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ABSTRACT

This two-part study was done to investigate the effectiveness of the University of Chicago School Mathematics Project (UCSMP) Transition Mathematics Program implemented by Lexington School District (South Carolina) during the 1993-94 school year. Results on four mathematics subtests of the Stanford Achievement Test, 8th Edition are considered in Part 1 of the study: Total Mathematics, Concepts of Number, Mathematics Computation, and Mathematics Application. PSAT results are considered in Part 2. The Experimental Group for Part 1 of the study was 260 7th grade UCSMP students. The Control Group consisted of 260 students from the prior year cohort individually matched with Experimentals on Total Mathematics scores with secondary consideration to Total Reading scores. No significant difference between experimental and control groups was found for the Total Mathematics or Concepts of Number subtests. The Experimental Group performed significantly better on the Mathematics Applications subtest. The Controls performed significantly better on the Mathematics Computation subtest. Complete sets of PSAT scores were available for 72 of the matched pairs of subjects. These 72 matched pairs became the subjects for Part 2 of the study. The Experimentals performed significantly better on the Mathematics portion of the PSAT. No difference was found on the Verbal portion of the PSAT. (Author/MKR)

AN INVESTIGATION INTO THE EFFECTIVENESS OF TRANSITION MATHEMATICS

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AN INVESTIGATION INTO THE EFFECTIVENESS OF TRANSITION MATHEMATICS

(Abstract)

This two-part study was done to investigate the effectiveness of the University of Chicago School Mathematics Project (UCSMP) Transition Mathematics Program implemented by Lexington School District One during the 1993-94 school year. Results on 4 mathematics subtests of the Stanford Achievement Test, 8th Edition are considered in Part One of the study: Total Mathematics, Concepts of Number, Mathematics Computation, and Mathematics Application. PSAT results are considered in Part Two. UCSMP Transition Mathematics is marketed as a full implementation of the National Council of Teachers of Mathematics (NCTM) Standards. A matched sample design was used for both parts of the study. The Experimental Group for Part One of the study was 260 7th grade UCSMP students. The Control Group consisted of 260 students from the prior year cohort individually matched with Experimentals on Total Mathematics scores with secondary consideration to Total Reading scores. No significant difference between experimental and control groups was found for the Total Mathematics subtest or for the Concepts of Number subtest. The Experimental Group performed significantly better on the Mathematics Applications subtest than did the Control Group but the Controls performed significantly better on the Mathematics Computation subtest than did the Experimentals. Complete sets of PSAT scores were available for 72 of the matched pairs of subjects. These 72 matched pairs became the subjects for Part Two of the study. The Experimentals performed significantly better than the Controls on the Mathematics portion of the PSAT. No difference was found on the Verbal portion of PSAT.

Chapter 1

Introduction

Beginning in 1983 with the publication of the report by the National Commission on Excellence in Education, A Nation at Risk: The Imperative for Educational Reform, mathematics education in the United States has been bombarded with a series of highly critical reports most of which echo the same ideas as those found in A Nation at Risk.

> Teaching of mathematics in high school should equip graduates to: (a) understand geometric and algebraic concepts; (b) understand elementary probability and statistics; (c) apply mathematics in everyday situations; and (d) estimate, approximate, measure, and test the accuracy of their calculations. In addition to the traditional sequence of studies available for college bound students, new, equally demanding mathematics curricula need to be developed for those who do not plan to continue their formal education immediately. (National Commission on Excellence in Education, 1983, p. 25)

The most prominent delineation of these ideas came from the National Council of Teachers of Mathematics in the form of the NCTM Curriculum and Evaluation Standards for School Mathematics issued in 1989 and the NCTM Professional Standards for Teaching Mathematics issued in 1991. A number of curricula have emerged which claim to address the NCTM Standards. The first and most prominent of these is the University of Chicago School Mathematics Project. UCSMP states that,

> Given what seemed to be a broad consensus on the problems and desirable changes in pre-college mathematics instruction, it was decided at the outset of UCSMP that UCSMP would not attempt to form its own set of recommendations, but undertake the task of translating the existing recommendations into the reality of classrooms and schools. (Professional Sourcebook for UCSMP, p. T19)

UCSMP also claims to be a full mathematical sciences curriculum and the first full implementation of the NCTM Standards.

The total UCSMP curriculum consists of six separate courses: (1) Transition Mathematics, (2) Algebra, (3) Geometry, (4) Advanced Algebra, (5) Functions, Statistics and Trigonometry with Computers, and (6) Precalculus and Discrete Mathematics. According to the authors of the program, each course is independent and free standing but with a synergistic effect if used in sequence. It is "Transition Mathematics", the first of the six courses, which was implemented by Lexington School District One during the 1993-94 school year. This course places heavy emphasis upon mathematics application and requires calculator and/or computer utilization.

Such radical curriculum changes have tremendous but as of yet untested potential to impact the ability to apply mathematics in practical situations, the ability to understand mathematical concepts, the ability to perform mathematical computations and overall mathematical competence. This study is designed to provide at least some partial answers for the important questions that must be answered in these areas.

The purpose of this research is two-fold. The first and primary purpose is to evaluate the effectiveness of the seventh grade Transition Mathematics program implemented on a full-scale by Lexington School District One during the 1993-94 school year. The second purpose is to utilize strengths and weaknesses identified for this program which may generalize in varying degrees to the entire class of currently popular mathematics curricula with heavy emphasis upon applications and heavy dependence upon calculators in order to suggest directions for additional research.

More specifically, Part One of this study addresses the question: "Will a full implementation of the UCSMP Transition Mathematics Curriculum result in increased scale scores on the Mathematics Subtests of the Stanford Achievement Test, Eighth Edition, a nationally normed achievement test?" There are four subtests of interest. The Total Mathematics Subtest is a measure of the overall level of mathematical functioning. The Concepts of Number Subtest is a measure of conceptual understanding of the real number system. The Mathematics Computation Subtest measures proficiency in performing rote mathematical computations. The Mathematics Application Subtest is a measure of problem solving skills. The student is required to identify then apply appropriate mathematical procedures to problem solving situations. Part Two addresses the question: "Will a full implementation of the UCSMP Transition Mathematics Curriculum result in increased scores on the Mathematics Portion of the Preliminary Scholastic Aptitude Test (PSAT)?" An attempt is also made in Part Two to determine the merit of teacher claims that the requirement that students must be performing at or above the 75th national percentile on the mathematics portion of a nationally normed standardized test is set too low and that the 85th national percentile should be used as a cut score.

Chapter 2

Background and Review of Related Literature

A History of Mathematics Education in the United States a.d Canada is a 557 page volume which reviews the forces that have shaped mathematics education in the United States and Canada from the earliest colonial days until its publication in 1970. Approximately two-thirds of the volume addresses issues specific to mathematics education in the United States. Detailed accounts of all developments referenced prior to 1970 can be found in this book.

A major push for reform in mathematics education started around 1920. The major developments occurred in this year. The National Council of Teachers of Mathematics was founded and the National Committee on Mathematical Requirements published its Preliminary Report. Its final report was published in 1923 and became known appropriately as the "1923 Report". This report recommended a reduction in manipulation of numbers and memorization and introduced the "function concept".

John Dewey's pragmatic influence was felt as he criticized mathematics education as lacking "utility" and led a sharp attack in which he espoused the idea that most mathematics taught in grades 7-12 was useless for the general student. The result was that much of the public believed him and enrollment in secondary mathematics courses plummeted.

These reform efforts were counteracted by two forces which were completely beyond the control of educators and reformers. The Great Depression so severely restricted the money flow that funding for any substantial reform effort became impossible. World War II broke out in Europe in 1939. The United States entered the war in December, 1941. Admiral Nimitz, then Commander of the Great Lakes Region Naval Training Program spoke strongly of weaknesses in the mathematics background of those entering the military. The emphasis shifted to rigorous mathematics preparation with the Commission on Post-War Plans of the NCTM calling for reconsideration of many prevalent practices such as postponement of formal mathematics instruction, reliance on incidental learning and a narrow interpretation of the utility of mathematics education. Much emphasis was now placed upon acceleration of able learners. In 1954 the School and College Study of Admission with Advanced Standing published a report calling for acceleration. A year later the Committee on Advanced Placement of the College Entrance Examination Board took responsibility for administering Advanced Placement Examinations.

On October 4, 1957, Sputnik was launched. Suddenly there seemed to be unanimous agreement that the United States was second rate in mathematics and science education. The National Science Foundation spawned the School Mathematics Study Group in 1958. SMSG then developed mathematics curricula that came to be known as "Modern

Math". NCTM extolled the merits of SMSG programs in its 1961 publication, The Revolution in School Mathematics.

Morris Kline of New York University emerged as the leader of those who opposed the "Modern Math" movement. In an October, 1961 article in the New York University Alumni News, he criticized SMSG for deemphasizing rigorous algebra, geometry and trigonometry for the sake of set theory, symbolic logic, matrices, and Boolean algebra. SMSG was also attacked by the National Association of Secondary School Principals for developing a national curriculum and usurping local and state authority. Many topics first introduced by SMSG survived in mathematics curricula. However, declining mathematics scores on standardized achievement tests resulted in most school districts retreating toward more traditional mathematics curricula.

The National Commission on Excellence in Education published its report, A Nation at Risk: The Imperative for Educational Reform, in 1983. This report had a profound effect upon mathematics education not unlike that of Sputnik from 1966. It called for a mathematics curriculum and mathematics instruction which would generate understanding of geometric, algebraic, probability and statistical concepts while enhancing student application abilities for problem solving with emphasis on estimation, approximation, measurement and reasonableness of calculations.

In 1986 the NCTM undertook the task of developing a set of standards for mathematics education. The final work, Curriculum and Evaluation Standards for School Mathematics, was published in March, 1989. A companion volume, NCTM Professional Standards for Teaching Mathematics, was published in 1991. These documents have generally been accepted as the authoritative documents for what mathematics education in the United States should be. While not a curriculum in the sense that SMSG was a curriculum, the Standards are exceedingly detailed and leave little room for deviation.

The University of Chicago School Mathematics Project claims to be "the first full implementation of the NCTM Standards." The six courses of study developed by UCSMP (Not to be confused with CSMP--Comprehensive School Mathematics Program, which closely resembles the old SMSG curriculum) do place heavy emphasis in the same areas as the Standards. It is interesting to note, however, that three of the six textbooks for the UCSMP went into commercial publication at the same time as the publication of the Standards which the project claims to implement fully.

UCSMP provides documentation of a large study conducted in 1985-86 using 1,084 students in 41 Transition Mathematics classes and 976 students in 38 matched comparison classes. It is less than clear how the matching of classes was done since no statistical data is furnished. Pretesting was done with some unspecified instrument to measure arithmetic, geometry, and algebra readiness. By the end of the year, all but 20 pairs of classes had been eliminated for various unspecified reasons. Out of the 20 pairs of classes that remained in the study, 7 pairs were seventh grade, 10 pairs were eighth grade, and 3 pairs were 9th grade. Three posttests were administered: the American Testronics High School Subjects Test: General mathematics (HSST), the Orleans-Hanna Algebra Readiness Test (Orleans-Hanna) and a geometry readiness test (Geometry). Three-fourths of the students took these tests without calculators. One-fourth used calculators. The only results supplied are descriptive statistics in the form of means of class means of raw scores. No inferential information is given. No normative information was supplied. The published conclusion of the study states:

> On virtually all tests, the Transition Mathematics classes outscored the comparison classes. These results hold for both high-performing and low-performing pairs, regardless of the year in school.
>
> The Transition Mathematics students outperformed comparison students significantly in geometry and algebra readiness, and also became effective calculator users without deterioration in their arithmetic skills.

Chapter 3

Effectiveness of Transition Mathematics

3.1 Research Questions

The primary purpose of this study is to evaluate the effectiveness of the seventh grade Transition Mathematics program implemented on a full-scale by Lexington School District One during the 1993-94 school year. More specifically, Part One of this study addresses the research question:

"Will a full implementation of the UCSMP Transition Mathematics Curriculum result in increased scale scores on the Mathematics Subtests of the Stanford Achievement Test, Eighth Edition, a nationally normed achievement test?"

Four hypotheses must be considered to answer the research question for Part One:

Hypothesis 1:

There is a difference in Total Mathematics Subtest scale scores on the SAT-8 for Transition Mathematics students and non-Transition Mathematics students.

Hypothesis 2:

There is a difference in Concepts of Number Subtest scale scores on the SAT-8 for Transition Mathematics students and non-Transition Mathematics students.

Hypothesis 3:

There is a difference in Mathematics Computation Subtest scale scores on the SAT-8 for Transition

Mathematics students and non-Transition Mathematics students.

Hypothesis 4:

There is a difference in Mathematics Application Subtest scale scores on the SAT-8 for Transition Mathematics students and non-Transition Mathematics students.

Part Two of the study addresses the research question: "Will a full implementation of the UCSMP Transition Mathematics Curriculum result in increased scores on the Mathematics Portion of the Preliminary Scholastic Aptitude Test (PSAT)?" An additional Hypothesis is examined to answer this research question:

Hypothesis 5:

Transition Mathematics Instruction students will have a different mean score on the Mathematics portion of the PSAT from non-Transition Mathematics Instruction Students.

However, both the Mathematics and the Verbal scores on the PSAT are of interest. The strongest case that could be made for Transition Mathematics Instruction would be a relative increase in the mean Mathematics Subtest PSAT score for TMI's over Controls without an accompanying increase in the mean Verbal Subtest score. This would point specifically to mathematics instruction and not to a general increase in cognitive functioning due to some unidentified extraneous variable. Consequently, Hypothesis 6 is added as a "Control" Hypothesis.

Hypothesis 6:

Transition Mathematics Instruction students will have a different mean score on the Verbal portion of the PSAT than non-Transition Mathematics Instruction Students.

3.2 Research Design and Subject Selection

A Matched Sample Design was used in both parts of this study. This design was selected because this was totally a post-hoc study. The researcher was not directly involved until after the treatment of the Experimental Group was completed and all posttest data had been gathered.

Lexington School District One fully implemented UCSMP Transition Mathematics in Grade 7 during the 1993-94 school year for all students at or above the 75th national percentile on SAT-8 Total Mathematics Subtest at its last administration which was at the end of Grade 5. A total of 260 students completed 7th Grade Transition Mathematics and took the SAT-8 at end of the Grade 7. The entire 260 students were used as the Experimental Group for Part One of the study. Since all students at or above the 75th percentile were included in the Experimental Group, it was necessary to draw the control group from those students who had been in Grade 7 the previous year, during the 1992-93 school year. No Transition Mathematics was taught during this year. This group contained 816 students with complete sets of SAT-8 test scores. From these, 260 were matched with the 260 Experimental Subjects based upon end of Grade 5 SAT-8 Total Mathematics Subtests scale scores with secondary consideration given to SAT-8 Total Reading Subtest scale scores. End of Grade 7 SAT-8 scale scores for Total Mathematics, Concepts of Number, Mathematics Computation and Mathematics Applications subtests were then used as dependent variables for Part One of the study. PSAT scores were available for 134 of the Experimental Group and for 102 of the Control Group. Complete sets of PSAT scores were available for both members of 72 of the matched pairs of subjects. These 72 matched pairs became the subjects for Part Two of the study which used PSAT Mathematics Subtest and PSAT Verbal Subtest scores as dependent variables.

Strong correlations exist between each of the matching variables and each dependent variable. The correlations for Part One shown in Table 1A are based upon the experimental group combined with the entire cohort from which the control group was drawn (N=1076). The correlations between the matching variable Total Mathematics Grade 5 and the Grade 7 dependent variables Total Mathematics, Concepts of Number, Mathematics Computation, and Mathematics Application were .85, .80, .76 and .81 respectively. The strength of the correlations between the secondary matching variable and the dependent variables was only slightly lower.

The selection process for the Control Group resulted in highly similar Experimental and Control Groups. Table 2A shows Experimental and Control Group means of 692.12 and 692.27 for the primary matching variable, Total Mathematics Grade 5. For the secondary matching variable, Total Reading Grade 5, the means were 690.43 and 684.46. The corresponding information for Part Two is found in Table 2B.

Table 1

<u>Pearson Correlations between Dependent Variables and Matching Variables - Part One of Study</u>

	Dependent Variable			
Matching Variable	Total Mathematics Grade 7	Concepts of Number Grade 7	Mathematics Computation Grade 7	Mathematics Application Grade 7
Total Mathematics Grade 5	.85	.80	.76	.81
Total Reading Grade 5	.71	.65	.59	.73

Table 2A

<u>Matching Variables for Control and Experimental Groups - Part One of Study</u>

Matching Variable	Control n	Control M	Control SD	Experimental n	Experimental M	Experimental SD
Total Mathematics Grade 5	260	692.27	24.55	260	692.12	24.42
Total Reading Grade 5	260	684.46	25.46	260	690.43	28.37

Table 2B

<u>Matching Variables for Control and Experimental Groups - Part Two of Study</u>

Matching Variable	Control n	Control M	Control SD	Experimental n	Experimental M	Experimental SD
Total Mathematics Grade 5	72	709.81	22.03	72	709.28	21.89
Total Reading Grade 5	72	702.54	22.54	72	712.68	24.25

A comparison of the performance of the Experimental and Control Groups on the Mathematics and Reading portions of South Carolina's Basic Skills Assessment Program (BSAP) shows that the similarities between the two groups still existed at the end of Grade 6. The Experimental Group BSAP Mathematics mean was 898.06 compared to the Control Group mean of 884.48 for Part One of the Study. The Grand Mean for the combined Experimental and Control Groups was 891.27 with a standard deviation of 93.96. Each group mean differed from the Grand Mean by only approximately 0.07 standard deviation and they differed from each other by less than 0.15 standard deviation. BSAP data for the 260 matched pairs of Part One and the 72 matched pairs of Part Two is summarized in Tables 3A and 3B respectively.

Table 3A

Basic Skills Assessment Program Data for Control and Experimental Groups - Part One of Study

BSAP Subtest	Control			Experimental			Combined		
	n	M	SD	n	M	SD	n	M	SD
Mathematics Grade 6	260	884.48	97.51	260	898.06	89.76	520	891.27	93.96
Reading Grade 6	260	856.20	69.02	260	876.01	66.94	520	866.10	68.70

Table 3B

Basic Skills Assessment Program Data for Control and Experimental Groups - Part Two of Study

BSAP Subtest	Control			Experimental			Combined		
	n	M	SD	n	M	SD	n	M	SD
Mathematics Grade 6	72	962.72	77.00	72	945.15	89.79	144	953.94	83.82
Reading Grade 6	72	886.96	57.40	72	901.71	59.93	144	894.33	58.94

Neither gender nor ethnicity nor poverty level was considered when selecting the control group. However, composition of the two groups was very much the same for each of these demographic variables. Both the Experimental and Control Groups were predominately white, not on free or reduced price lunch and slightly more female than male. This data is summarized in Tables 4A, 5A, and 6A for Part One of the Study and in Tables 4B, 5B, and 6B for Part Two.

Table 4A

<u>Composition of Experimental and Control Groups by Gender - Part One of Study</u>

	Male	Female
Experimental		
Number	122	138
Percent	46.9	53.1
Control		
Number	116	144
Percent	44.6	55.4

Table 4B

<u>Composition of Experimental and Control Groups by Gender - Part Two of Study</u>

	Male	Female
Experimental		
Number	31	41
Percent	43.1	56.9
Control		
Number	32	40
Percent	44.4	55.6

Table 5A

Composition of Experimental and Control Groups by Ethnicity - Part One of Study

	Black	White	Other
Experimental			
Number	7	253	0
Percent	2.7	97.3	0.0
Control			
Number	7	251	2
Percent	2.7	96.6	0.7

Table 5B

Composition of Experimental and Control Groups by Ethnicity - Part Two of Study

	Black	White	Other
Experimental			
Number	1	71	0
Percent	1.4	98.6	0.0
Control			
Number	2	70	0
Percent	2.8	97.2	0.0

Table 6A

Composition of Experimental and Control Groups by Lunch Status - Part One of Study

	Free/Reduced Lunch	Paid Lunch
Experimental		
Number	28	232
Percent	10.8	89.2
Control		
Number	31	229
Percent	11.9	88.1

Table 6B

Composition of Experimental and Control Groups by Lunch Status - Part Two of Study

	Free/Reduced Lunch	Paid Lunch
Experimental		
Number	0	72
Percent	0.0	100.0
Control		
Number	3	69
Percent	4.2	95.8

3.3 Description of Instrumentation

The Stanford Achievement Test, Eighth Edition published by the Psychological Corporation was used for all matching and posttests for Part One of the study. This is a nationally normed test and all descriptive statistics including reliability data are derived from information furnished by the publisher. Level I2 was used in Grade 5 and Level A1 was used in Grade 7.

The Kuder-Richardson Formula #20 Reliability Coefficient is .95 for both Total Mathematics and Total Reading on Level I2 for Grade 5. For Level A1 for Grade 7, it is .96 for Total Mathematics, .88 for Concepts of Number, .93 for Mathematics Computation, and .91 for Mathematics Applications.

This was obviously an instrument of convenience since for all of the years and grades involved, it is part of South Carolina's mandated State Testing Program. This implies some degree of construct validity for the instrument. A detailed analysis of construct validity is not possible, however. The South Carolina Department of Education has prohibited the distribution to school districts of the Instructional Skills Index prepared by the Psychological Corporation for the purpose of allowing districts to assess construct validity.

Results from the Preliminary Scholastic Aptitude Test (PSAT) which was administered at the beginning of Grade 8 to selected high achieving students were used for the dependent variables in Part Two of the study. The matching variables were the same as those in Part One.

3.4 Statistical Procedures

Related Sample T-Tests were conducted for each of the six dependent variables: Total Mathematics Scale Score, Concepts of Number Scale Score, Mathematics Computation Scale Score, Mathematics Application Scale Score, PSAT Math Subtest Score, and PSAT Verbal Subtest Score. The results of the Related Sample T-Tests were used to answer the research questions.

Linear Regression was also used in Part Two of the study to determine whether the slopes of the regression lines were the same for the Experimental and Control Groups when the PSAT Mathematics Score was regressed onto the 5th Grade Total Mathematics Scale Score on SAT-8. Note that all of the Experimental Group from Part One for whom PSAT scores were available (N=134) and all of the Control Group from Part One for whom PSAT scores were available (N=102) were used in the regression analysis.

3.5 Limitations of the Study

1. The control group was selected from among the prior year cohort. It has been established, however, that the Experimental and Control Groups did not differ prior to treatment. This was true for both Part One and Part Two of the study. The school district had no Transition Mathematics classes during the 1992-93 school year. The same teachers in the same schools who taught Transition Mathematics during 1993-94 taught the upper quartile of the cohort the year before.

2. The Experimental and the Control Groups for both Part One and Part Two of the study are composed almost entirely of white middle class students. Results from this study may not be generalizable to other populations.

Chapter 4

Results and Discussion

4.1 Results

Four hypotheses were formulated to assist in answering the research question for Part One of this study. These hypotheses are:

Hypothesis 1:

There is a difference in Total Mathematics Subtest scale scores on the SAT-8 for Transition Mathematics students and non-Transition Mathematics students.

Hypothesis 2:

There is a difference in Concepts of Number Subtest scale scores on the SAT-8 for Transition Mathematics students and non-Transition Mathematics students.

Hypothesis 3:

There is a difference in Mathematics Computation Subtest scale scores on the SAT-8 for Transition Mathematics students and non-Transition Mathematics students.

Hypothesis 4:

There is a difference in Mathematics Application Subtest scale scores on the SAT-8 for Transition Mathematics students and non-Transition Mathematics students.

Hypothesis 5 was formulated to assist in answering the research question for Part Two of this study. Hypothesis 6 is a control hypothesis designed to provide additional information for the interpretation of the results of Hypothesis 5. These hypotheses are:

Hypothesis 5:

Transition Mathematics Instruction students will have a different mean score on the Mathematics portion of the PSAT from non-Transition Mathematics Instruction Students.

Hypothesis 6:

Transition Mathematics Instruction students will have a different mean score on the Verbal portion of the PSAT than non-Transition Mathematics Instruction Students.

Table 7A presents the summary data for both the Experimental and Control Groups for Part One of the study along with correlations between Experimental and Control scale scores on each subtest considered. Table 7B contains the same information for Part Two.

Table 7A

Summary Data for Control and Experimental Groups - Part One of Study

SAT-8 Subtest	Control n	Control M	Control SD	Experimental n	Experimental M	Experimental SD	r
Total Mathematics	260	718.61	30.13	260	720.58	31.11	0.511
Concepts of Number	260	730.31	40.97	260	732.06	36.13	0.447
Mathematics Computation	260	729.46	42.61	260	717.35	40.76	0.351
Mathematics Applications	260	708.40	29.63	260	720.26	30.27	0.417

Table 7B

Summary Data for Control and Experimental Groups - Part Two of Study

PSAT Subtest	Control n	Control M	Control SD	Experimental n	Experimental M	Experimental SD	r
Mathematics	72	47.05	6.21	72	49.88	4.79	0.511
Verbal	72	48.73	6.26	72	47.75	6.51	0.447

Tables 8A and 8B present the data pertinent to the research question for Part One and Part Two of the study respectively.

Table 8A

Discrepancies Between Control and Experimental Groups by Subtest - Part One of Study

SAT-8 Subtest	Number of Cases	Mean Discrepancy	SD of Discrepancy	Standard Error	t	prob >|t|
Total Mathematics	260	1.97	30.29	1.88	1.051	0.2945
Concepts of Number	260	1.75	40.74	2.53	0.693	0.4891
Mathematics Computation	260	-12.10	47.53	2.95	-4.106	0.0001
Mathematics Applications	260	11.86	32.35	2.01	5.912	0.0001

Table 8B

Discrepancies Between Control and Experimental Groups by Subtest - Part Two of Study

PSAT Subtest	Number of Cases	Mean Discrepancy	SD of Discrepancy	Standard Error	t	prob >|t|
Mathematics	72	1.75	7.09	0.84	2.09	0.04
Verbal	72	0.07	9.11	1.07	0.953	0.95

From these data it may be concluded that Hypotheses 1, 2 and 6 are not supported but that Hypotheses 3, 4 an 5 are supported.

For Part One of the study the Transition Mathematics program produced significant gains in the area of Mathematics Applications which is supposed to be its greatest strength. Large gains were anticipated in the area of Concepts of Number but were not realized. Losses in the area of Mathematics Computations of approximately the same magnitude as the gains in Mathematics Applications were certainly disappointing. Given these results, the finding of no significant difference in Total Mathematics could be expected since this Subskill amounts to a weighted composite of the other subskills considered. It would appear that this program has rearranged instructional emphasis but has not improved overall mathematics instruction.

For Part Two of the study, the Transition Mathematics Program produced significant gains on the Mathematics Subtest of the PSAT but had no impact upon the Verbal Subtest of the PSAT. This indicates that the mathematics gains were the result of Transition Mathematics instruction and not some other extraneous variable which increased the overall level of cognitive functioning. The results of regressing PSAT Mathematics Scores on 5th Grade Total Mathematics Scale Scores on SAT-8 are presented graphically by superimposing the linear regression line on a scatterplot of the scores. This information is contained in Figure 1 for the Experimental Group and Figure 2 for the Control Group. Figure 3 shows the two regression lines drawn on the same set of axes. Figure 3 indicates that students with lower scores on the Total Mathematics Scale Score on the SAT-8 administered at the end of Grade 5 benefit more from Transition Mathematics than do students with higher scores. It must be kept in mind that the lowest students in the study were at the 75th national percentile on this measure. This finding seems to contradict the recommendation from Transition Mathematics teachers that only students at or above the 85th national percentile should be allowed to take Transition Mathematics.

Figure 1

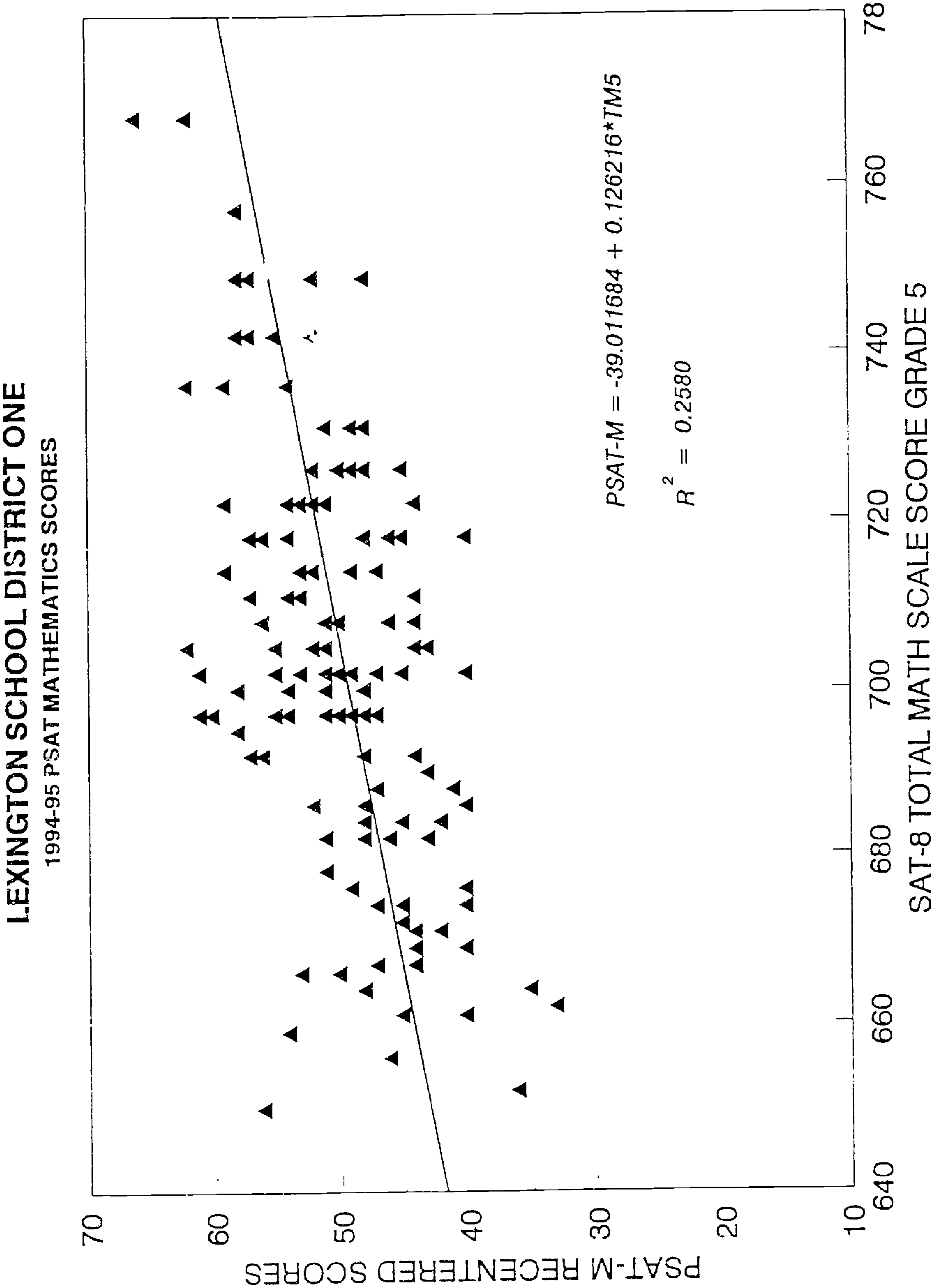

LEXINGTON SCHOOL DISTRICT ONE
1994-95 PSAT MATHEMATICS SCORES
PSAT-M = -39.011684 + 0.126216*TM5
R² = 0.2580
SAT-8 TOTAL MATH SCALE SCORE GRADE 5
640
660
680
700
720
740
760
780
PSAT-M RECENTERED SCORES
10
20
30
40
50
60
70

Figure 2

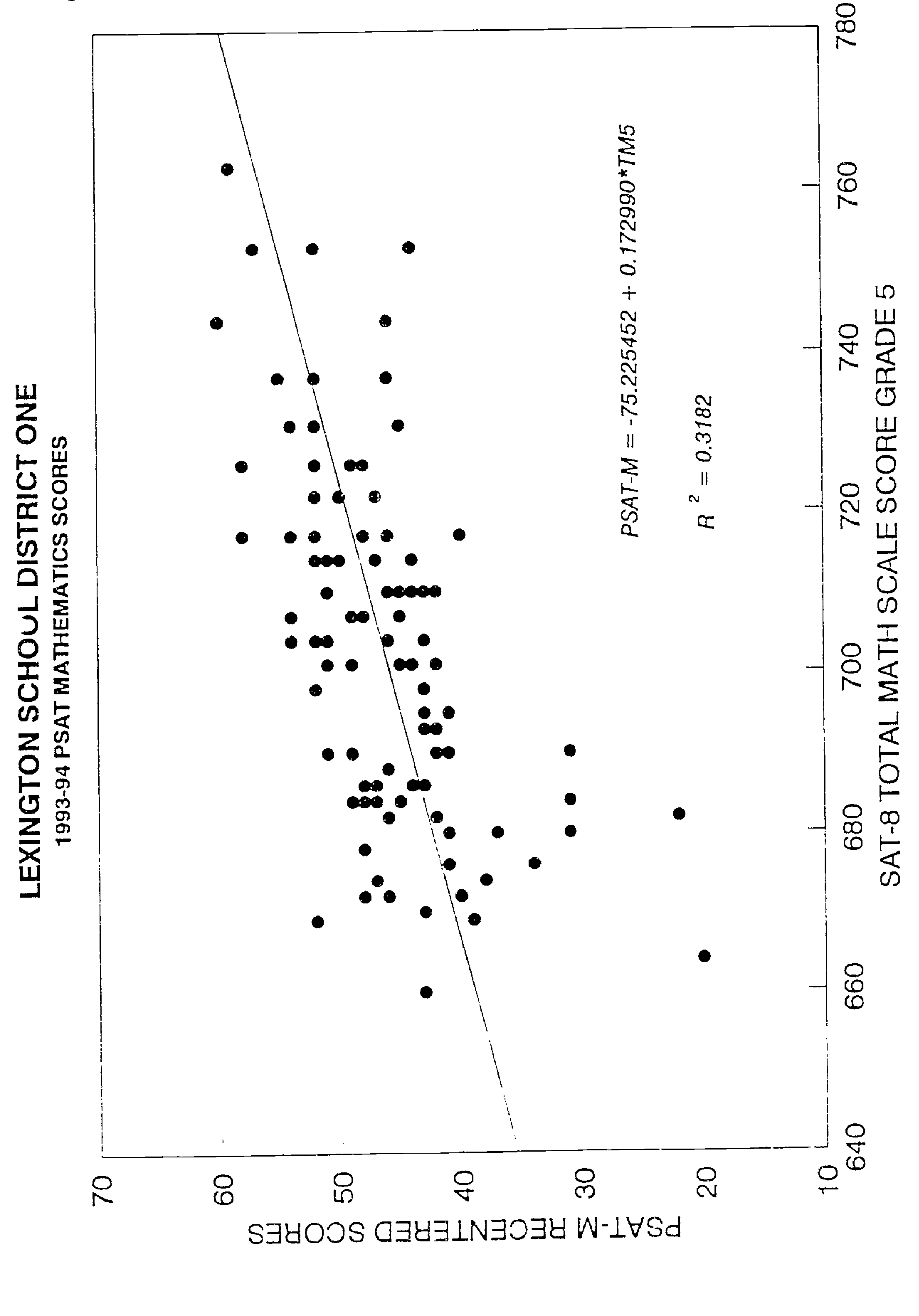
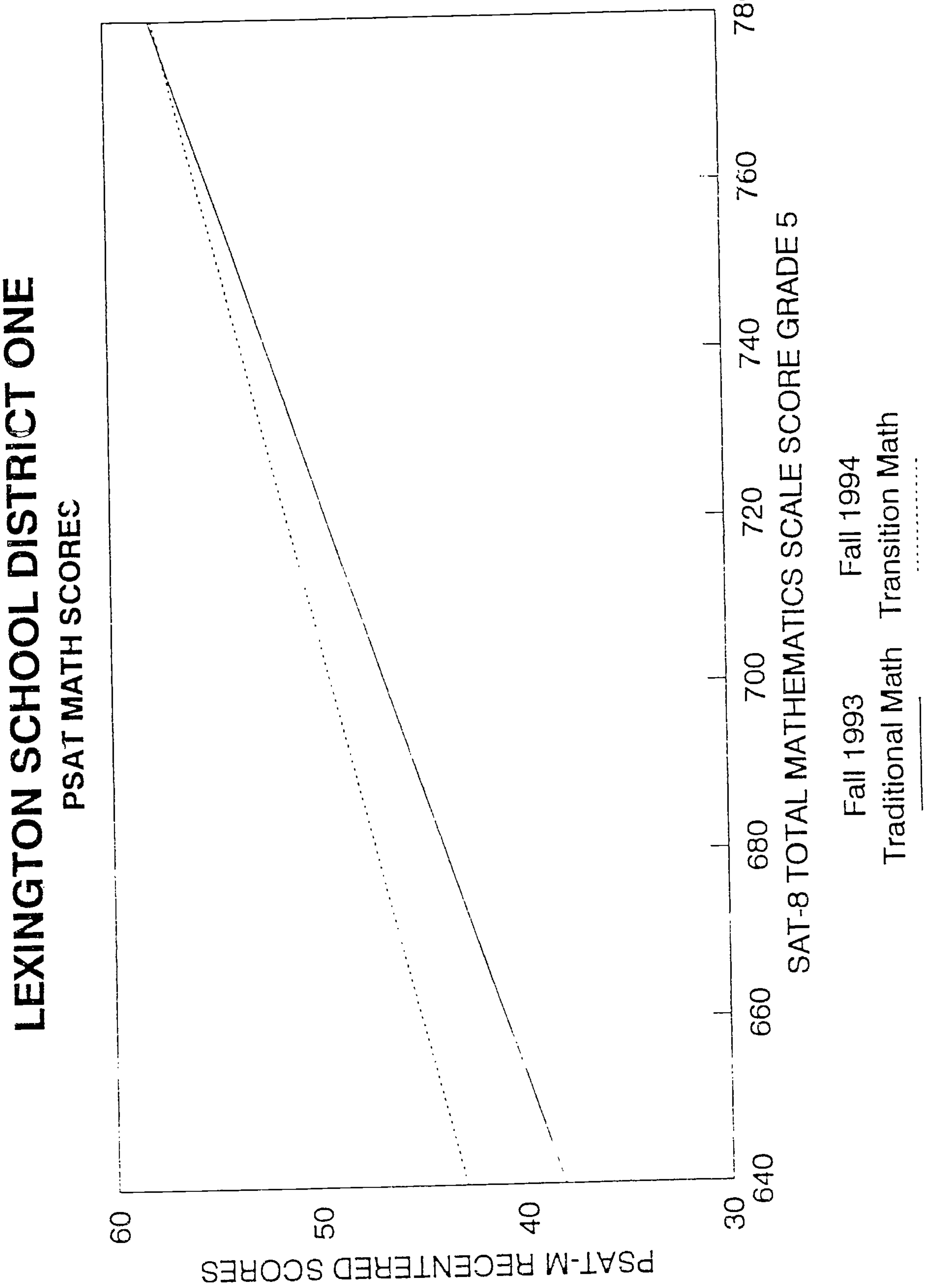

LEXINGTON SCHOOL DISTRICT ONE
1993-94 PSAT MATHEMATICS SCORES
PSAT-M = -75.225452 + 0.172990*TM5
R 2 = 0.3182
SAT-8 TOTAL MATH SCALE SCORE GRADE 5
PSAT-M RECENTERED SCORES
640
660
680
700
720
740
760
780
10
20
30
40
50
60
70

Figure 3


LEXINGTON SCHOOL DISTRICT ONE
PSAT MATH SCORES
PSAT-M RECENTERED SCORES
60
50
40
30
640
660
680
700
720
740
760
780
SAT-8 TOTAL MATHEMATICS SCALE SCORE GRADE 5
Fall 1993
Traditional Math
Fall 1994
Transition Math

4.2 Discussion

UCSMP claims to be a full implementation of the NCTM Standards and further claims that each of its six courses can stand alone as a complete course of study. The logical conclusion if these claims are accepted at face value is that Transition Mathematics represents a full implementation of the NCTM Standards for seventh grade above average students. This is a curricular rather than a statistical question, however.

It has been verified that all Transition Mathematics Teachers received all training recommended by UCSMP prior to the beginning of the program and that all recommended materials including calculators were available throughout the course. All fourteen Transition Mathematics classes received a full implementation of the program.

An underlying assumption of Transition Mathematics is that once a student has demonstrated computational proficiency that this skill should no longer be emphasized and that calculators and computers should be employed to broaden the student's ability to solve more complicated problems without expending great effort on computation. The results of Part One of this study raise serious questions about this assumption.

A second underlying assumption of Transition Mathematics is that by applying mathematics in real life problem solving situations, students will increase their understanding of mathematics. Increased understanding should show up in increased scores on the Concepts of Number Subskill on the SAT-8. This simply did not happen. The question must be raised whether the students are being taught that a particular algorithm applies to a particular problem type and that the algorithm can be solved using a calculator. This could have the effect of isolating the student from the mathematics involved and consequently fail to increase mathematical understanding.

NCTM Standards call for increasing student ability to apply mathematics in practical situations. The results for Hypothesis 4 indicate that Transition Mathematics does this exceedingly well.

The results from Part Two of this study add considerable validity to the claims of TMI supporters that only instruments that test high level skills can properly evaluate the effect of TMI on student performance. TMI students definitely outperformed the controls on the Mathematics portion of PSAT. Yet, on the Verbal portion, TMI and Control means were virtually the same. This would seem to indicate that the progress being measured is purely mathematical and not part of some sort of overall intellectual development.

Figures 1-3 indicate that students around the 75th national percentile on Total Mathematics as measured by the end of Grade 5 SAT-8 benefit more from Transition Mathematics instruction than higher functioning students. This contrasts sharply with the teacher recommendation that requirements for program participation be raised. It is critical that this difference between measured results and teacher perceptions be resolved. It is possible that following teacher recommendations in this case could minimize gains and possibly result in the elimination of the program as not being cost effective.

Two questions face us now: (1) Which students benefit significantly from Transition Mathematics Instruction? (2) How do we realize the gains of Transition Mathematics without an accompanying decline in areas which it does not emphasize? Much additional research is needed to answer both of these questions. This should be true experimental research instead of the post hoc variety reported in this paper.

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