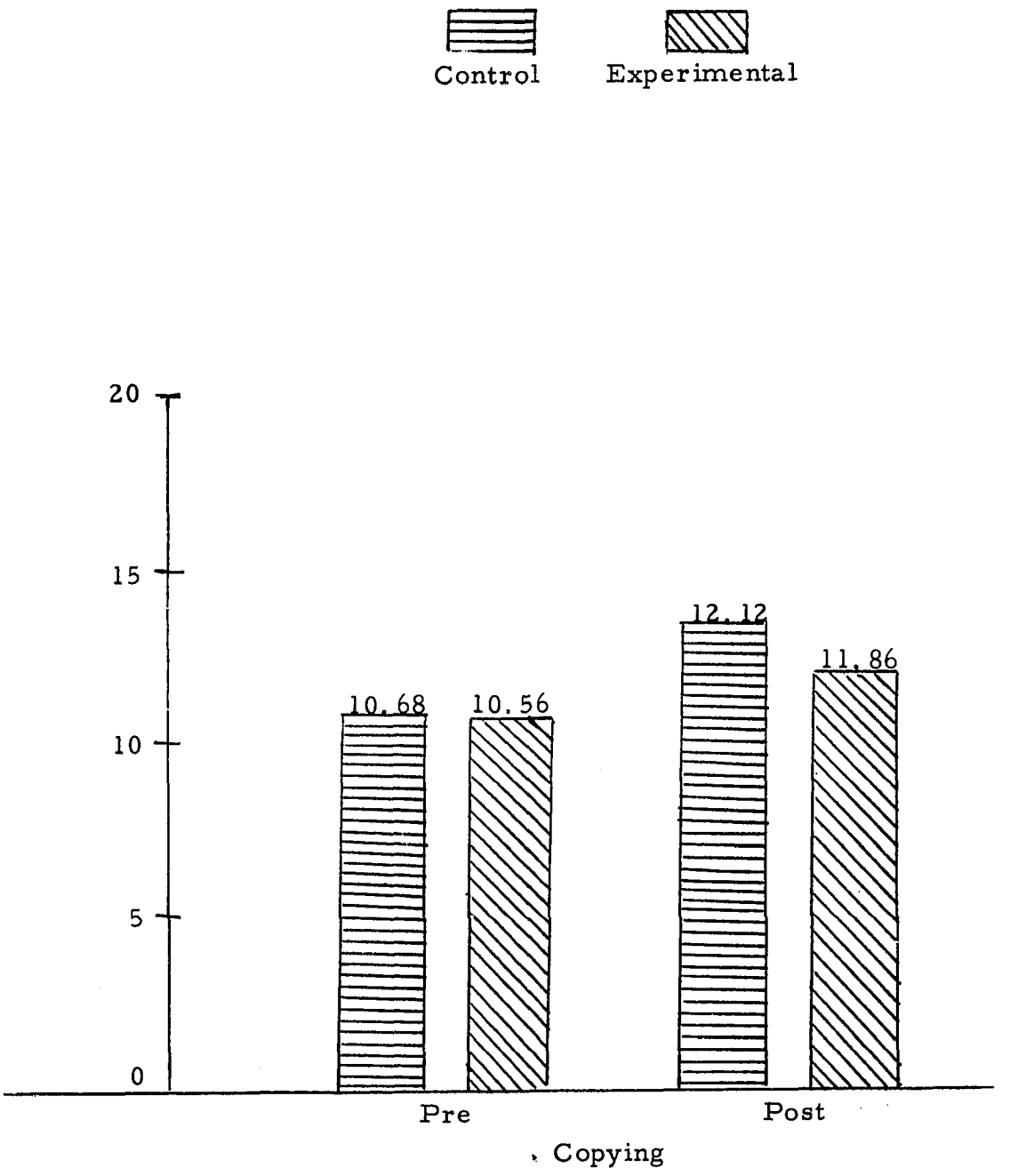
Average Scores on Metropolitan Sub-tests Pre and Post



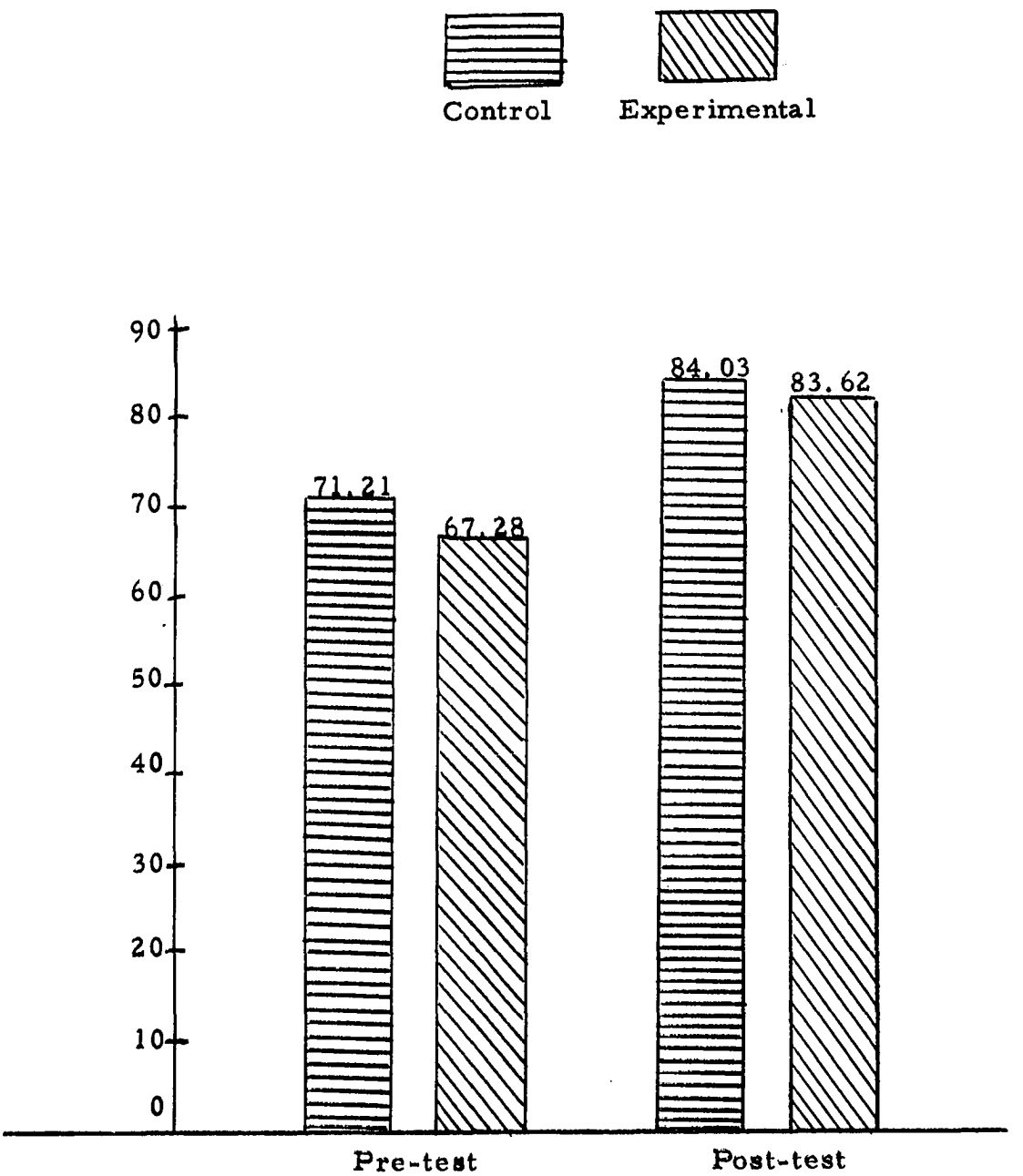
Graph III (con't.)

Average Scores on Metropolitan Sub-tests Pre and Post



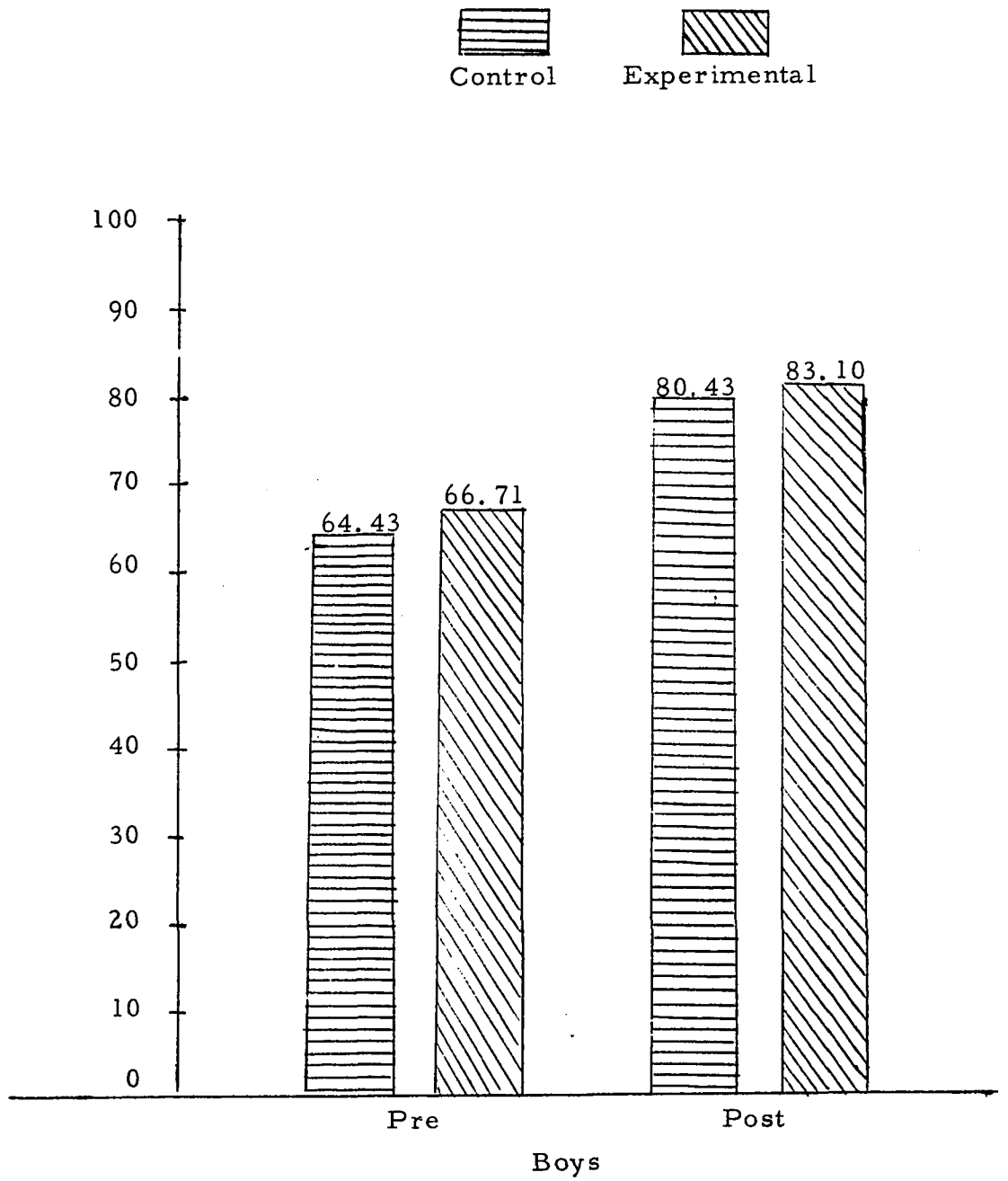
Graph IV

Average total Score on Metropolitan test Pre and Post



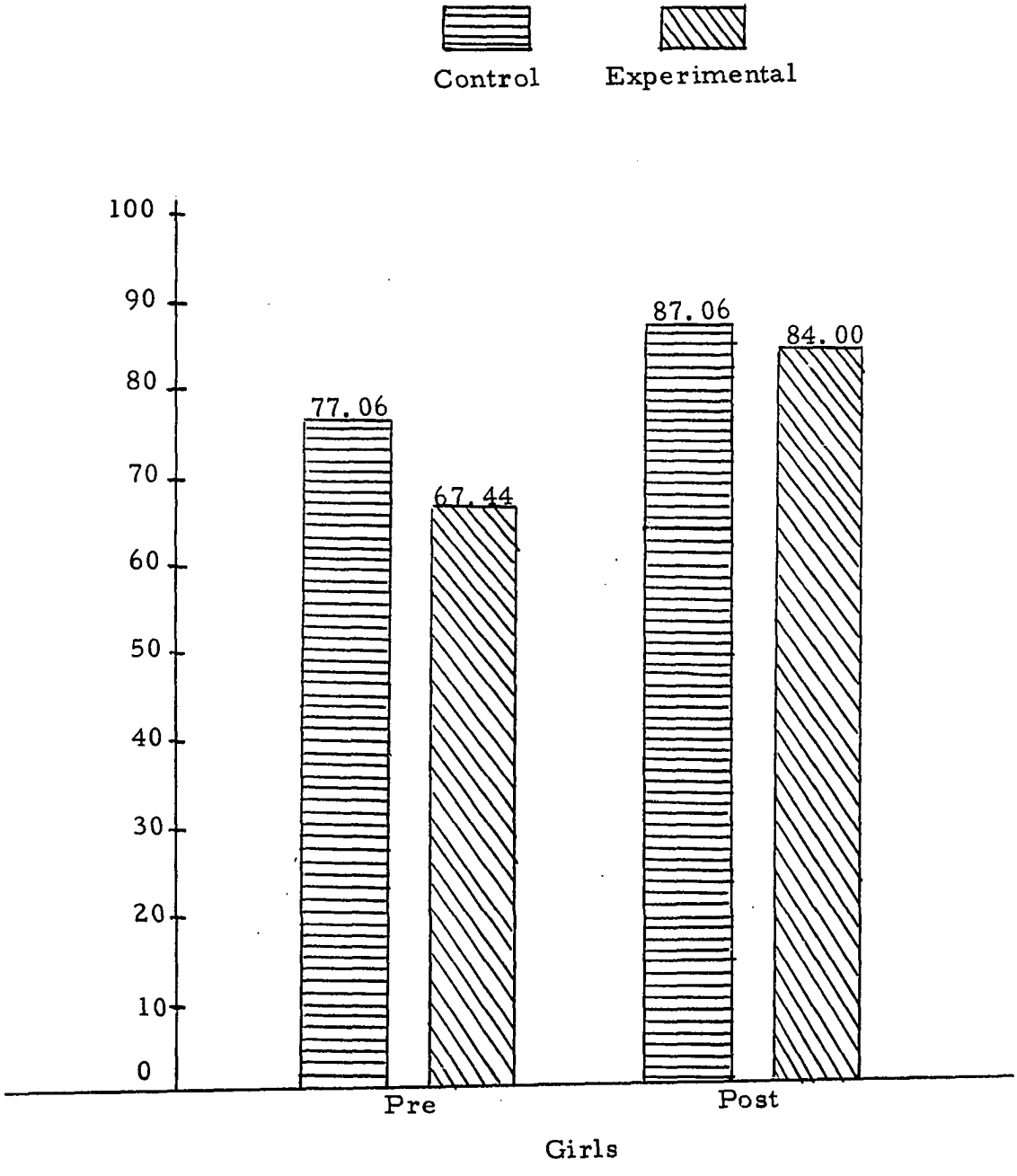
Graph V

Average total Metropolitan Score by Sex



Graph V (con't.)

Average total Metropolitan Score by Sex



Graph VI

Average Gain in total Metropolitan Score by Sex

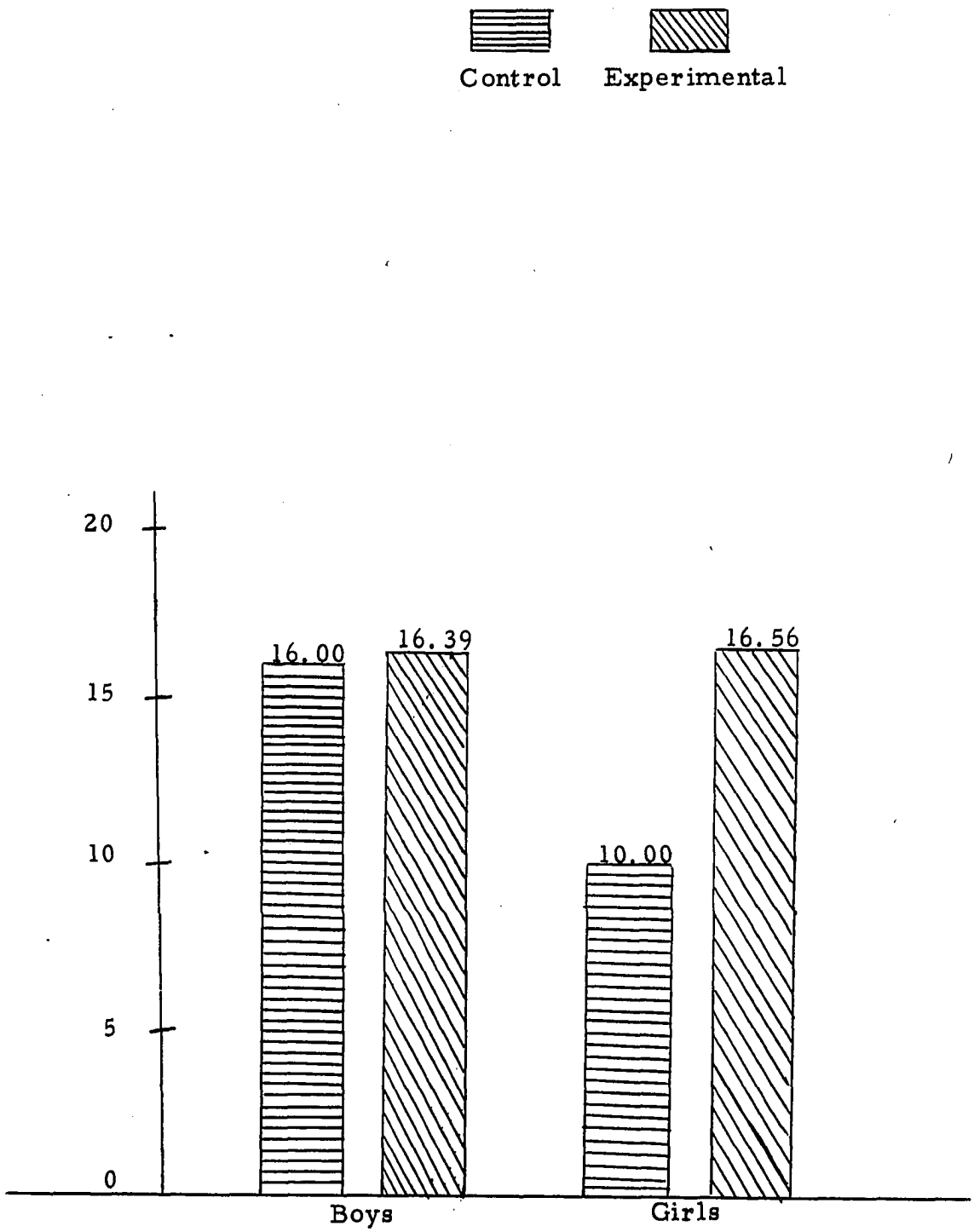


Table III

Significance of Pre and Post Test Scores

Control Group		Experimental Group		t	Significance
Pre Test	Post Test	Pre Test	Post Test		
71.21		67.27		0.9193	None
	84.03		83.62	0.1697	None

CHAPTER III

CONCLUSION, EDUCATIONAL IMPLICATIONS AND SUGGESTIONS FOR FURTHER STUDY

The tabular and graphic displays of the data show certain trends and the statistical treatment lends a scientific validity to those data. There are, however, certain factors in this study that neither statistics nor graphs clearly show and those might go unnoticed if they were not examined more closely. A consideration of some of those foactors plus an analysis of the findings follows.

Word Meaning Sub Test

In this area the experimental group out-gained the control by a margin of 1.62 to 0.43. The results of the pre-test showed that the control out-scored the experimental by an average of 1.57 points on word meaning; the post-test shows the control group ahead by 0.37 points. When the difference in those gains was tested with a t-test, it was found to be significant at between 0.05 and 0.10 levels. That level of significance is sufficient to reject the hypothesis that there are no differences in gains in reading readiness, as indicated by word meaning mean scores, between the group whick experienced Material Objects as a reading readiness program and the group which experienced the Harper & Row Reading Readiness Program. This level of significance favors the experimental group.

Listening Sub Test

The gains on this sub-test were quite comparable for both groups, i.e., 1.34 for the control and 1.43 for the experimental group. The experimental did outgain the control group. The level of significance of that difference, which was less than 0.50 when a t-test was applied, does not warrant the rejection of the hypothesis that there are no differences in gains in reading readiness, as indicated by listening skills mean scores between the group which experienced Material Objects as a reading readiness program and the group which experienced the Harper & Row Reading Readiness Progeam. The hypothesis of no difference was accepted.

Matching Sub Test

On the development of the ability to match, the experimental group scored an average of 0.89 points per student lower than the control group on the pre-test yet outscored the control by 0.20 per student on the post-test. The experimental outgained the control group 2.81 to 1.71. When the t-test is applied to the difference in those gains the level of significance obtained is between 0.10 and 0.20 in favor of the experimental group. That difference is sufficient to reject the hypothesis that there are no differences in gains in reading readiness, as indicated by matching ability mean scores, between the group which experimented Material Objects

as a reading readiness program and the group which experienced the Harper & Row Reading Readiness Program. The difference was in favor of the experimental group.

Alphabet Sub Test

On the alphabet pre-test the experimental group was outscored by the control by an average of 0.70 points per student. Both groups showed good gains in this area and the experimental group pulled to within 0.36 points per student of the control on the post-test to establish a superior gain of 4.29 for the experimental to 3.84 for the control. The level of significance for the difference, as indicated by the t-test was less than 0.50. This was insufficient to reject the hypothesis that there are no differences in gains in reading readiness, as indicated by mean scores on alphabet understanding, between the group which experiences Material Objects as a reading readiness program and the group which experienced the Harper & Row Reading Readiness Program. The hypothesis of no difference is accepted here.

Numbers Sub Test

The most striking differences in the entire research showed up on the numbers subtest. The experimental group was outscored by the control group on the pre-test by an average of 0.69 points per student. Both groups again made good gains

but on the post-test the experimental group outscored the control by an average of 0.53 points per student. The gains were 3.84 for the control group to 4.29 for the experimental group. The t-test yielded a level of significance of between 0.10 and 0.20 in favor of the experimental group. That level of significance, then, is sufficient to reject the hypothesis that there are no differences in gains in reading readiness, as indicated by mean scores on number skills, between the group which experienced Material Objects as a reading readiness program and the group which experienced the Harper & Row Reading Readiness Program. The difference favors the experimental group.

Copying Sub Test

Copying represents the only area in which the experimental group was outgained by the control group. The difference between the groups on the pre-test was 0.12 points per student in favor of the control group. On the post-test the difference was 0.26 points per student again in favor of the control group. The level of significance for the difference in gains, using the t-test, was not sufficient to reject the hypothesis that there are no differences in gains in reading readiness, as indicated by mean scores on copying ability, between the group which experienced Material Objects as a reading readiness program and the group

which experienced the Harper & Row Reading Readiness Program. The difference favors the control group.

Total Scores

The total score for the pre-test was an average of 71.21 points per student for the control and 67.28 points per student for the experimental group which is a difference of 3.93 points per student. The post-test scores were 84.03 points per student for the control and 83.62 points per student for the experimental group representing a difference of only 0.41. In the experimental group each of the 37 students gained in total reading readiness while in the control group, one student showed no change, four showed a loss and 27 gained. The experimental group gained an average of 16.35 points per student while the control group gained an average of 12.81 points per student. The level of significance for the difference was between 0.10 and 0.20. This level is sufficient to reject the hypothesis that there are no differences in gains in reading readiness as measured by gains in mean scores between the group which experienced Material Objects as a reading readiness program and the group which experienced the Harper & Row Reading Readiness Program. The difference favors the experimental group.

Some Reflections on the Results

In light of the greater gains by the experimental group in five of the six sub-test areas one is almost compelled to ask himself "How can a science program out-perform a reading readiness program when compared on reading readiness standards?" The answer to this question lies in the examination of two factors: 1. The nature of the Material Objects unit and 2. The purpose of education.

The experimental group out-performed the control group in the areas of Word Meaning, Listening, Matching, and Numbers because the members of the experimental group, through the use of the Material Objects unit, were allowed to have concrete experiences in each of these areas to the limit of their interest and ability. The children learned to match because they were allowed to match properties to objects with objects they could grasp, manipulate and even alter. The developed skills in listening because they listened, not so much to the teacher as to their fellow students describing, classifying and discussing experiences. They learned word meaning when words were invented by the teacher (or themselves) as needed to describe experiences with objects. Number skills were gained as they serial ordered objects or groups of objects. They were outgained on the copying subtest because they didn't do much copying. This investigator has no

explanation, at this time, for the superior gains of the experimental group on the alphabet sub-test.

The second factor concerns a very basic area, the purpose of education. In a 1961 statement[23] the Education Policies Commission states:

> The purpose which runs through and strengthens all other educational purposes - the common thread of education - is the development of the ability to think.

If this statement is accepted, the implication is undeniable; in order to learn to read the child must first have developed some ability in the reasoning process. A person need not be able to read in order to reason but is the converse true, must a person be able to reason to read? This investigator is convinced that indeed this is true, Almy[24] indicated that progress in beginning reading is related to performance in conservation tasks. Stafford[25] found that the use of the Material Objects unit would accelerate the attainment of conservation abilities. The research described in this dissertation shows that the use of Material Objects can develop reading readiness. The conclusion to this investigation is obvious, to best teach beginning reading, first teach thinking, as represented by conservation reasoning.

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[23]Educational Policies Commission, The Central Purpose of American Education, National Education Association of the United State, 1961, p. 12.

[24]Almy, Op. Cit.

[25]Stafford, Op. Cit.

Conclusion

On the basis of the preceding evidence it is concluded that those children who experienced the Material Objects unit, (a part of the first year's work of a science program developed by the Science Curriculum Improvement Study) as a reading readiness program established superior gains in reading readiness as measured by the Metropolitan Reading Readiness Test when compared to a group which used the Harper & Row Reading Readiness Program. It has also served the additional function of the development of scientific literacy as defined by Thier[26];

> The individual must have a conceptual structure and a means of communication that enables him to interpret the information as though he had obtained it himself.

Education Implications

Two major implications, in regard to elementary schools, emerge from the combination of this research and that done by Almy[27] and Stafford[28]. The research described in this dissertation shows that the Material Objects unit functions as both a science program and a reading readiness program. The combination of the three studies (Almy, Stafford and Kellogg) strongly implies that conservation abilities are strong indicators of reading readiness.

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[26] Robert Karplus and Herbert Thier, A New Look at Elementary School Science, Rand McNally and Company, Chicago, 1967.

[27] Almy. Op. Cit.

[28] Stafford, Op. Cit.

Research by Blackwood[29] has shown that the mean expenditure for science in elementary schools is from 44 to 60 cents per pupil per year. However the mode, for his sample, indicates that the largest percent of schools spent from 11 to 14 cents per pupil! Since science, when taught by the inquiry method, is an excellent subject for developing the child's ability to think[30], it would seem that schools would be willing to invest a greater amount for science teaching (at least as much as for a formal reading readiness program). The figures seem to indicate that this is not the case and that particularly in the primary grades reading comes first. Any program which can fulfill the needs of the reading readiness program. while at the same time allowing the child to have experiences which will enhance his thinking ability should be welcomed by the school systems. Especially if this involves only the expense of a science program.

The second implication could lead not only to savings of money but also to wise and economical use of teacher and learner time. Reading readiness tests such as the Metropolitan Reading Readiness Test, though not expensive in terms of dollars and cents, are at best slow and cumbersome to administer and to grade. Since the

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[29] Paul E. Blackwood, "Science in the Elementary School." School Life, November 1964, pp. 13-15, 27-28.

[30] Elizabeth Friot, "The Relationship Between an Inquiry Teaching Approach and Intellectual Development", unpublished dissertation, University of Oklahoma, 1970.

strong relationship exists between abilities to conserve and reading readiness these tests could be used as indicators of reading readiness. The conservation tests, in addition to being inexpensive, are quick and easy to administer[31]. The time saved could then be used in experiences which develop thinking skills thus helping the child better prepare to read.

Suggestions for Further Study

The data and educational implications from this study suggest several areas in which further study is needed. Among these are the following:

1. The fact that the girls in the experimental group outgained all other groups seems to warrant further study to examine any sex related differences in the development of reading readiness. The types of experiences provided by the Material Objects unit may be more beneficial in developing reading readiness in one sex than in the other.
2. An analysis of the experiences provided by Material Objects should be undertaken and a study designed to determine which of the experiences seem to be most fruitful in the development of reading readiness.

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[31] Op. Cit., Stafford, pp. 26-33.

3. Inquiry-centered programs in subjects other than science, should be tested as reading readiness to determine if similar results can be obtained.
4. A longitudinal study should be initiated to compare the reading abilities of the group which attained reading readiness with Material Objects units and the group which used the traditional readiness program.
5. In view of the gains achieved by the experimental group in number, the relationship between the use of Material Objects and the development of arithmatic skills should be studied. Perhaps the Material Objects unit could serve a threefold purpose.
6. A study should be designed to determine more precisely the correlation between the development of conservation abilities and reading readiness.

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APPENDIX A

APPENDIX A

AN OVERVIEW OF THE FIRST GRADE PROGRAM OF THE SCIENCE CURRICULUM IMPROVEMENT STUDY

The first grade program of SCIS consists of a physical science unit, Material Objects, and a life science unit, Organisms. The following is a brief overview of each of the Material Objects units taken from the teachers guide for the unit.

Material Objects

The concept that matter exists and has properties is one of the first abstractions the child is able to understand and deal with. Thus, after the introductory work in kindergarten, the first SCIS unit presented to the child is Material Objects. In it he learns to apply this basic concept.

Material Objects introduces the child to the fundamental concepts of objects and their properties. It leads him to manipulate, describe, compare, and change the form of samples of metals, woods, plastics, granular materials, liquids, gases, etc.

This overview is taken from the Teacher's Guide for Material Objects, pp. ix-x.

The main objective of the unit is to teach the child to recognize material objects in his own environment. The objects themselves are to be distinguished from their properties. In the first two chapters the child learns to understand and use the word object as a term for referring to a piece of matter. The range of objects used is as broad as conveniently possible. The pupil observes manipulates rigid, well-defined objects such as rocks and twigs, wood dust, samples of liquid such as glycerin in a jar, living organisms, and samples of gas such as air in a balloon.

For contrast, one can consider what would not be objects in this sense. All abstractions such as love and hate, time and space, beauty and color, hunger and thirst, are examples of things that are not material objects. The word thing, which can be used to refer to abstractions, has too broad a meaning to be useful in a science program which tries to communicate a concept of matter. The contrast between objects and non-objects is introduced in later units; in this unit, the child becomes acquainted with the objects in his environment and merely distinguishes the objects from their properties.

The first chapter uses familiar objects in the classroom home and playground to introduce the concepts of object and

property. The new ideas are then applied to other objects, to plants and animals and their parts, and to collections of buttons and wooden blocks that can be sorted according to a number of properties such as shape, color, texture and size.

In Chapter Two, the child's comparison of similarly shaped pieces of aluminum, brass, pine, walnut, vinyl, and polystyrene leads to the introduction of the concept of material. This concept is then applied in additional work with other metals and various kinds of wood, as well as with rocks, liquids, and gases.

In Chapter Three, comparison signs ($>$ and $<$) and serial ordering introduce a semiquantitative aspect to the child's comparison of objects.

Chapter Four allows the child to carry out experiments in which he collects evidence about the material of which lump sugar and rock candy are composed, tests whether objects float or sink in water, and uses air to displace water from submerged containers. These experiments give the child opportunities to apply what he has learned about material objects and their properties; the experiments also provide an informal introduction to the concept of systems, which is the subject of a later physical science unit in the SCIS program.

While dealing with material objects in this unit, the child will develop various attitudes, abilities, and skills, including habits of careful observation, a vocabulary that is useful in describing objects, methods of recording observations and experiences, and the ability to discriminate fine differences and to recognize broad similarities.

Hopefully each child will have many and varied experiences in:

1. manipulating and observing different kinds of objects;
2. describing the properties of observed objects;
3. comparing and sorting objects, with close attention to their properties;
4. developing the concept of material -- the "stuff" that makes up an object;
5. applying certain mathematical concepts to concrete situations;
6. acting upon and experimenting with objects in the solid, liquid, and gaseous phases;
7. using certain tools such as a magnifier, a mortar and pestle, and a medicine dropper;
8. keeping a record of observations;
9. working with other children as part of a team.

Frequent use of the question "What is your evidence?" can help the children in many ways. Whenever a child makes and reports an observation, draws an inference, or states a conclusion, the teacher should ask this question or a similar one. The child's answers will help the teacher analyze and evaluate his ability to observe and/or manipulate objects and to use his observations in making decisions. In addition, as different children report varying evidence while observing and manipulating similar objects, the teacher will have excellent opportunities for promoting pupil-to-pupil discussions about the evidence. With the teacher's guidance, these discussions can lead the children to decide that they need to obtain further evidence to settle the controversies. Situations such as these will increase the child's interest and involvement in the concrete operations which are at the core of this unit.

APPENDIX B

APPENDIX B

SCIS BIBLIOGRAPHY

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APPENDIX C

APPENDIX C

RAW DATA EXPERIMENTAL GROUP

Student Number	Sex	Word Meaning		Listening		Matching		Alphabet		Numbers		Copying		Total	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	M	16	14	13	15	12	14	12	16	22	25	14	14	89	98
2	M	8	9	9	11	3	11	1	7	4	13	0	6	24	47
3	M	14	12	12	15	12	14	9	16	20	20	14	14	81	94
4	F	11	12	16	14	13	14	10	15	16	24	7	10	73	89
5	M	10	10	11	15	13	14	16	16	19	20	13	14	82	89
6	M	10	12	12	12	9	13	8	16	14	22	11	14	64	89
7	M	11	11	12	12	11	13	15	16	19	24	13	13	81	89
8	M	13	13	13	12	8	12	16	16	15	24	9	10	66	87
9	M	11	12	12	13	11	14	12	16	15	20	13	12	73	87
10	M	14	11	11	13	11	13	13	16	16	20	12	13	77	86
11	F	5	7	10	13	13	14	16	15	19	22	10	14	73	85
12	F	4	11	7	13	10	12	12	16	12	20	13	9	58	81
13	M	9	10	9	12	3	10	9	16	16	19	7	14	53	81
14	F	6	9	11	13	7	13	7	16	10	16	7	11	48	78
15	F	12	12	14	13	12	12	14	16	14	15	10	10	76	78
16	F	10	11	10	14	5	10	5	14	12	19	11	10	53	78
17	M	12	10	9	13	9	9	4	16	8	20	4	9	46	77
18	M	4	11	13	11	5	13	7	14	13	18	8	10	50	77
19	F	5	9	5	12	6	8	4	14	12	17	8	13	40	73
20	F	12	12	15	12	13	13	15	16	22	25	13	14	90	92
21	F	11	14	15	15	12	14	16	16	22	25	14	14	90	98
22	M	10	14	14	15	13	14	16	16	20	19	14	12	89	90
23	F	11	12	15	12	8	11	16	16	20	24	14	13	84	88

APPENDIX C -- Continued

Student Number	Sex	Word Meaning		Listening		Matching		Alphabet		Numbers		Copying		Total	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
24	M	12	13	13	14	14	16	15	16	19	21	11	13	84	88
25	M	12	11	13	13	13	14	15	16	15	22	13	13	81	89
26	M	12	12	13	12	12	13	15	15	20	21	9	11	81	84
27	M	11	12	10	15	9	14	16	16	19	21	12	13	77	91
28	F	8	12	14	12	11	14	13	14	20	18	8	12	74	82
29	M	11	13	13	14	13	12	8	15	15	21	13	12	73	81
30	F	4	12	12	11	11	13	13	15	18	21	13	11	71	83
31	F	11	13	15	15	8	13	7	16	13	21	13	13	67	91
32	F	8	11	8	10	9	14	6	15	13	18	10	10	54	78
33	M	5	5	11	9	7	13	6	16	14	20	10	8	53	71
34	M	6	6	6	10	9	12	7	14	7	21	12	14	47	77
35	F	6	12	7	12	5	14	7	14	12	18	8	12	45	82
36	M	9	12	7	14	5	12	8	14	6	10	6	5	41	67
37	F	9	11	14	16	13	13	13	16	20	24	14	19	83	93

APPENDIX D

APPENDIX D

RAW DATA CONTROL GROUP

Student Number	Sex	Word Meaning		Listening		Matching		Alphabet		Numbers		Copying		Total	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	M	15	13	15	14	16	14	15	16	21	25	14	14	96	96
2	F	10	14	16	15	14	13	16	16	20	24	14	14	90	96
3	F	15	12	14	12	12	13	13	16	21	22	12	14	87	89
4	F	10	11	13	13	13	13	14	16	20	23	14	14	84	90
5	F	13	12	9	13	13	14	16	16	19	25	11	14	81	94
6	F	12	13	13	13	14	14	14	16	17	19	10	14	80	89
7	F	9	15	9	14	14	14	16	16	18	19	13	14	79	92
8	M	15	12	11	14	14	12	13	16	13	22	12	13	78	89
9	M	11	10	12	14	13	13	8	16	21	22	13	14	78	89
10	F	9	10	13	14	10	12	13	16	16	18	12	13	73	83
11	F	12	14	13	14	9	13	9	16	15	20	9	12	67	89
12	M	13	16	12	13	4	13	12	16	15	18	9	11	65	87
13	F	9	6	9	7	10	11	4	16	15	19	11	14	58	73
14	M	10	12	10	13	9	9	10	16	9	11	3	11	51	72
15	F	8	5	10	12	6	14	4	16	9	15	13	13	50	75
16	M	7	8	6	12	3	12	9	13	8	17	11	14	44	76
17	F	13	14	15	15	14	14	16	16	23	23	14	14	95	96
18	F	14	14	14	13	14	14	16	16	22	22	12	12	92	91
19	M	14	13	15	14	13	13	16	16	22	22	12	13	92	91
20	F	14	13	13	13	12	14	15	16	22	21	14	12	90	89
21	M	11	13	10	16	13	14	16	16	22	23	14	11	86	93
22	F	11	9	13	13	12	14	16	16	20	20	14	12	86	84
23	M	11	13	11	12	11	14	16	16	14	11	14	12	77	84

APPENDIX D -- Continued

Student Number	Sex	Word Meaning		Listening		Matching		Alphabet		Numbers		Copying		Total	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
24	F	13	12	14	12	12	14	12	16	20	22	14	13	75	89
25	M	11	14	10	15	14	13	11	15	16	22	9	7	71	86
26	F	12	10	9	11	11	11	11	16	16	18	6	10	65	76
27	F	7	15	9	13	7	12	15	16	15	19	11	13	64	88
28	F	11	13	15	11	10	11	7	16	12	19	6	10	61	80
29	M	11	10	13	13	10	8	7	16	11	15	8	11	60	73
30	M	8	7	10	13	9	10	4	15	10	17	12	13	53	75
31	M	10	9	9	11	1	12	9	15	6	16	1	8	36	71
32	M	6	7	5	11	1	1	0	6	3	15	0	4	15	44