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ABSTRACT

Fifth- and sixth-grade students in one school were instructed using the Mathematics Target System, an individualized approach, while those at a comparable school were given more traditional instruction. Students in both the experimental and control groups were pretested using the Pupil Opinionnaire, Attitude Toward Mathematics scale, and the Stanford Achievement Test. After a year's instruction, students were again tested using parallel forms of these instruments. Differences between groups at each test administration and differences between pre- and post-test means were submitted to analyses using the Chi-square statistic. Although there were some differences between the groups at the outset of the study, the individualized approach was shown to be quite effective with fifth-grade students. The authors observe that independent influences on the control group resulting from increased systemwide emphasis on computational skills and curriculum supervision tended to enhance the learning of students in the control group. (SD)

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THE INDIVIDUALIZATION OF MATH IN GRADES FIVE AND SIX:

AN EXPERIMENTAL PROGRAM

by

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"THE INDIVIDUALIZATION OF MATH IN GRADES FIVE AND SIX: AN EXPERIMENTAL PROGRAM"

OVERVIEW

The emphasis upon "new math" during the past decade has caused many changes in instructional materials, content, and teaching methodology. However, when pupil outcomes were evaluated, it became evident that a number of learners were experiencing difficulty in the area of computation. This very problem has also been evident in the sixth grade math scores in the Uniondale Public Schools. While many arguments can be generated which downgrade the importance of computational skill, most of these are inherently faulty. For the foreseeable future, the facility to add, subtract, multiply and divide will be advantageous to students. It is not enough that students have only a conceptual base in math. Consequently, this experimental program was developed to stress computational skills. In addition, the program which was implemented in September of 1974 provided a vehicle for the teacher to embark on the process of individualizing the math curriculum. Such a process required the selection of materials which provided for core instruction, recycling for additional skill development, and enrichment for more advanced pupils.[1]

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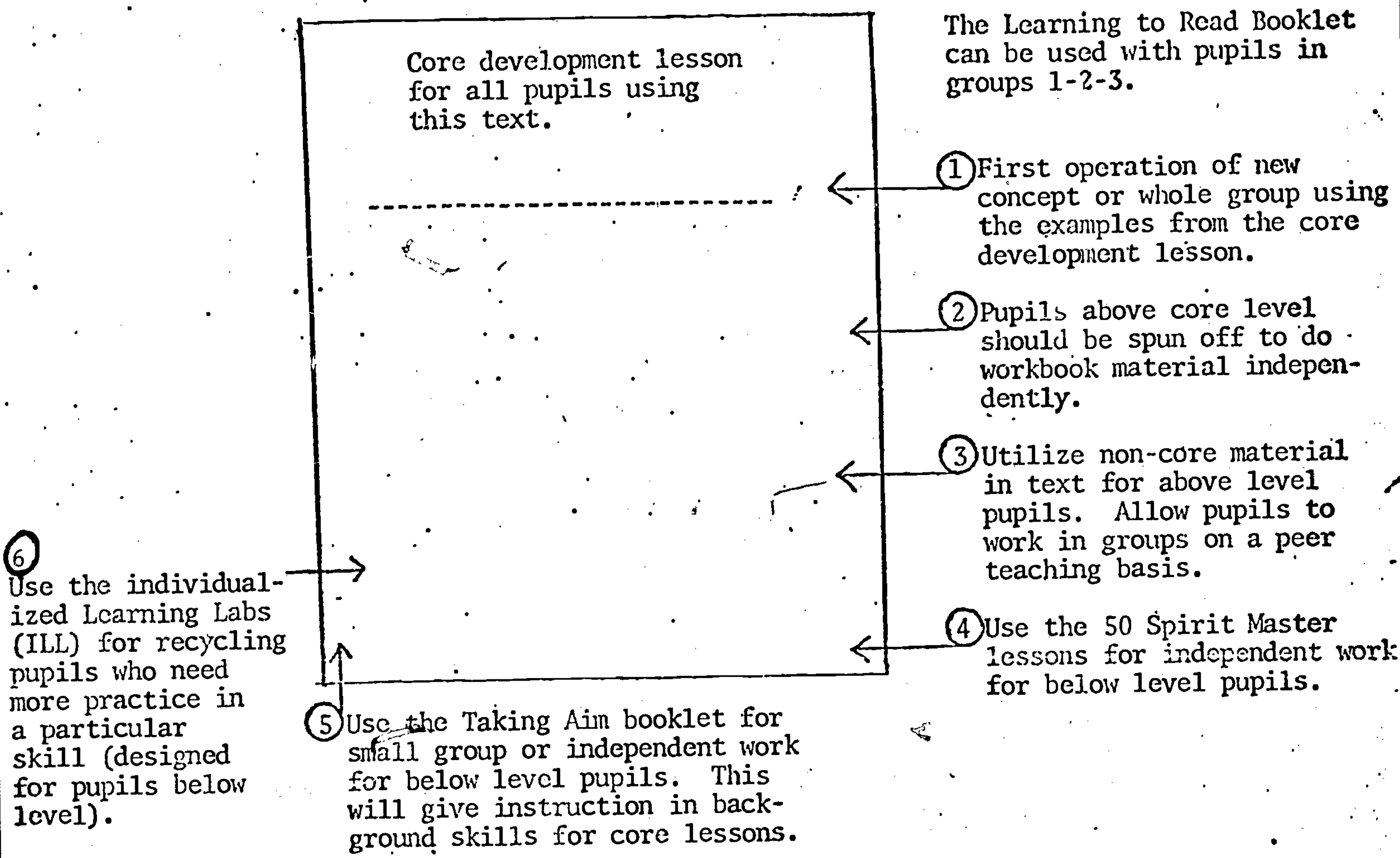
[1] See Figure 1 for the core lesson format.

Figure 1
Sample Page



Materials

The materials selected for instructional usage in the implementation of this experimental program were the "Mathematics Target System" (MTS), a modular instructional system. This system fulfilled the need created by the individualization process since it offered seven instructional components which could be utilized to meet the needs of each pupil[2].

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[2] See Figure II for an analysis of the seven components.

Figure II
The Structure of MTS

Meeting	Student Textbooks:	Nine non-graded basis texts designed to be used independently in conjunction with a varie of supplementary modules listed below.
	Worksheets & Workbooks:	Duplicating-masters and student books designed provide learners with practice and review.
Applying	Individualized Learning Lab:	Kits of instructional cards, practice exercise and mastery tests for use as recycling materia to insure skill and concept mastery.
Testing	Placement Tests:	Test designed to place a learner at an appropriate level at the beginning of the year.
	Chapter Pre-Tests:	Test for use before each chapter or before eacl section designed to help determine which objectives should be emphasized for certain learners.
	Mastery Assessment Tests:	Tests designed to determine each student's mastery of objectives in specific lessons.
	Development Assessment Tests:	Test designed to evaluate the learners growth after completing a chapter or section.
Helping	Taking Aim:	Booklets designed to prepare learners for math concepts and skills met in each chapter of the basic test.
	Learning to Read Mathematics:	Booklets designed to teach reading skills particularly relevant to reading the language of math.

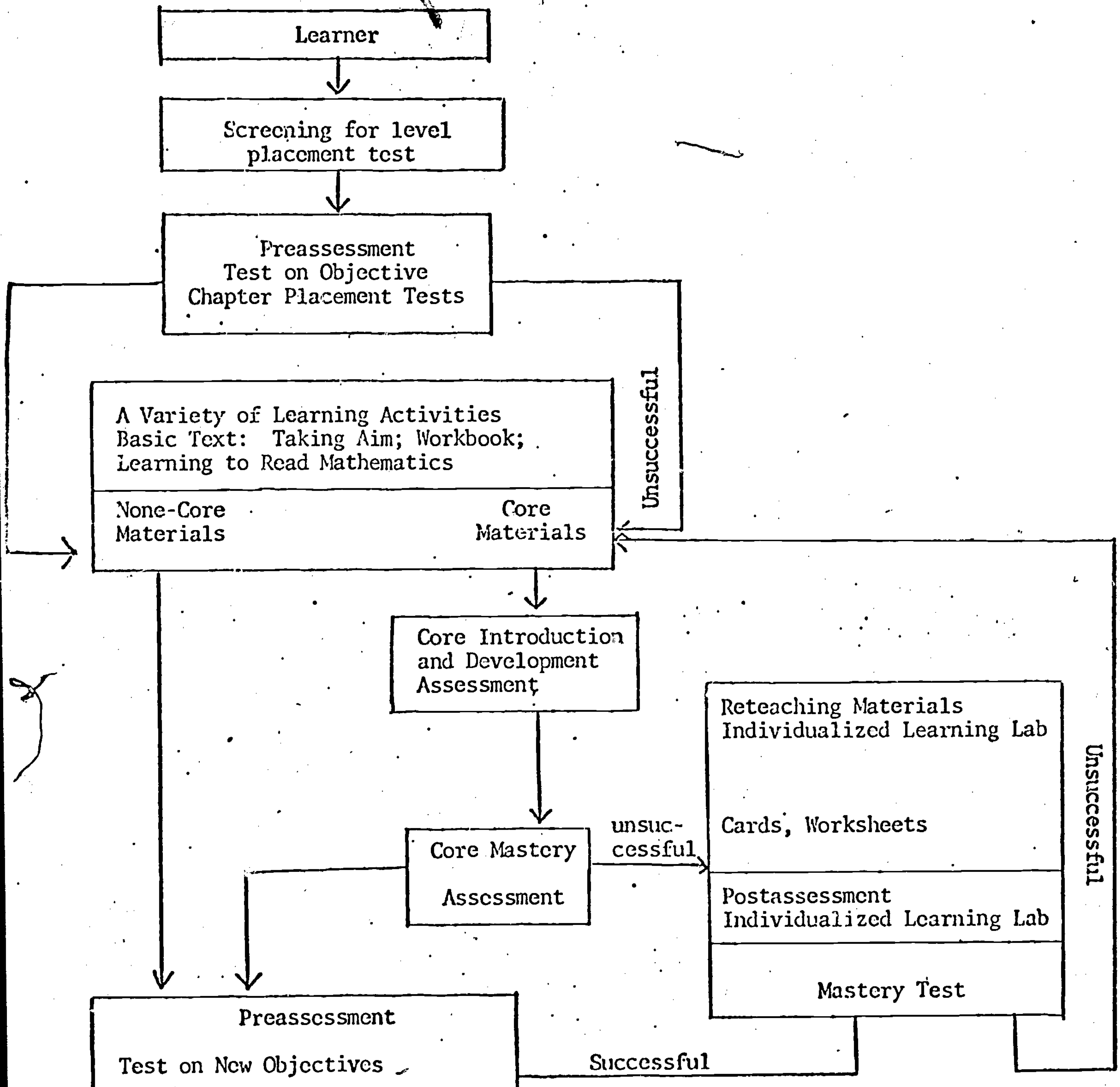
Approach to Instruction

The MTS materials offer two alternatives in classroom instruction. One approach is the individualization of instruction in which every pupil is guided through a sequence of testing, evaluation, and instruction according to individual ability. The experimental program followed the approach outlined above, but also allowed opportunity for both small and large group instruction, the second alternative provided by MTS. In either case, the teacher utilized all the management tools of MTS[3].

[3] See Figure III for the Instructional Sequence.

FIGURE III

INSTRUCTIONAL SEQUENCE



Research Design.

Historically, administrators and classroom teachers have changed curriculum objectives, instructional materials, and teaching strategies without designing or adopting a methodology whereby the results of such changes could be objectively evaluated. Where the results of such changes were evaluated, it was usually on the sole basis of pupil cognitive achievement. No consideration of pupil attitude was apparent.

The research design utilized by the writers in this project was a conscious attempt to overcome both of the historical weaknesses of classroom research projects. The study utilized a control and an experimental group of pupils and both groups were pretested and posttested for cognitive learning (pupil achievement) and attitude toward the subject matter.

The control group was composed of the fifth and sixth grade pupils at California Avenue School. This school was chosen since its pupil population was drawn from a socio-economic area that approximated that of the pupils in the experimental group--Walnut Street School. It was, therefore, assumed that the pupils in the control and experimental groups would not differ significantly in math achievement or attitude toward math. This assumption was tested to verify that no significant differences did in fact exist. The results are detailed in the following paragraphs and tables. Since attitude tests rarely have a high reliability, especially for elementary school pupils, the writers decided to utilize two such tests so that the initial assumption could be more rigidly examined.

The "Pupil Opinionnaire,"[4] Form A, was used as a pretest measure of pupil attitude toward math. This attitude questionnaire employs a semantic differential technique as shown in Figure IV.

FIGURE IV
SAMPLE ITEM FROM "PUPIL OPINIONNAIRE"

TAKING A MATH TEST IS

	Very:	Sort of:	Neither:	Sort of:	Very:	
Bad	______	______	______	______	______	Good
Happy	______	______	______	______	______	Sad

The statistical procedure chosen for the analysis of data derived from this questionnaire was the Chi-square test. The five point scale of the opinionnaire was collapsed into three cells for the purpose of analysis. The intensity dimension represented by the three cells was "very positive," "sort of positive," and "not positive." The results of this analysis are reported in Tables I and II.

[4] The "Pupil Opinionnaire" was developed by Eugenia S. Scharf in 1970 and published by Research for Better Schools, Philadelphia, Pennsylvania.

TABLE I

COMPARISON OF PRE-TEST SCORES FOR CONTROL AND EXPERIMENTAL GROUPS ON THE "PUPIL OPINIONNAIRE" -- GRADE FIVE

ITEM	df.	X^2	Sign. at
Taking a Math Test is: GOOD-BAD	2	2.833	NS
Taking a Math Test is: HAPPY-SAD	2	5.661	NS
Doing Math is: GOOD-BAD	2	5.337	NS
Doing Math is: HAPPY-SAD	2	1.207	NS
My Math Class is: GOOD-BAD	2	1.636	NS
My Math Class is: HAPPY-SAD	2	.132	NS

TABLE II

COMPARISON OF PRE-TEST SCORES FOR CONTROL AND EXPERIMENTAL GROUPS ON THE "PUPIL OPINIONNAIRE" -- GRADE SIX

ITEM	df.	X^2	Sign. at
Taking a Math Test is: GOOD-BAD	2	1.215	NS
Taking a Math Test is: HAPPY-SAD	2	.369	NS
Doing Math is: GOOD-BAD	2	2.100	NS
Doing Math is: HAPPY-SAD	2	1.379	NS
My Math Class is: GOOD-BAD	2	.155	NS
My Math Class is: HAPPY-SAD	2	1.572	NS

On the basis of the analysis of the results from the "Pupil Opinionnaire, it is evident that no significant differences in math attitude prevailed between the control and the experimental groups of learners on the basis of the three concepts tested. As can be seen from Tables I and II, each of the three concepts was tested by means of two pairs of bipolar adjectives--good-bad; happy-sad.

The second instrument used by the writers to test the similarity of attitude between the two groups was the "Attitude Toward Mathematics."[5] This test is a series of twenty-two short statements about math and require only a "yes" or "no" response from the pupil. Each "yes" response is then scored according to a numerical value assigned to each positive response. The difference in the means for the control and experimental groups were then analyzed by using the two-tailed t-test. (See Table III.)

TABLE III

COMPARISON OF PRE-TEST SCORES FOR CONTROL AND EXPERIMENTAL GROUPS ON "ATTITUDE TOWARD MATHEMATICS"

Grade	Control $\bar{x}$	Experimental $\bar{x}$	T-Score	df.	Sign. at
Grade 5	6.3	6.5	1.000	∞	NS
Grade 6	6.1	6.1	.000	∞	NS

The data in Table III indicates that on the second attitude test the learners in the control and experimental groups were not significantly different. On the basis of the results of the two attitude tests, the writers concluded that no significant attitude differences prevailed between the two groups.

In order to test the assumption that there were no significant differences between the two groups in math achievement, the writers

[5]This instrument was given to the writer by Dr. Larry E. Frase who had utilized it in a research project with sixth graders in Mesa, Arizona.

pretested both groups by means of the Stanford Achievement Test - Form W. This test gave the writers data on three areas in math: computation, concepts and applications. Table IV shows the results of the analysis of data derived from those tests.

TABLE IV

COMPARISON OF PRETEST SCORES FOR CONTROL AND EXPERIMENTAL GROUPS ON THE "STANFORD ACHIEVEMENT TEST"

Grade	Control $\bar{x}$	Experimental $\bar{x}$	T-Score	df.	Sign. at
Grade 5-Computation	4.5	4.7	1.667	∞	NS
Grade 5-Concepts	5.2	5.8	2.727	∞	.01
Grade 5-Applications	4.9	5.2	.625	∞	NS
Grade 6-Computation	5.2	5.6	2.500	∞	.01
Grade 6-Concepts	6.0	6.6	2.727	∞	.01
Grade 6-Applications	6.0	6.3	1.250	∞	NS

The results of the analysis of the data (Table IV) indicate that in grade five the two groups were significantly different in one of the three sub-tests of math achievement. In the area of math concepts the fifth grade pupils at Walnut Street School were significantly more advanced than their counterparts at California Avenue School. In grade six the pupils at Walnut Street School were significantly more advanced in both computation and concepts than were the California Avenue pupils.

While these results were not in total accord with the writers initial assumption, the experiment was allowed to continue and the posttest analysis will indicate how this difficulty was taken into account.

At this point it is essential to point out several events which made the evaluation of the experimental program very difficult.

1) The administration of the control school was not highly cooperative in terms of the pretest situation. One of the administrators from the experimental school was required to be present at the control school during testing to insure proper testing procedures. Even with this safeguard, the administration of the control school permitted the destruction of two additional attitude surveys by the building's union representative with its lack of careful test monitoring. At least one of these surveys would have permitted an analysis of the pupils' reaction to individual math classes. An analysis of such data would serve to determine how much the environment of a classroom affects the actual cognitive achievement.

2) One teacher at the experimental school had some initial difficulty in utilizing the components of the MTS materials with a group of very slow learners. When this difficulty became known to the junior and senior high school math departments, three of their teachers spent much time sending memoranda and otherwise interfering in the ongoing experimental program.

3) One of the administrators at the control s hool designed a management objective which required the careful monitoring of the math program in the control school in relation to the District's math objectives. This careful observation

of the control school's math program, while highly worthwhile and commendable, must be considered in the analysis of posttest scores.

Each of the factors cited above helped to destroy a truly experimental-control group research design. Therefore, the following analysis of posttest scores must be viewed in light of these three factors.

The posttest attitude scores were analyzed by comparing the control and experimental groups by means of the chi-square and t-test. The achievement scores were analyzed in a twofold manner. First, the posttest scores were analyzed in terms of a comparison of the control to the experimental group and secondly, the expected posttest and actual posttest scores within each school were compared and analyzed. Both types of analysis were by means of the two-tailed t-test.

Form B of the "Pupil Opinionnaire" was administered to both the control and experimental groups as a means of assessing any significant math attitude change. The results of the analysis of these scores are shown in Tables V-VI.

TABLE V

COMPARISON OF POSTTEST SCORES FOR CONTROL AND EXPERIMENTAL GROUPS ON THE "PUPIL OPINIONNAIRE" -- GRADE FIVE

ITEM	df.	X^2	Sign. at
Taking a Math Test is: GOOD-BAD	2	2.322	NS
Taking a Math Test is: HAPPY-SAD	2	12.292	.01
Doing Math is: GOOD-BAD	2	7.983	.02
Doing Math is: HAPPY-SAD	2	21.444	.0001
My Math Class is: GOOD-BAD	2	2.266	NS
My Math Class is: HAPPY-SAD	2	11.944	.01

TABLE VI

COMPARISON OF POSTTEST SCORES FOR CONTROL AND EXPERIMENTAL GROUPS ON THE "PUPIL OPINIONNAIRE" -- GRADE SIX

ITEM	df.	X^2	Sign. at
Taking a Math Test is: GOOD-BAD	2	17.692	.001
Taking a Math Test is: HAPPY-SAD	2	9.182	.02
Doing Math is: GOOD-BAD	2	3.254	NS
Doing Math is: HAPPY-SAD	2	5.635	.06
My Math Class is: GOOD-BAD	2	9.329	.01
My Math Class is: HAPPY-SAD	2	9.862	.01

The analysis of the data as shown in Tables V and VI indicate quite conclusively that the use of the MTS math program with the experimental group resulted in significant differences from the students involved in the control group. The students in the experimental group exhibited a more positive attitude toward math on five or six variables at each grade level than did those pupils in the control group.

The writers also utilized the second math attitude instrument, "Attitude Toward Mathematics" to verify the findings from the initial posttest attitude instrument. Table VII shows the comparison of the control and experimental groups on this instrument.

TABLE VII

COMPARISON OF POSTTEST SCORES FOR CONTROL AND EXPERIMENTAL GROUPS ON "ATTITUDE TOWARD MATHEMATICS"

GRADE	Control $\overline{X}$	Experimental $\overline{X}$	T-Score	df.	Sign. at
Grade 5	6.1	6.7	4.000	∞	.001
Grade 6	6.1	6.4	1.765	∞	.07

The results of the scores on the "Attitude Toward Mathematics" show that the experimental groups of pupils had a much more positive attitude toward math than did the pupils in the control group. A check of the pretest and posttest means of the control and experimental groups indicate that in grade 5 the control group means declined from 6.3 to 6.1 while the experimental group mean rose from 6.5 to 6.7. In grade 6 the control group mean remained constant at 6.1 while the experimental group mean rose from 6.1 to 6.4.

The posttest of math achievement utilized the Stanford Achievement Test, Form X. Tables VII - X indicate the results of the two-fold analysis of these scores.

TABLE VIII

COMPARISON OF POSTTEST SCORES FOR CONTROL AND EXPERIMENTAL GROUPS ON THE "STANFORD ACHIEVEMENT TEST"

GRADE	Control $\bar{X}$	Experimental $\bar{X}$	T-Score	df.	Sign. at
Grade 5-Computation	6.5	7.4	4.500	∞	.001
Grade 5-Concepts	5.8	7.1	6.500	∞	.0001
Grade 5-Applications	5.7	6.9	5.455	∞	.0001
Grade 6-Computation	7.5	7.4	.385	∞	NS
Grade 6-Concepts	6.9	7.0	.385	∞	NS
Grade 6-Applications	6.1	7.4	1.000	∞	NS

The data analyzed in Table VIII show that the grade five pupils in the experimental group made significantly greater progress during the school year than did the control group. Even in the area of "concepts", which was significantly different on the pretest, showed

showed greater growth. While the groups were significantly different on the pretest (.01), the posttest indicates a significant difference of .0001.

TABLE IX

OMPARISON OF EXPECTED AND ACTUAL POSTTEST SCORES FOR THE CONTROL GROUP ON THE "STANFORD ACHIEVEMENT TEST"

Grade	Expected Posttest $\bar{X}$	Actual Posttest $\bar{X}$	T-Score	df.	Sign. at
Grade 5-Computation	5.4	6.5	10.000	∞	.0001
Grade 5-Concepts	6.1	5.8	2.727	∞	.01
Grade 5-Applications	5.8	5.7	.769	∞	NS
Grade 6-Computation	6.1	7.5	8.235	∞	.0001
Grade 6-Concepts	6.9	6.9	.000	∞	NS
Grade 6-Applications	6.9	7.1	1.176	∞	NS

The "expected" posttest score was derived by adding .9 years to the actual pretest mean for each of the three areas: computation, concepts, and applications.This figure represented the number of months of actual instruction in mathematics. While the grade five control group gained significantly beyond their expected posttest score in the area of computation, they were significantly below their expected gain in math concepts and showed no significant difference in terms of math applications

The sixth grade control group also made significant gains in math computation but showed no significant gains in math concepts or applications.

These results can be better understood if the reader recognizes that the District math curriculum emphasized spending an additional seventy-five (75) minutes per week on computational skills and that one of the administrators at the control school did, in fact, carefully monitor the math program as was previously mentioned.

TABLE X

COMPARISON OF EXPECTED AND ACTUAL POSTTEST SCORES FOR THE EXPERIMENTAL GROUP ON THE "STANFORD ACHIEVEMENT TESTS"

GRADE	Expected Posttest $\bar{X}$	Actual Posttest	T-Score	df.	Sign. at
Grade 5-Computation	5.6	7.4	11.250	∞	.0001
Grade 5-Concepts	6.7	7.1	2.500	∞	.02
Grade 5-Applications	6.1	6.9	4.706	∞	.0001
Grade 6-Computation	6.5	7.0	2.500	∞	.02
Grade 6-Concepts	7.5	7.4	.500	∞	NS
Grade 6-Applications	7.2	7.4	.953	∞	NS

The information presented in Table X shows that the fifth grade experimental group made significant gains in computation, concepts, and applications. The fifth grade experimental group showed significant gains in concepts and applications while the control group failed to make even the expected .9 years gain in those two areas.

The grade six control and experimental groups both significantly exceeded their expected gain scores in computation but did not show significant gain in concepts or applications.

CONCLUSIONS

The analysis and interpretation of the data lead to several important conclusions.

1) The stress on developing computational skill by allowing additional time daily for that task paid rich dividends in both the control and experimental schools. The additional time allotment together with administrative monitoring of the actual instruction seems to guarantee greater pupil gains. Extrapolating from this, the writers believe that administrative leadership and more careful monitoring of all curriculum programs would be helpful in obtaining better pupil performance.

2) While the analysis of pre- and posttest data relative to pupil achievement was not conclusive for the total experimental group, the data did reveal that the experimental program was of great benefit to the fifth grade pupils. This would seem to indicate that such a program has better benefits when utilized with students beginning at grade one and continuing through grade six rather than beginning such a program with sixth grade pupils. Walnut Street School is currently scheduled to begin such a schedule in September, 1975.

3) The comparison of pre- and posttest scores for the attitude tests clearly shows that the use of a multi-component math system which makes the implementation of an individualized math program a reality serves to improve the pupil's attitude toward the subject matter. This concept has far reaching implications. If attitude and achievement are interrelated as supposed by a number of researchers, then the more positive attitude of pupils

in the experimental program may well result in greater math achievement for those pupils in the years to come.

While the research design and evaluation of this pilot program were not as statistically definitive as one could desire, the factual data are much more supportive of the writers conclusions than mere conjecture about the programs worth would have been. It is our belief that such pilot testing of programs is an important first step in improving the quality of education in the public schools.

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