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ABSTRACT

Project Special Elementary Education for the Disadvantaged (Project SEED) is a nationwide program in which mathematicians and scientists from academia and industry teach abstract, conceptually oriented mathematics to full-sized classes of elementary school students as a supplement to their regular arithmetic classes. A Socratic group-discovery format is used. In its implementation in the Dallas (Texas) public schools, SEED was used with all levels of children in schools with high percentages of minority and low-income children. The 1989-90 evaluation considered the program's impact on the achievement of more than 3,000 students who had one, two, or three semesters of SEED instruction in grades four through six. The achievement these students attained was compared, using longitudinal information where possible, with that of non-SEED students through the use of Iowa Tests of Basic Skills scores and other measures. Impact of one, two, and three semesters was apparent, with the minimum at 2.2 months (1 semester, in problem solving) and the maximum at 9.0 months (computation, after 3 semesters). Project SEED students were also more likely to enroll in advanced mathematics in secondary school. Evaluators recommend that the program be expanded to as many students as possible. Thirteen tables present evaluation findings, and two appendixes contain an additional 13 tables of findings from prior program evaluations. (SLD)

EVALUATION OF PROJECT SEED

REIS90-043-2

DEPARTMENT OF RESEARCH, EVALUATION, AND INFORMATION SYSTEMS

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THE EVALUATION OF PROJECT SEED 1989-90

REIS90-043-2

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Approved Report of the Department of Research, Evaluation, and Information Systems

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Dallas, Texas
October, 1990

EXECUTIVE SUMMARY

EVALUATION OF PROJECT SEED 1989-90

Evaluators: William J. Webster and Russell A. Chadbourn

Project SEED is a nationwide program in which professional mathematicians and scientists from major universities and research corporations teach abstract, conceptually oriented mathematics to full-sized classes of elementary school children on a daily basis as an extra-period supplement to their regular arithmetic program. The mathematics is presented through the use of a Socratic group discovery format in which children discover mathematical concepts by answering a sequence of questions posed by the SEED instructor. Project SEED believes that only persons who understand mathematics in depth possess the versatility to capitalize on the unconventional and often original insights that children are capable of making in an open-ended mathematical dialogue. The initial mathematical topics are chosen from high school and college algebra to reinforce and improve the students' computational skills and to help equip them for success in college-preparatory mathematics courses at the secondary level. Subsequent material establishes the mathematical foundation for a number of advanced areas of study and progresses into advanced topics in abstract algebra and other areas. Project SEED teaches entire regular elementary school classes rather than specially selected groups of students. Although SEED was originally begun as a program for the educationally disadvantaged (the acronym SEED stands for Special Elementary Education for the Disadvantaged), the project now is implemented with all levels of children across the nation. In its DISD implementation, SEED was used with all levels of students and was not intended as a program for a specific group of students. The DISD implementation of SEED also continued SEED's nationwide practice of using intact classes in the schools in which it is implemented.

EVALUATION QUESTIONS

1.0 What is the impact of one, two, and three semesters of SEED instruction at the 4-6 level on mathematics achievement as measured by the STEELS and the ITBS?

2.0 Is there a cumulative impact of SEED instruction on mathematics achievement?

3.0 Is there a differential grade-retention rate between SEED participants and the nonparticipant comparison groups? This question will be examined longitudinally.

4.0 Do former SEED students enroll in more higher level math classes than their non-SEED comparison groups?

5.0 Do former SEED students withdraw from school less than their non-SEED comparison groups?

6.0 What is the long-term impact of three semesters of SEED instruction on mathematics achievement?

7.0 What reading trends are evident among students who have been exposed to SEED?

All SEED and comparison groups were matched on pretreatment variables. The variables were sex, ethnicity, socioeconomic status, grade level, and achievement level on the Mathematics Total subtest of the ITBS. Eight different samples were used:

1.0 Students who had one semester of SEED in the South Dallas Learning Centers in the fourth grade in 1989-90; two semesters of SEED in the South Dallas Learning Centers in the fourth and fifth grade in 1988-89 and 1989-90; or, three semesters of SEED in the South Dallas Learning Centers in the fourth, fifth, and sixth grades in 1987-89, 1988-89, and 1989-90. These students and their matched comparison groups were compared on achievement on the ITBS and STEELS (Study A).

2.0 Students who had three semesters of SEED in the South Dallas Learning Centers in grades 4-6 in 1984-87, 1985-88, or 1986-89. These students and their matched comparison groups are compared on achievement on the ITBS both for the years that they were exposed to SEED and up to two years later. Course enrollment, retention rates, and withdrawal rates were also compared for these students (Study B).

3.0 Students who had one semester of SEED in 1982-83 or 1983-84 in a non-Learning Center environment. These students were compared on course enrollment, retention rates, and withdrawal rates (Study C).

All SEED students in groups 1.0 and 2.0 were also Learning Center students. This makes straight forward data interpretation difficult. Reading results are analyzed to aid in interpretation of SEED/Center mathematics results.

MAJOR EVALUATION FINDINGS AND RECOMMENDATIONS

Finding. There is an impact of one, two, and three semesters of SEED instruction on mathematics achievement as measured by both the ITBS and STEELS. The one semester impact ranges from a low of 2.2 months in Problem Solving to a high of 3.9 months in computation. The three semester impact ranges from a low of 4.7 months in Problem Solving to a high of 9.0 months in Computation. STEELS impact is as high as 13.7 scale points. Tables 2 and 3 display these data.

Finding. There is a cumulative impact of SEED instruction on mathematics achievement. The more semesters of SEED that students take, the greater the difference between their grade equivalent levels and those of a matched comparison group. Groups had up to three semesters of SEED instruction.

Recommendation. Achievement results suggest that the District should expose as many students as is feasible to SEED instruction or, at least, to an instructional methodology that is similar to SEED.

Finding. Former SEED students enroll in significantly more higher level mathematics classes than do their matched comparisons. Table 11 displays relevant data.

Finding. The student withdrawal rates favor former SEED/Center students in three of four comparisons, but not significantly so.

Finding. Two years after the conclusion of their SEED experience, former SEED students still achieve significantly higher in mathematics than do their comparisons. This is not the case in Reading.

Finding. There is evidence that the South Dallas Learning Centers are having a positive impact on Reading achievement. That impact, however, is not nearly as great as the impact in mathematics, nor does the impact last as long. Once former Learning Center students have matriculated to middle school, there is no longer any difference in reading achievement between them and their matched comparisons. Mathematics achievement differences are still significant two years after matriculation from a Learning Center.

For 1990-91, SEED instruction is being expanded to serve students in grades 7-8 in a Learning Center environment. This will enable not only an analysis of impact of SEED instruction on ITBS and STEELS, but also an analysis of impact of SEED instruction on course grades and specific STEELS tests since at the middle school level students take separate and distinct courses.

At this point, however, based on four series of longitudinal studies, the evaluators would recommend that as many students as feasible, both within and outside of Learning Centers, be exposed to SEED instruction or to a methodology that is similar to SEED.

Table 2
The Impact Of One And Two Semesters
Of SEED/Center Instruction
On Mathematics Achievement
Spring, 1989-90

SEED, 1989-90	Spring, 1989				Spring, 1990				
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	N
Concepts (ITBS)	5.26	1.17	4	.33**	6.48	1.51	5	.38**	424
Problem Solving (ITBS)	4.51	1.25		.22**	5.60	1.29		.17**	
Computation (ITBS)	5.31	0.96		.39**	6.40	1.15		.40**	
Total (ITBS)	5.03	0.97		.32**	6.16	1.18		.32**	
STEELS Mathematics	53.5	26.2		8.2 **	54.5	27.5		12.00**	
Reading (ITBS)	4.36	1.07		.15*	5.46	1.15		.30**	

COMPARISON, 1989-90	Spring, 1989				Spring, 1990				
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	N
Concepts (ITBS)	4.93	1.35	4	-	6.10	1.52	5	-	424
Problem Solving (ITBS)	4.29	1.35		-	5.43	1.40		-	
Computation (ITBS)	4.92	1.03		-	6.00	1.17		-	
Total (ITBS)	4.71	1.12		-	5.84	1.24		-	
STEELS Mathematics	45.3	29.2		-	42.5	28.8		-	
Reading (ITBS)	4.21	1.15			5.16	1.26			

Where:

$\bar{X}$ = mean

S = standard deviation

G = grade tested

D = difference between experimental (SEED) and comparison groups with the difference being tabled with the group that is highest

* = $p \leq .05$

** = $p \leq .01$

Table 3
The Impact Of Two And Three Semesters Of SEED/Center Instruction On Mathematics Achievement
Spring, 1988-90[1]

SEED, 1988-90	Spring, 1989				Spring, 1990				
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	N
Concepts (ITBS)	6.86	1.35	5	.74**	7.52	1.76	6	.88**	290
Problem Solving (ITBS)	5.59	1.19		.32**	6.57	1.55		.47**	
Computation (ITBS)	6.54	1.00		.53**	7.65	1.17		.90**	
Total (ITBS)	6.33	1.05		.53**	7.24	1.35		.74**	
STEELS Mathematics	48.9	28.7		.93	53.8	26.0		13.7 **	
Reading (ITBS)	5.51	1.32		.32**	6.11	1.36		.24**	

COMPARISON, 1988-90	Spring, 1989				Spring, 1990				
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	N
Concepts (ITBS)	6.12	1.43	5	-	6.64	1.60	6	-	
Problem Solving (ITBS)	5.27	1.38		-	6.10	1.65		-	
Computation (ITBS)	6.01	1.11		-	6.75	1.34		-	
Total (ITBS)	5.80	1.16		-	6.50	1.40		-	
STEELS Mathematics	47.2	28.5		-	40.1	27.6		-	
Reading (ITBS)	5.19	1.30		-	5.87	1.49		-	

[1] There was no Spring testing program in 1988.

Where:

$\bar{X}$ = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental (SEED) and comparison groups with the difference being tabled with the group that is highest

* = $p \leq .05$

** = $p \leq .01$

Table 11
Number And Percentage Of
Higher Level Mathematics
Courses Enrolled In By Former
SEED And Comparison Students[1]

Cohort[2]	SEED						COMPARISON					
	N	M	H	A	HM	P	N	M	H	A	HM	P
1989(7)	293	589	388	2.01	1.32**	65.9**	291	579	238	1.99	0.82	41.1
1988(8)	229	919	309	4.01	1.35**	33.6**	236	897	205	3.80	0.87	22.9
1987(9)	314	1870	423	5.96	1.35	22.6	302	1833	413	6.07	1.37	22.5
1984(10-12)	200	2114	1228	10.57	6.14**	58.1**	215	2132	906	9.92	4.21	42.5
1983(11-G)	197	2143	1390	10.88	7.06**	64.9	208	1913	1248	9.2	6.0	65.2

[1] The 1983 and 1984 cohorts were exposed to one semester of SEED and were not enrolled in Learning Centers.

[2] The date represents the last year that students were enrolled in SEED. The number in parenthesis represents the grade that the students were in in 1989-90.

Where:

N = the number of students in the cohort

M = the total number of math courses taken

H = the number of higher level math courses taken

A = the average number of semesters of math taken per student

HM = the average number of semesters of higher level math courses taken per student

P = the percentage of higher level math courses taken

** = $p \leq .01$

THE EVALUATION OF PROJECT SEED, 1989-90

William J. Webster and Russell A. Chadbourn

PROGRAM DESCRIPTION

Project SEED is a nationwide program in which professional mathematicians and scientists from major universities and research corporations teach abstract, conceptually oriented mathematics to full-sized classes of elementary school children on a daily basis as an extra-period supplement to their regular arithmetic program. The mathematics is presented through the use of a Socratic group discovery format in which children discover mathematical concepts by answering a sequence of questions posed by the SEED instructor. Project SEED believes that only persons who understand mathematics in depth possess the versatility to capitalize on the unconventional and often original insights that children are capable of making in an open-ended mathematical dialogue. The initial mathematical topics are chosen from high school and college algebra to reinforce and improve the students' critical thinking and computational skills and to help equip them for success in college-preparatory mathematics courses at the secondary level. Subsequent material establishes the mathematical foundation for a number of advanced areas of study and progresses into advanced topics in abstract algebra and other areas. Project SEED teaches entire regular elementary school classes rather than specially selected groups of students. Although SEED was originally begun as a program for the educationally disadvantaged (the acronym SEED stands for Special Elementary Education for the Disadvantaged), the project now is implemented with all levels of children across the nation. In its DISD implementation, SEED was used with all levels of students and was not intended as a program for a specific group of students. The DISD implementation of SEED also continued SEED's nationwide practice of using intact classes in the schools in which it is implemented.

A Typical SEED Class

Project SEED is a supplementary program which is taught entirely by the SEED specialist assigned to a given class. The students in the class receive regular baseline instruction in mathematics from their DISD teacher. (This will either be a mathematics teacher in a departmentalized setting or the classroom teacher in a self-contained setting.) The students then receive a period of SEED instruction four days a week from the SEED specialist. The fifth period is an inservice period for the SEED specialist which will be discussed in more detail later. In this fifth period, the students work at the direction of the classroom teacher. This work may or may not be related to the material taught in Project SEED at the discretion of the teacher, but it usually is not. The teacher is always present while SEED is being taught but has no direct instructional role in the project.

Instruction in the SEED program will be considered in two parts, the instructional methodology of SEED and the mathematics content of the program. SEED uses a group instruction methodology. The class is taught using a series of directed questions. The instructor asks questions of individuals in the class or of the class as a whole. New material is introduced at a slow pace and the majority of classroom time is usually spent in working on applications related to material previously encountered or in reviewing new and previous work. This stress upon application and review is intended to insure that the students have a solid foundation in previously learned material before new material is introduced.

The SEED specialist uses a number of devices to manage the instruction in the classroom. The students are required to respond to most of the questions and discussions in the class. The responses are given using hand signals unless the students are asked directly to respond verbally. Signals are used to indicate agreement and disagreement with the topics of discussion and to respond to questions. The purpose of the signals is to give the instructor continual feedback about student perceptions of the material, to ensure group response which involves most (if not all) of the students in the dialogue on the material, and to maintain a degree of order in the classroom which could not be achieved using verbal responses. On the basis of the observations of SEED classes during the process evaluation, the signals seem to succeed in accomplishing these purposes.

To help ensure student involvement, each student is called upon several times each period to provide answers or comment. In the event a student is not participating in the discussions, the SEED instructor will use such devices as having the student call upon another student to provide an answer or calling upon the student to provide a number for a problem. Other devices used to keep student involvement at a high rate include having all students participate in group verbal responses to questions, having students write answers to questions on their papers and checking all or part of the papers immediately, or having all students show the answer to a question on their fingers. These methods and a number of others are all designed to keep student interest and involvement high, as well as to accomplish other instructional objectives.

To mitigate problems associated with locus of control in the classroom, the SEED instructor moves frequently in the classroom and avoids teaching and questioning from the same spot. This also helps keep students attentive since, at any moment, the instructor may be asking the next question from any part of the room. SEED classes have a higher proportion of visitors than usual, and the visitors and the teacher are utilized by the instructor. For example, the instructor might ask a visitor to call upon a student with his or her hand up to answer a question. In this fashion, the students become accustomed to visitors, who are not usually a source of interruption in the classroom.

The primary feature of the instructional system, however, is the set of questions asked by the SEED specialist. Almost all of the instruction is done through the use of questions. Rarely does the instructor directly tell the students anything. This is done, again, to help keep the student actively involved in the progress of the class and to avoid having the student as a passive recipient of the subject material. The instructor, in preparing for the class, thinks through the subject matter to be presented and assembles a list of sequenced questions which will be used as the basis of the questions asked of the students in class. These questions develop the content to be covered in a logical and detailed sequence which is then transferred to the classroom and form the heart of the SEED instructional process. In general, the SEED classes observed in the process evaluation visits exhibited thorough preparation on the part of the instructors as evidenced by the careful sequence of questions used in the instructional process.

SEED Mathematics Content

The mathematics content observed in the SEED classes consisted primarily of a thorough preparation in pre-algebra mathematics and beginning concepts of abstract algebra, with examples taken from the real number system. Some of the topics observed included properties of positive and negative numbers, properties of exponents, the additive law of exponents, definition and properties of logarithms, use of the distributive law of real numbers to prove properties of positive and negative numbers, the definition and properties of additive and multiplicative identities, the definition of additive inverses, the definition and properties of negative exponents, the definition and application of summation and product symbols, and an introduction to mathematical series.

As indicated by the former General Superintendent, the Dallas Independent School District (DISD) has an underlying goal in instituting the SEED program. This goal is to encourage more students to participate in the high school algebra sequence and the mathematics sequences following algebra. The hope is that participation in the SEED program will give more students the motivation to take the course sequences and will equip them with the necessary mathematical skills to succeed in these sequences. The sample of mathematical skills observed in the SEED classes was relevant to this goal. One of the objectives of this study is, within the limitations discussed in the Methods section, to determine if this phenomenon can be documented.

SEED as a Classroom Methodology

During the 1982-83 school year, a number of SEED classroom observations were conducted by the District's Research and Evaluation Department.

The procedure was informal with no quantifiable criteria, but, rather, it was based on impressions of the SEED program contrasted with other instructional systems. These impressions are relevant because they further describe the treatment as implemented in the District.

According to an earlier evaluation report (Mendro, REIS83-019, 1983), the first impression produced by SEED was that it contained a highly effective instructional system which could be implemented successfully by a wide variety of instructors. The organization of the classroom management techniques was such that the program generally showed good control of instruction in all the classes observed.

The second positive feature of the SEED program was the inservice system. Recall that the SEED instructor teaches four periods and has one inservice period per class each week. The purpose of this inservice period is to conduct discussions with the classroom teachers about the students and the progress of the SEED class, and to observe other SEED instructors and provide them with feedback on their implementation of the program. This system has two obvious advantages. First, during an inservice period, the instructor has a chance to reflect on the instructional components of the program and his or her implementation of them; the instructor has a chance to see and critique other instructors, which helps keep these skills sharp and allows for transmission of effective techniques through direct observation; and, finally, the instructor has a chance to participate in discussions with other instructors, all of whom share common problems and interests. This first advantage of the inservice period generally provides the instructor with a chance to keep the instructional techniques fresh and alive and gives the project a formal mechanism for transmitting effective teaching techniques. The second advantage is that during the non-inservice days, the instructor is liable at any time to have other SEED instructors and trainees sit in on a class and provide a required critique of his or her teaching that day. This process of continual peer-evaluation is perceived as an extremely powerful method of insuring high quality teaching throughout the program.

Thus, the conclusion drawn regarding the instructional quality of SEED was that the program had a very good classroom management system. The quality of instruction was consistently good across the program and it seemed to have an excellent internal procedure for building and maintaining that quality.

PREVIOUS EVALUATION STUDIES

Three series of studies on the impact of SEED were completed during the 1987-88 and 1988-89 school years. All studies focused on the immediate and longitudinal impact of SEED instruction on achievement in and attitudes toward mathematics.

Series 1. The first series of studies examined the impact of one semester of SEED instruction on mathematics achievement and attitude. Six different treatment groups with their respective comparison groups were compared relative to post-SEED achievement trends and mathematics course enrollment. The design was set up so that each study was replicated within the design. Analyses were performed on two separate and distinct groups of fourth, fifth, and sixth graders, each being followed for a period of five years. Further replication studies were accomplished by examining the immediate impact of SEED instruction on student achievement in the year that SEED was offered, thus examining the impact of SEED on a group of students that did not exhibit the mortality of the five-year longitudinal groups.

In the case of this series of studies, SEED students were exposed to regular math plus SEED instruction, while comparison students were exposed only to regular math. Thus, part of the treatment was additional exposure to mathematics (45 minutes). Longitudinal group sizes ranged from 32 to 87. Short-term group sizes ranged from 245 to 295. Initial groups were chosen in 1982-83 and 1983-84.

The results of this first series of studies suggested strong and consistent immediate impact of SEED instruction on mathematics achievement as measured by the Concepts, Problem Solving, Computation, and Total sections of the Iowa Tests of Basic Skills (ITBS). These improved scores were generally present at least one year after students had been exposed to SEED. The results also suggested greater impact of SEED on the achievement of lower socioeconomic students. In addition, former SEED students clearly took higher percentages of advanced courses than did their matched comparisons (Webster and Chadbourn, 1988). Relevant achievement data are tabled in Appendix A.

Series 2. The second series of studies examined the achievement trends of students who were enrolled in SEED three semesters: one in the fourth grade in 1984-85, one in the fifth grade in 1985-86, and one in the sixth grade in 1986-87.

Project SEED has been implemented in three special schools since the 1984-85 school year. Although the schools have many special programs and arrangements, they were primarily designed to raise student achievement levels in reading. Classes were self-contained and the homeroom teacher generally taught all subject areas except music and art. We must recognize from the outset that the instructional treatment in mathematics represents an extra 45-minutes of SEED instruction per day for four days a week. Comparison students had mathematics instruction by either self-contained teachers or mathematics specialists for 60-minutes per day. SEED students had instruction by self-contained teachers (non-mathematics specialists) plus the instruction by SEED instructors. These were the best comparisons that were available, since all students in the special schools had SEED.

As in the series of studies outlined as Study 1 of this investigation, Comparison Groups were selected from groups of students similar to those who received SEED instruction. The same selection criteria were used as were used in Study 1 of the investigation except, of course, the Comparison Groups matched the characteristics of the Study 2 SEED students.

Two major questions were examined. First, were the post-SEED instruction achievement trends of SEED students different from those of Comparison students who were not exposed to SEED? This question was examined separately using the Math Concepts, Math Problem Solving, Math Computation, and Math Total scores on the ITBS.

Second, given that the schools studied were Learning Centers and had many special arrangements over other schools, the same type of longitudinal analysis was done on reading. The case for a treatment effect of Project SEED would be greatly enhanced if math trends among Center students were more positive than reading trends. The Reading subtest of the ITBS was used for this analysis. In addition, SEED data bases were established so that SEED student achievement as well as mathematics course selection versus that of Comparison Students can be analyzed over succeeding years.

The cohort samples for this part of the study required four years of test data. There were 517 SEED and 517 comparison students. The samples were one hundred percent Black and Hispanic, and seventy-nine percent on free and reduced lunch. Their pre-1984 achievement levels ranged from the first to the tenth decile.

The results of this series of studies suggested an immediate impact of SEED at the fourth grade level on mathematics achievement. This impact increased at grade 5 and further accelerated at grade 6. Thus, students who entered the fourth grade about even with their peers left the sixth grade about one-half year ahead of their peers in Problem Solving and almost one year ahead in Concepts. In addition, they were at or above grade level in Concepts, Computation, and Total Math scores.

Both the SEED and comparison samples had Spring, 1984 mean scores of 3.33 in Reading. During the succeeding three years of instruction, the SEED sample advanced to a mean score of 5.98 while the comparison sample advanced to a mean score of 5.55. Thus, the SEED sample gained 2.65 grade equivalent units in reading while the comparison sample gained 2.22 grade equivalents in reading. Compare this to a mean gain of 3.18 grade equivalent units in mathematics for the SEED students versus 2.36 grade equivalents for the comparison group. Relevant data are tabled in Appendix A.

Series 3. The third series of studies replicated the Series 2 studies plus added an additional outcome variable, a criterion-referenced test entitled the *Survey Tests of Essential Elements/Learner Standards (STEELS)*. This series of studies also examined retention rates, enrollment in higher level mathematics classes, withdrawal rates, and long-term impact of SEED. Four different samples were used. These samples included: students who had SEED instruction in the Learning Centers in grades 4-6 in 1985 through

1988; students who had SEED instruction in the Learning Centers in grades 4-6 in 1986 through 1989; follow-up of students who had one semester of SEED in 1982-83 or 1983-84 as well as Learning Center students who had three semesters of SEED in 1984-87.

This series of studies on SEED took an indepth look at the impact of SEED instruction on mathematics achievement as measured by the ITBS and STEELS and on student attitudes toward mathematics as measured by the enrollment of students in advanced math courses. Most of the students in the SEED group were also Learning Center students, thus introducing an intervening variable into the process of interpreting the results. Analyses of Learning Center Reading achievement were conducted to provide some measure of the impact of the Centers independent of SEED. Early non-Center SEED groups were also studied for this purpose.

Although the primary focus of this series of investigations was to examine the impact of Project SEED in the Learning Center environment, part of the study focused on non-Learning Center students who had only one semester of SEED in the fourth, fifth, or sixth grade. Although the achievement impact of this strategy appeared to wash out after two years, former SEED students still appeared to enroll in more higher level math classes, withdraw from the District less, and be retained fewer times than did their matched comparison groups.

The results of this series of studies suggested that SEED instruction in the Learning Centers contributed substantially to increased mathematics achievement as measured by the ITBS and STEELS, increased enrollment in higher level mathematics courses, lowered grade retention and District withdrawal rates, a cumulative impact on mathematics achievement, that is, longer exposure to SEED (up to three semesters) appeared to accelerate measured mathematics achievement growth, and, retention of mathematics gains for at least two years after exposure to SEED. Relevant data are tabled in Appendix B.

STUDY DESCRIPTION

The Theoretical Comparison Group

In the field of practical evaluation it is often impossible to implement true experimental designs. The concept of randomly assigning students to treatments is repugnant to most educators, particularly in situations where it is perceived that one group of randomly assigned students will be deliberately withheld from what is often believed to be an effective educational treatment. Thus the problem of identifying appropriate comparison groups is crucial to the interpretability of results. The literature is replete with warnings of the threats to the validity of experiments involved in comparing non-randomly assigned intact groups.

All of the comparisons in this series of studies utilize theoretical comparison groups. Each student in each of the experimental groups (SEED) was systematically matched to a comparison student. These comparison students were drawn from many District schools and thus represent many different math treatments. The one thing that they all have in common is that they have not been exposed to SEED. All matching was done in the year prior to exposure to SEED. Variables used in the matching process were:

1. sex
2. ethnicity
3. grade (previous and current year)
4. socioeconomic status as indicated by free lunch
5. achievement levels (math total)

Design

Major Evaluation Questions

The major purpose of this series of studies is to determine if the findings from the previous studies can be replicated. Major evaluation questions include:

1.0 What is the impact of one, two, and three semesters of SEED instruction at the 4-6 level on mathematics achievement as measured by the STEELS and the ITBS?

2.0 Is there a cumulative impact of SEED instruction on mathematics achievement?

3.0 Is there a differential grade-retention rate between SEED participants and the nonparticipant comparison groups? This question will be examined longitudinally?

4.0 Do former SEED students enroll in more higher level math classes than their non-SEED comparison groups?

5.0 Do former SEED students withdraw from school less than their non-SEED comparison groups?

6.0 What is the long-term impact of three semesters of SEED instruction on mathematics achievement?

7.0 What reading trends are evident among students who have been exposed to SEED?

All SEED and comparison groups were matched on pretreatment variables. The variables are sex, ethnicity, socioeconomic status, grade level, and achievement level on the Mathematics Total subtest of the ITBS. Eight different samples were used:

1.0 Students who had one semester of SEED in the South Dallas Learning Centers in the fourth grade in 1989-90; two semesters of SEED in the South Dallas Learning Centers in the fourth and fifth grade in 1988-89 and 1989-90; or, three semesters of SEED in the South Dallas Learning Centers in the fourth, fifth, and sixth grades in 1987-89, 1988-89, and 1989-90. These students and their matched comparison groups were compared on achievement on the ITBS and STEELS (Study A).

2.0 Students who had three semesters of SEED in the South Dallas Learning Centers in grades 4-6 in 1984-87, 1985-88, or 1986-89.

These students and their matched comparison groups are compared on achievement on the ITBS both for the years that they were exposed to SEED and up to two years later. Course enrollment, retention rates, and withdrawal rates were also compared for these students (Study B).

3.0 Students who had one semester of SEED in 1982-83 or 1983-84 in a non-Learning Center environment. These students were compared on course enrollment, retention rates, and withdrawal rates (Study C).

Thus, three different series of studies were conducted.

Study A. Study of students who were exposed to one, two, or three semesters of SEED instruction in the Centers culminating in Spring, 1990. These students were compared with their matched comparison group on the ITBS Math Total, Concepts, Problem Solving, and Computation Subtests as well as the STEELS Mathematics test. Their ITBS Reading subtests were also compared as a point of reference for their math results.

Study B. Longitudinal follow-up of those students who had three semesters of SEED in the Centers in 1984-87, 1985-88, or 1986-89. These students were compared with their matched comparison groups on the Math Total, Concepts, Problem Solving, and Computation subtests of the ITBS. Their ITBS Reading scores were also compared to those of their matched comparison group as a point of reference for their math results. Retention rates, course enrollments, and withdrawal rates were also compared.

Study C. Report of the follow-up of students who had one semester of SEED instruction in the fourth, fifth, or sixth grades in 1982-83 or 1983-84. These students were not associated with Learning Centers. This is a follow-up of those students studied in Series 1. SEED students were compared to comparison students on course selection, retention rate, and withdrawal rate. Students were either in the 10th, 11th, or 12th grade, or graduated.

Limitations

Project SEED is currently implemented in the Learning Centers. The Learning Centers are special grades 4-6 schools that have a number of enhancements over regular 4-6 schools. It is practically impossible to completely eliminate the effects of the Learning Centers from the effects of SEED instruction. However, a number of observations seem appropriate.

The Learning Centers were established in 1984-85. For the first two years of operation, the Learning Centers had staff incentive pay goals based on student reading achievement. Mathematics achievement was not part of the goal, but was added for the 1986-87 school year. The reader will note that all comparisons in this study include longitudinal reading comparisons. It was reasoned that if there were major differences between reading achievement trends and mathematics achievement trends, and reading achievement was, and still is, the primary goal of the Learning Centers, that much of the mathematics achievement differences could be attributed to Project SEED.

In 1986-87 the Learning Centers implemented a Computer Math Program that was to supplement Project SEED. That is, Project SEED was to be taught one semester and Computer Math was to be taught one semester. According to the Program Manager, 1986-87 was beset with implementation problems for the Computer Math Program. Insufficient hardware, no software, and not enough computer specialists were among the problems that plagued the program during most of the 1986-87 school year. Thus, any impact that the Computer Math program had would have to be reserved for 1987-90 and later.

A final confounding variable relates to teacher training. During the summer of 1986, all Center math teachers were trained in SEED strategies by Project SEED staff. This training had, of course, varying influence on different teachers.

Method

Grade equivalent scores, the scale scores for the ITBS, were used for all achievement comparisons. Tests for statistical significance were computed on all comparisons using tests for the differences between means for correlated data. In all cases directional tests were used.

Characteristics of the samples used in the various studies included a high percentage of Black students (over 95%), about 80% students that were on free or reduced lunch, and students who scored in every decile of the pretreatment achievement distributions.

RESULTS

Results are reported in relation to the major evaluation questions investigated.

1.0 What is the impact of one, two, and three semesters of SEED instruction at the 4-6 level on mathematics achievement as measured by the STEELS and ITBS?

Tables 1, 2, and 3 display the impact of one, two, and three semesters, respectively, of SEED instruction in the Centers on mathematics achievement as measured by the ITBS Concepts, Problem Solving, Computation,

Table 1
The Impact Of One Semester
Of SEED/Center Instruction
On Mathematics Achievement
Spring, 1990

SEED, 1990	Spring, 1989				Spring, 1990				
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	N
Concepts (ITBS)	3.91	1.03	3	.02	4.85	1.22	4	.25**	466
Problem Solving (ITBS)	3.31	1.01		-	4.26	1.19		.21**	
Computation (ITBS)	3.89	0.90		-	5.17	1.06		.28**	
Total (ITBS)	3.70	0.85		-	4.76	1.02		.25**	
STEELS Mathematics	48.0	29.2		-	48.2	22.7		3.8 **	
Reading (ITBS)	3.48	1.12		-	4.43	1.11		.22**	

COMPARISON, 1990	Spring, 1989				Spring, 1990				
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	N
Concepts (ITBS)	3.89	1.03	3	-	4.60	1.24	4	-	466
Problem Solving (ITBS)	3.32	1.05		.01	4.05	1.25		-	
Computation (ITBS)	3.90	0.87		.01	4.89	1.02		-	
Total (ITBS)	3.71	0.86		.01	4.51	1.05		-	
STEELS Mathematics	49.0	30.3		1.0	44.4	28.1			
Reading (ITBS)	3.48	1.13		-	4.21	1.14		-	

Where:

$\bar{X}$ = mean grade equivalent

S = standard deviation

G = grade tested

D = difference between experimental (SEED) and comparison groups with the difference being tabled with the group that is highest

* = $p \leq .05$

** = $p \leq .01$

Table 2
The Impact Of One And Two Semesters
Of SEED/Center Instruction
On Mathematics Achievement
Spring, 1989-90

SEED, 1989-90	Spring, 1989				Spring, 1990				
	$\overline{X}$	S	G	D	$\overline{X}$	S	G	D	N
Concepts (ITBS)	5.26	1.17	4	.33**	6.48	1.51	5	.38**	424
Problem Solving (ITBS)	4.51	1.25		.22**	5.60	1.29		.17**	
Computation (ITBS)	5.31	0.96		.39**	6.40	1.15		.40**	
Total (ITBS)	5.03	0.97		.32**	6.16	1.18		.32**	
STEELS Mathematics	53.5	26.2		8.2 **	54.5	27.5		12.00**	
Reading (ITBS)	4.36	1.07		.15*	5.46	1.15		.30**	

COMPARISON, 1989-90	Spring, 1989				Spring, 1990				
	$\overline{X}$	S	G	D	$\overline{X}$	S	G	D	N
Concepts (ITBS)	4.93	1.35	4	-	6.10	1.52	5	-	424
Problem Solving (ITBS)	4.29	1.35		-	5.43	1.40		-	
Computation (ITBS)	4.92	1.03		-	6.00	1.17		-	
Total (ITBS)	4.71	1.12		-	5.84	1.24		-	
STEELS Mathematics	45.3	29.2		-	42.5	28.8		-	
Reading (ITBS)	4.21	1.15			5.16	1.26			

Where:

$\overline{X}$ = mean

S = standard deviation

G = grade tested

D = difference between experimental (SEED) and comparison groups with the difference being tabled with the group that is highest

* = $p \leq .05$

** = $p \leq .01$

Table 3
The Impact Of Two And Three Semesters Of SEED/Center Instruction On Mathematics Achievement
Spring, 1988-90[1]

SEED, 1988-90	Spring, 1989				Spring, 1990				
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	N
Concepts (ITBS)	6.86	1.35	5	.74**	7.52	1.76	6	.88**	290
Problem Solving (ITBS)	5.59	1.19		.32**	6.57	1.55		.47**	
Computation (ITBS)	6.54	1.00		.53**	7.65	1.17		.90**	
Total (ITBS)	6.33	1.05		.53**	7.24	1.35		.74**	
STEELS Mathematics	48.9	28.7		.93	53.8	26.0		13.7 **	
Reading (ITBS)	5.51	1.32		.32**	6.11	1.36		.24**	

COMPARISON, 1988-90	Spring, 1989				Spring, 1990				
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	N
Concepts (ITBS)	6.12	1.43	5	-	6.64	1.60	6	-	
Problem Solving (ITBS)	5.27	1.38		-	6.10	1.65		-	
Computation (ITBS)	6.01	1.11		-	6.75	1.34		-	
Total (ITBS)	5.80	1.16		-	6.50	1.40		-	
STEELS Mathematics	47.2	28.5		-	40.1	27.6		-	
Reading (ITBS)	5.19	1.30		-	5.87	1.49		-	

[1] There was no Spring testing program in 1988.

Where:

$\bar{X}$ = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental (SEED) and comparison groups with the difference being tabled with the group that is highest

* = $p \leq .05$

** = $p \leq .01$

and Total Mathematics subtests as well as the STEELS Mathematics test. Study of Table 1 suggests that, while the two groups were equivalent on the Spring, 1989, tests, by Spring, 1990, SEED students were significantly better than the comparisons on all subtests of the ITBS and on the STEELS. These data also suggest a Center impact on Reading. It should be noted that Spring, 1989, was prior to SEED instruction, that instruction occurring during the 1989-90 school year and prior to the Spring, 1990, testing.

Table 2 displays the impact of one and two semesters of SEED instruction in the Centers. Once again, all comparisons favor the SEED students. The two groups were matched, as previously outlined, on 1988 data. The data in this table also support the conclusion that the Learning Centers are having an impact on Reading as well as on Mathematics.

Table 3 displays the results of two and three semesters of SEED instruction in the Learning Centers. These data tend to support findings from previous studies relating to the cumulative impact of more than one semester of SEED instruction on mathematics achievement. Spring, 1988, scores are not tabled because there was no Spring, 1988, testing program. The Spring, 1989, mathematics results represent the impact of two semesters of SEED instruction while the Spring, 1990, mathematics results represent the effect of three semesters of SEED instruction. On all mathematics subtests of the ITBS, the differences between the SEED students and the matched comparison groups are largest after three semesters of instruction (Table 3, Spring, 1990 Results); larger after two semesters of instruction (Table 3, Spring, 1989 Results); and, positive after only one semester of SEED instruction (Table 1, Spring, 1990, Results and Table 2, Spring, 1989 Results). The lone exception to this trend involves the data in Table 2, Spring, 1990, results where the differences between SEED and comparison groups are not any larger after two years of instruction than they were after one year of instruction. The Reading trend represented in Table 3 is more similar to the trend represented in previous studies which is one of Center impact that is immediate but not cumulative.

Results on the STEELS are similar to those reported for the ITBS. With the exception of Table 3, Spring, 1989, fifth grade results, the STEELS scores are significantly better for SEED students than for their matched comparison groups. Comments about the cumulative impact of the program on STEELS scores, while tempting to make, are not appropriate because of the lack of comparability of STEELS scores across different grade levels. Nevertheless, program results on the STEELS are generally impressive.

2.0 Is there a cumulative impact of SEED instruction on mathematics achievement?

Based on the information provided in Tables 1,2, and 3, there appears to be a cumulative impact of SEED instruction on mathematics achievement. Tables 4, 5, and 6 further explore this phenomenon. Table 4 tracks students who had SEED in 1986-87 through 1988-89. In every case on all mathematics subtests, the difference in mathematics scores between SEED and comparison students is greater after three semesters of instruction than it was after one semester of instruction. This same trend held in Reading.[1]

1 Spring, 1988 data are not available for any comparisons discussed in this report since there was no Spring, 1988 testing program.

Table 4
Longitudinal Follow-up Of Achievement (ITBS) Of
SEED/Center and Comparison
Students[1] 1986-1990

SEED, 1986-89	Spring, 1986		Spring, 1987		Spring, 1989		Spring, 1990		N
	$\bar{X}$	G	$\bar{X}$	G	$\bar{X}$	G	$\bar{X}$	G	
Concepts	4.08	3	5.47**	4	7.77**	6	8.16**	7	294
Problem Solving	3.64		4.49**		6.83**		7.29		
Computation	4.03		5.49**		7.75**		8.12**		
Total	3.92		5.16**		7.45**		7.85**		
Reading	3.67		5.37**		6.55**		6.99		

COMPARISON	Spring, 1986		Spring, 1987		Spring, 1989		Spring, 1990		N
	$\bar{X}$	G	$\bar{X}$	G	$\bar{X}$	G	$\bar{X}$	G	
Concepts	4.05	3	4.82	4	6.87	6	7.66	7	294
Problem Solving	3.67		4.16		6.35		7.10		
Computation	4.04		4.81		6.96		7.71		
Total	3.92		4.60		6.73		7.50		
Reading	3.71		5.18		6.18		6.86		

[1] SEED/Center students had three semesters of SEED in grades 4-6, 1986-1989.

Where:

$\bar{X}$ = mean grade equivalent

G = grade tested

* = $p \leq .05$

** = $p \leq .01$

Table 5
Longitudinal Follow-up Of Achievement (ITBS)
Of SEED/Center And
Comparison Students[1] 1986-90

SEED, 1985-88	Spring, 1986		Spring, 1987		Spring, 1989		Spring, 1990		N
	$\overline{X}$	G	$\overline{X}$	G	$\overline{X}$	G	$\overline{X}$	G	
Concepts	4.97**	4	6.88**	5	7.99**	7	8.68**	8	247
Problem Solving	4.30 *		5.55**		7.48**		7.93**		
Computation	5.40**		6.62**		8.24**		8.69**		
Math Total	4.89**		6.35**		7.92**		8.43**		
Reading	4.74		5.17		6.58		7.66		

COMPARISON	Spring, 1985		Spring, 1987		Spring, 1989		Spring, 1990		N
	$\overline{X}$	G	$\overline{X}$	G	$\overline{X}$	G	$\overline{X}$	G	
Concepts	4.57	4	6.03	5	7.52	7	8.33	8	247
Problem Solving	4.13		5.08		7.18		7.57		
Computations	4.93		6.01		7.77		8.22		
Math Total	4.55		5.71		7.50		8.04		
Reading	4.63		5.00		6.57		7.72		

[1] SEED/Center students had three semesters of SEED in grades 4-6, 1985-88

Where:

$\overline{X}$ = mean grade equivalent

G = grade tested

* = $p \leq .05$

** = $p \leq .01$

Table 6
Longitudinal Follow-up Of
Achievement (ITBS) Of
SEED/Center And
Comparison Students[1] 1985-1990

SEED, 1984-87	Spring, 1985 $\bar{X}$	G	Spring, 1986 $\bar{X}$	G	Spring, 1987 $\bar{X}$	G	Spring, 1989 $\bar{X}$	G	Spring, 1990[2] $\bar{X}$	G	N
Concepts	5.01**	4	6.32**	5	7.57**	6	8.61**	8	-	9	337
Problem Solving	4.49*		5.47**		6.44**		7.82*		-		
Computation	5.17**		6.49**		7.63**		8.68**		-		
Math Total	4.89**		6.09**		7.21**		8.37**		-		
Reading	4.43**		5.75**		6.24**		7.30		-		

COMPARISON	Spring, 1985 $\bar{X}$	G	Spring, 1986 $\bar{X}$	G	Spring, 1987 $\bar{X}$	G	Spring, 1989 $\bar{X}$	G	Spring, 1990 $\bar{X}$	G	N
Concepts	4.86	4	5.76	5	6.61	6	8.27	8	-	9	337
Problem Solving	4.37		5.17		5.97		7.60		-		
Computation	4.95		6.05		6.87		8.41		-		
Math Total	4.72		5.66		6.49		8.11		-		
Reading	4.25		5.53		5.92		7.33				

1 SEED/Center students had three semesters of SEED in grades 4-6, 1984-89.

2 The ITBS/TAP are not given at grade 9.

Where:

$\bar{X}$ = mean grade equivalent

G = grade tested

* = $p \leq .05$

** = $p \leq .01$

Table 5 examines SEED and comparison students who had three semesters of instruction during the 1985-86 through 1987-88 school years. In every case on all mathematics subtests, the difference between SEED and comparison students is greater after two semesters of instruction than it was after one semester. In this case, the Reading scores are not significantly different.

Table 6 displays ITBS scores for students who were enrolled three semesters in SEED during the 1984-85 through 1986-87 school years. Once again, in every case on every mathematics subtest the difference between SEED and comparison students is greater after two semesters of instruction and greatest after three semesters of instruction in SEED.

Table 7 summarizes all of the studies that have been conducted on SEED during the past three years. The numbers in the table are grade-equivalent differences between the various SEED groups and their matched comparison groups after one, two, or three semesters of treatment. It is important to recall that all of these groups started out even, that is, there were no practical achievement differences prior to the implementation of SEED. Rarely have a series of studies been so consistent. Every entry in Table 7 favors SEED except the non-Center 1983-84 sixth grade group Problem Solving score. One hundred out of one hundred eight comparisons are statistically significant at at least the $p \leq .05$ level.

Twelve out of twelve possible comparisons support the cumulative impact hypothesis on the Math Concepts subtest; eleven out of twelve possible comparisons support the cumulative impact hypothesis on the Math Problem Solving subtest; twelve of twelve comparisons support the cumulative impact hypothesis on the Computation subtest; and, eleven of twelve comparisons support this hypothesis on the Math Total subtest. Thus, the

Table 7
The Impact Of One, Two,
And Three Semesters Of SEED/Center
Instruction On Mathematics
Achievement As Measured In
Grade Equivalent Differences Over
Matched Comparison Groups In
Three Different Series Of Studies

Series	Grade(s)	Semesters In SEED	C	PS	C	T	Center Program	N
1	4	1 (82 or 83)	.39	.43	.65	.49	No	32
	5	1 (82 or 83)	.52	.16	.28	.32	No	87
	4	1 (83 or 84)	.38	.22	.14	.23	No	57
	5	1 (83 or 84)	.79	.33	.30	.48	No	66
	6	1 (83 or 84)	.09	-.21	.23	.04	No	72
2	4	1 (84 or 85)	.15	.21	.20	.19	Yes	517
	5	2 (85 or 86)	.50	.32	.41	.41	Yes	517
	6	3 (86 or 87)	.93	.59	.81	.78	Yes	517
3	4	1 (84 or 85)	.13	.10	.19	.14	Yes	479
	5	2 (85 or 86)	.61	.29	.45	.45	Yes	475
	6	3 (86 or 87)	.86	.44	.69	.61	Yes	475
	4	1 (85 or 86)	.34	.15	.41	.30	Yes	329
	5	2 (86 or 87)	.89	.41	.60	.63	Yes	329
	4	1 (86 or 87)	.52	.29	.52	.45	Yes	545
	6	3 (88 or 89)	1.04	.65	.82	.83	Yes	545
4	4	1 (89 or 90)	.25	.21	.28	.25	Yes	466
	4	1 (88 or 89)	.33	.22	.39	.32	Yes	424
	5	2 (89 or 90)	.38	.17	.40	.32	Yes	424
	5	2 (88 or 89)	.74	.32	.53	.53	Yes	290
	6	3 (89 or 90)	.88	.47	.90	.74	Yes	290
	4	1 (86 or 87)	.65	.33	.68	.56	Yes	294
	6	3 (88 or 89)	.90	.48	.79	.72	Yes	294
	4	1 (85 or 86)	.40	.17	.47	.34	Yes	247
	5	2 (86 or 87)	.85	.47	.61	.64	Yes	247
	4	1 (84 or 85)	.15	.12	.22	.17	Yes	337
	5	2 (85 or 86)	.56	.30	.44	.43	Yes	337
	6	3 (86 or 87)	.96	.47	.76	.72	Yes	337

Note: All underlined comparisons are significant, $p \leq .05$.

hypothesis that students gain more with increased exposure to SEED (up to three semesters) is supported in forty-six of forty-eight comparisons.

Table 8 presents similar data in Reading for Center students. Since Reading achievement was not a variable in the Series 1 and 2 studies, only the results of Series 3 and 4 studies are tabled. In the case of Reading, there are fifteen of nineteen comparisons that are statistically significant and favor Center students. Eight of ten comparisons support a cumulative impact of the Centers on Reading. However, the differences in mean grade equivalents between SEED and non-SEED groups are generally much greater in Mathematics than they are in Reading. The data support cumulative impact of SEED and the Centers in Mathematics much more strongly than they support a cumulative impact of the Centers in Reading.

The case for a cumulative impact of SEED instruction on mathematics achievement is strengthened when patterns on the Problem Solving subtest of the ITBS are examined. The Problem Solving subtest of the ITBS is the subtest that requires more higher order thinking skills than the other subtests. Table 9 displays relevant data.

Study of Table 9 reveals some interesting trends. In four of eight cases, two semesters of Center Instruction have more impact on Reading achievement than does one semester of SEED instruction plus a semester of Center math instruction on mathematics problem solving. This is true in only two of six comparisons after four semesters of Reading instruction and two semesters of SEED and is not true in a single one of five comparisons made after six semesters of Center Reading Instruction versus three semesters of SEED. In addition, the aggregate impact of SEED/Center instruction on mathematics problem solving is greater with additional semesters of exposure.

Table 8
The Impact Of One,
Two, And Three Semesters
Of Center Instruction
On Reading Achievement As Measured
In Grade Equivalent
Differences Over Matched
Comparison Groups In
Two Different Series Of Studies

Series	Grade(s)	Semesters In SEED	Reading	Center Program	N
3	4	1 (84 or 85)	.20	Yes	479
	5	2 (85 or 86)	.24	Yes	479
	6	3 (86 or 87)	.28	Yes	479
	4	1 (85 or 86)	.19	Yes	329
	5	2 (86 or 87)	.09	Yes	329
	4	1 (86 or 87)	-.09	Yes	545
	6	3 (88 or 89)	.23	Yes	545
4	4	1 (89 or 90)	.22	Yes	466
	4	1 (88 or 89)	.15	Yes	424
	5	2 (89 or 90)	.30	Yes	424
	5	2 (88 or 89)	.32	Yes	290
	6	3 (89 or 90)	.24	Yes	290
	4	1 (86 or 87)	.19	Yes	294
	6	3 (88 or 89)	.37	Yes	294
	4	1 (85 or 86)	.11	Yes	247
	5	2 (86 or 87)	.17	Yes	247
	4	1 (84 or 85)	.18	Yes	337
	5	2 (85 or 86)	.22	Yes	337
	6	3 (86 or 87)	.32	Yes	337

Note: All underlined comparisons are significant, $p \leq .05$.

Table 9
The Impact Of One,
Two, And Three Semesters
Of SEED/Center Instruction
On Mathematic Problem
Solving Compared To Center
Impact On Reading As Measured In
Grade Equivalent Differences
Over Matched Comparison Groups

Series	Grades(s)	Semesters SEED	Semesters Center	Reading	Math Problem Solving	N
3	4	1	2	.20	.10	479
	5	2	4	.24	.29	475
	6	3	6	.28	.44	475
	4	1	2	.19	.15	329
	5	2	4	.09	.41	329
	4	1	2	-.09	.29	545
	6	3	6	.23	.65	545
4	4	1	2	.22	.21	466
	4	1	2	.15	.22	424
	5	2	4	.30	.17	424
	5	2	4	.32	.32	290
	6	3	6	.24	.47	290
	4	1	2	.19	.33	294
	6	3	6	.37	.48	294
	4	1	2	.11	.17	247
	5	2	4	.17	.47	247
	4		2	.18	.12	337
	5	2	4	.22	.30	337
	6	3	6	.32	.47	337

Note: All underlined comparisons are significant, $p \leq .05$.

3.0 Is there a differential grade retention rate between SEED participants and the nonparticipant comparison groups?

In order to eliminate the effect of the Learning Centers, the 1982-83 and 1983-84 non-Center SEED students were studied. Retention rates were longitudinally tracked. Table 10 shows the number of SEED and comparison students who graduated with their class. These students are from the original SEED non-Center cohorts from 1982-83 and 1983-84. Study of Table 10 suggests no difference between the two groups.

Center students from the 1986-89, 1985-88, and 1984-87 groups have not yet had time to graduate, the most advanced students being in the ninth grade. The most appropriate test of differential grade retention rates for these groups will be graduation rates. These students will continue to be tracked.

4.0 Do former SEED students enroll in more higher level math classes than their non-SEED Comparison Group?

This question was examined from two different perspectives. First, the percentage of higher-level math courses enrolled in by SEED students and comparison students was analyzed. Second, the average number of higher-level math courses per student was examined.

Five different groups of former SEED students were studied. These groups include students who had SEED in the Learning Centers and matriculated from the sixth grade in 1989, 1988, or 1987. In 1990 these students are in either the seventh, eighth, or ninth grades. The other two groups include students who had one semester of SEED in 1982-83 or 1983-84.

Table 10
Percentage Of SEED/Center And Comparison Group Students Graduating With Their Class

Cohort SEED	N	G	%	
Grade 5	106	76	71.7	1982-83 Grade 5 Cohort
Grade 6	136	76	55.9	1982-83 Grade 6 Cohort
Grade 6	90	60	66.7	1983-84 Grade 6 Cohort
TOTAL	332	212	63.9	

Cohort COMPARISON	N	G	%	
Grade 5	106	73	68.9	1982-83 Grade 5 Cohort
Grade 6	136	77	56.6	1982-83 Grade 6 Cohort
Grade 6	90	61	67.8	1983-84 Grade 6 Cohort
TOTAL	332	211	63.6	

Where:

N = number of students in the cohort

G = number of students graduating with their class

% = percentage of students graduating with their class

Those students are in the tenth, eleventh or twelfth grade or graduated in 1990. Table 11 displays relevant information about each of the five groups.

Analysis of Table 11 suggests that there is a difference between the number of higher-level math courses in which former SEED students enroll as compared to their matched comparison group. In the 1989 and 1988 cohorts, former SEED students enrolled in significantly more higher level mathematics courses and took a significantly higher proportion of those courses than did their matched comparison groups. There was no difference between the two groups in the 1987 cohort. However, in the 1984 and 1983 cohorts, former SEED students again enrolled in significantly more higher level mathematics classes and, in the 1984 cohort, took a significantly higher proportion of higher level math classes. In these two groups, which afforded the maximum length of comparison, former SEED students also appeared to take more semesters of mathematics than the matched comparison group. In the 1983 cohort this phenomenon accounted for the proportion of higher level courses taken not being significant since the SEED group, with fewer students, took 230 more semesters of mathematics than did the comparison group. This amounted to 1.68 more semesters of mathematics per student, 1.06 of which were higher level mathematics courses.[1] These findings support the results of two previous studies.

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1 Higher level math courses included for the 1989 cohort: Math 7 PH, Math 7 ADV, Math 8, and Algebra I PH; for the 1988 cohort: Math 7 PH, Math 7 ADV, Pre-Algebra PH, and Algebra I PH; for the 1987 cohort: Math 8 PH, Pre-Algebra PH, Algebra I PH, Algebra II PH, Algebra I, Geometry, Geometry PH, and Algebra II; and, for the 1984 and 1983 cohorts: Algebra I PH, Algebra II PH, Algebra I, Geometry, Geometry PH, Algebra II, Trigonometry H, Elementary Analysis H, Pre-Calculus H, Calculus W/AG AP, Number Theory H, Probability and Statistics H, and Math Topics.

Table 11
Number And Percentage Of
Higher Level Mathematics
Courses Enrolled In By Former
SEED And Comparison Students[1]

Cohort[2]	SEED						COMPARISON					
	N	M	H	A	HM	P	N	M	H	A	HM	P
1989(7)	293	589	388	2.01	1.32**	65.9**	291	579	238	1.99	0.82	41.1
1988(8)	229	919	309	4.01	1.35**	33.6**	236	897	205	3.80	0.87	22.9
1987(9)	314	1870	423	5.96	1.35	22.6	302	1833	413	6.07	1.37	22.5
1984(10-12)	200	2114	1228	10.57	6.14**	58.1**	215	2132	906	9.92	4.21	42.5
1983(11-G)	197	2143	1390	10.88	7.06**	64.9	208	1913	1248	9.2	6.0	65.2

[1] The 1983 and 1984 cohorts were exposed to one semester of SEED and were not enrolled in Learning Centers.

[2] The date represents the last year that students were enrolled in SEED. The number in parenthesis represents the grade that the students were in in 1989-90.

Where:

N = the number of students in the cohort

M = the total number of math courses taken

H = the number of higher level math courses taken

A = the average number of semesters of math taken per student

HM = the average number of semesters of higher level math courses taken per student

P = the percentage of higher level math courses taken

** = $p \leq .01$

5.0 Do former SEED students withdraw from school less than their non-SEED comparison groups?

Probably not. These data are extremely inconclusive. The available data are withdrawal rates, not dropout rates. There are numerous reasons for withdrawals other than dropout. The 1983 cohort withdrawal rate favors SEED; the 1984 cohort favors the comparison group; the 1987 cohort favors SEED; and, the 1988 cohort also favors SEED. However, the differences are sufficiently small and unexplained so as to limit meaningful interpretation.[1] Overall, fewer former SEED students have withdrawn from the DISD in years subsequent to their SEED experience.

6.0 What is the long-term impact of three semesters of SEED instruction on mathematics achievement?

Table 12 shows the gap between the SEED and comparison groups in the Spring of the last year of SEED instruction and in subsequent years. In all cases the SEED Group performed significantly better on all mathematics subtests up to two years after exposure to SEED instruction.

7.0 What reading trends are evident among students who have been exposed to SEED?

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[1] 150 former SEED students withdrew from the 1983 cohort while 162 former Comparison students did. Similar statistics for the other cohorts were: 1984, 45 SEED, 30 Comparison; 1987, 23 SEED, 35 Comparison; 1988, 18 SEED, 20 Comparison.

Table 12
The Gap In Grade Equivalents Between SEED and Comparison Groups On Various ITBS Subtests In The Spring Of The Last Year Of SEED/Center Instruction And In Subsequent Years

Subtests	Spring, 1989		Spring, 1990	
Concepts	.90**	6	.50**	7
Problem Solving	.48**		.19*	
Computation	.79**		.41**	
Math Total	.72**		.35**	
Reading	.37**		.13	

Subtests	Spring, 1987		Spring, 1989		Spring, 1990	
	Gap	Grade	Gap	Grade	Gap	Grade
Concepts	.85**	5	.47**	7	.35**	8
Problem Solving	.47**		.30**		.36**	
Computation	.61**		.47**		.47**	
Math Total	.64**		.42**		.39**	
Reading	.17		.01		-.06	

Subtests	Spring, 1987		Spring, 1988		Spring, 1989*	
	Gap	Grade	Gap	Grade	Gap	Grade
Concepts	.96**	6	-	7	.34**	8
Problem Solving	.47**		-		.22**	
Computation	.76**		- No Spring		.27**	
Math Total	.72**		- Testing Program		.26**	
Reading	.32*		-		-.03	

*This is the last year of data on these students because the systemwide testing program is not administered at Grade 9. These students will be measured by the TAP in 1991.

** $p \leq .01$

* $p \leq .05$

All students studied during this phase of the SEED evaluation were, as mentioned previously, Learning Center students. Since the Learning Centers have many special arrangements, it is impossible to separate the impact of SEED from the overall impact of the Centers. However, one comparison that sheds some light on this problem is the reading comparison. SEED does not teach reading. The Centers emphasize reading. More Center resources are focused on teaching reading than are focused on teaching mathematics, if SEED is excluded. Therefore, one should be able to make some statements about the impact of SEED depending on the extent of the differences between SEED and comparison students in mathematics versus the differences in reading.

Table 13 displays gaps between SEED students and matched comparison groups in reading and mathematics. The Series 3 and Series 4 studies, as previously outlined, are studies of students after varying amounts of exposure to SEED and the Centers. The three longitudinal studies tabled at the bottom of the table follow former SEED and comparison students into the seventh and eighth grade.

Seventeen of nineteen comparisons favor mathematics when SEED and comparison groups are compared in the Spring following SEED instruction. Three of three follow-up comparisons favor mathematics and SEED. The gap between mathematics and reading also tends to get progressively wider with additional semesters of SEED/Center instruction.

Thus, when one considers available data, it appears that Center instruction impacts reading achievement but that that impact washes out one year after students leave the Learning Centers. SEED/Center instruction impacts mathematics achievement progressively with additional semesters of instruction and is still present two years after instruction.

Table 13
The Immediate And Longitudinal Impact Of One, Two, and Three Semesters Of Center Instruction On Reading And Mathematics Achievement As Measured By Grade Equivalent Differences Over Matched Comparison Groups In Two Different Series Of Studies

Series	Grades	Semester In SEED	Mathematics	Gap	Reading	N	Advantage
3	4	1 (84 or 85)	.14	-.06	.20	479	R
	5	2 (85 or 86)	.45	.21	.24	479	M
	6	3 (86 or 87)	.61	.33	.28	479	M
	4	1 (85 or 86)	.30	.11	.19	329	M
	5	2 (86 or 87)	.63	.54	.09	329	M
	4	1 (86 or 87)	.45	.54	-.09	545	M
	6	3 (88 or 89)	.83	.60	.23	545	M
4	4	1 (89 or 90)	.25	.03	.22	466	M
	4	1 (88 or 89)	.32	.17	.15	424	M
	5	2 (89 or 90)	.32	.02	.30	424	M
	5	2 (88 or 89)	.53	.21	.32	290	M
	6	3 (89 or 90)	.74	.50	.24	290	M
	4	1 (86 or 87)	.56	.37	.19	294	M
	6	3 (88 or 89)	.72	.35	.37	294	M
	4	1 (85 or 86)	.34	.23	.11	247	M
	5	2 (86 or 87)	.64	.47	.17	247	M
	4	1 (84 or 85)	.17	-.01	.18	337	R
	5	2 (85 or 86)	.43	.21	.22	337	M
	6	3 (86 or 87)	.72	.40	.32	337	M
	7	3 (86 or 87)	.42	.41	.01	247	M
	8	3 (86 or 87)	.39	.45	-.06	247	M
	8	3 (86 or 87)	.26	.29	-.03	337	M

SUMMARY AND DISCUSSION

This study is the fourth in a series of studies that examine the impact of Project SEED on mathematics achievement and attitudes. All series of studies utilized a theoretical comparison group, that is, groups of students matched to SEED students on five characteristics from the pretreatment year. Three of the four series of studies were on Learning Center students, that is, students enrolled in special schools. The fourth series of studies were on non-Learning Center students enrolled in regular schools. These studies were conducted over a three-year period but encompass SEED and co parison groups back as far as 1982-83.

A major intervening variable in the three most recent series of studies is the fact that the SEED students were also Learning Center students. Since all Learning Center students had Project SEED, and all Center teachers had SEED training, there was no opportunity for comparison of Learning Center SEED students versus Learning Center non-SEED students. However, Reading scores of SEED and comparison group students were analyzed to attempt to determine Center impact, and the first series of studies were conducted utilizing non-Center SEED students.

All studies on SEED conducted during the past three years have been extremely consistent. Similar results have been replicated through additional studies utilizing different groups of students. Major results from these studies include:

1. There is an immediate impact of one semester of SEED instruction on mathematics achievement.

2. There is a cumulative impact of SEED instruction on mathematics achievement. The more semesters (up to three) of SEED instruction that students take, the greater the difference between their grade equivalent levels and those of matched comparison groups.

3. Former SEED students enroll in significantly more higher level mathematics classes than do their matched comparison groups.

4. Two years after the conclusion of their SEED experience, former SEED students still achieve significantly higher in mathematics than do their matched comparison groups.

APPENDIX A

Tables From The 1988
Evaluation Of Project
SEED

These studies suggested:

1. short-term impact of SEED instruction on mathematics achievement, particularly for low socioeconomic status students, as measured by the ITBS, and

2. long-term impact of SEED instruction on attitude toward mathematics as measured by enrollment patterns of SEED and comparison students in advanced mathematics courses at the middle and early high school levels, and

3. long-term impact on student retention, that is, SEED graduates did not appear to be retained in grade as often as their matched cohorts, and

4. a cumulative impact of SEED instruction on mathematics achievement, that is, longer exposure to SEED appears to accelerate mathematics achievement. The impact of a second semester of SEED instruction appears to be greater than the first, and a third semester greater than a second.

Table A1

Longitudinal Achievement Trends
of SEED and Comparison
Students, Grade 4, Spring, 1983 and 1984

	Spring, 1982				Spring, 1983				Spring, 1984				Spring, 1985				Spring, 1986				Spring, 1987			
	X	S	G	D	X	S	G	D	X	S	G	D	X	S	G	D	X	S	G	D	X	S	G	D
SEED, 1982-83 (N = 32)																								
Concepts	4.66	1.24	3	.22	6.12	1.38	4	.39	7.19	2.00	5	.09	7.96	2.30	6	-	8.95	1.83	7	-	9.57	1.86	8	-
Problem Solving	4.29	1.03		-	5.65	1.36		.43	6.49	1.59		.09	7.36	1.88		-	8.30	2.03		.02	9.19	1.69		-
Computation	4.54	0.78		.06	6.07	1.00		.65	7.39	1.32		.63	8.08	1.46		.11	8.63	1.37		.17	9.48	1.30		.03
Total	4.50	0.93		.08	5.95	1.16		.49	7.03	1.52		.28	7.79	1.79		-	8.63	1.65		.04	9.31	1.52		-
Comparison, 1982-83 (N = 32)																								
Concepts	4.44	1.10	3	-	5.73	1.05	4	-	7.10	1.58	5	-	8.39	1.54	6	.43	9.02	1.72	7	.07	9.84	1.75	8	.27
Problem Solving	4.33	1.16		.04	5.22	1.51		-	6.40	1.67		-	7.59	1.80		.23	8.28	1.93		-	9.63	1.63		.44
Computation	4.48	0.88		-	5.42	0.90		-	6.76	1.29		-	7.98	1.41		-	8.46	1.30		-	9.45	1.19		-
Total	4.42	0.96		-	5.46	1.06		-	6.75	1.43		-	7.98	1.47		.19	8.59	1.54		-	9.65	1.43		.34
SEED, 1983-84 (N = 57)																								
Concepts	4.09	1.27	2	.25	5.04	1.25	3	.02	6.51	1.38	4	.38	7.38	1.42	5	.35	8.24	1.43	6	.15	9.19	1.74	7	.21
Problem Solving	3.52	1.29		.18	4.73	1.35		.03	5.88	1.34		.22	6.78	1.31		.25	7.62	1.88		.14	9.11	1.77		.27
Computation	3.65	0.75		-	4.74	0.76		-	5.89	0.93		.14	7.00	0.97		.01	7.84	1.20		-	8.77	1.09		0
Total	3.76	0.97		.10	4.85	1.02		-	6.08	1.11		.23	7.05	1.14		.20	7.91	1.37		.05	9.03	1.43		.17
Comparison, 1983-84 (N = 57)																								
Concepts	3.86	1.13		-	5.02	1.17		-	6.13	1.62	4	-	7.03	1.65		-	8.09	1.86		-	8.98	1.84		-
Problem Solving	3.34	1.13		-	4.70	1.21		-	5.66	1.37		-	6.53	1.41		-	7.48	1.94		-	8.84	1.73		-
Computation	3.76	0.78		.11	4.95	0.76		.21	5.75	1.06		-	6.99	1.26		-	8.02	1.32		.18	8.77	1.34		-
Total	3.66	0.88		-	4.89	0.94		.04	5.85	1.27		-	6.85	1.35		-	7.86	1.58		-	8.86	1.51		-

where:

X = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

Table A2

Longitudinal Achievement Trends
of SEED and Comparison
Students, Grade 5, Spring, 1983 and 1984

	Spring, 1982 X	S	G	D	Spring, 1983 X	S	G	D	Spring, 1984 X	S	G	D
SEED, 1982-83 (N = 87)												
Concepts	5.48	1.46	4	-	7.20	1.64	5	.52	8.35	1.76	6	.15
Problem Solving	5.45	1.34		.06	6.46	1.25		.16	7.61	1.46		.20
Computation	5.53	0.93		.06	6.98	1.03		.28	8.08	0.96		.27
Total	5.49	1.13		-	6.88	1.18		.32	8.01	1.27		.21
Comparison, 1982-83 (N = 87)												
Concepts	5.65	1.37	4	.17	6.68	1.66	5	-	8.20	1.91	6	-
Problem Solving	5.39	1.43		-	6.30	1.67		-	7.41	1.84		-
Computation	5.47	0.94		-	6.70	1.31		-	7.81	1.33		-
Total	5.51	1.15		.02	6.56	1.43		-	7.80	1.60		-
SEED, 1983-84 (N = 66)												
Concepts	4.50	1.03	3	.12	6.15	1.67	4	.37	7.80	1.64	5	.79
Problem Solving	4.34	0.89		-	5.55	1.52		.03	6.97	1.42		.33
Computation	4.47	0.77		.01	5.59	1.23		-	7.32	1.05		.30
Total	4.44	0.79		.03	5.77	1.39		.07	7.37	1.26		.48
Comparison, 1983-84 (N = 66)												
Concepts	4.38	1.00	3	-	5.78	1.73		-	7.01	2.04	5	-
Problem Solving	4.37	1.11		.03	5.52	1.62		-	6.64	1.66		-
Computation	4.46	0.73		-	5.79	1.13		.20	7.02	1.38		-
Total	4.41	0.83		-	5.70	1.39		-	6.89	1.60		-

	Spring, 1985 X	S	G	D	Spring, 1986 X	S	G	D	Spring, 1987 X	S	G	D
SEED, 1982-83 (N = 87)												
Concepts	8.65	1.78	7	.04	9.32	1.95	8	-	Different Test			
Problem Solving	8.16	1.66		.05	8.78	1.87		.06				
Computation	8.69	1.22		.43	9.23	1.32		.15				
Total	8.49	1.42		.16	9.11	1.60		.04	10.48	3.45	9	-
Comparison, 1982-83 (N = 87)												
Concepts	8.61	1.91	7	-	9.41	1.73	8	.09	Different Test			
Problem Solving	8.11	1.78		-	8.72	2.06		-				
Computation	8.26	1.35		-	9.08	1.41		-				
Total	8.33	1.56		-	9.07	1.59		-	10.66	2.84	9	.18
SEED, 1983-84 (N = 66)												
Concepts	8.38	1.64	6	.38	9.02	1.67	7	.07	10.10	1.62	8	.23
Problem Solving	7.68	1.63		.22	8.59	1.85		.20	9.57	1.70		.27
Computation	8.09	1.17		.22	8.69	1.37		-	9.55	1.21		.05
Total	8.05	1.39		.27	8.77	1.51		.08	9.72	1.39		.17
Comparison, 1983-84 (N = 66)												
Concepts	8.00	1.87		-	8.95	1.88		-	9.87	1.75	8	-
Problem Solving	7.46	2.15		-	8.39	2.30		-	9.30	1.81		-
Computation	7.87	1.36		-	8.72	1.64		.03	9.50	1.22		-
Total	7.78	1.72		-	8.69	1.83		-	9.55	1.48		-

where:

X = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

Table A3

Longitudinal Achievement Trends
of SEED and Comparison Students,
Grade 6, Spring, 1984

	Spring, 1982				Spring, 1983				Spring, 1984				Spring, 1985				Spring, 1986				Spring, 1987			
	X	S	G	D	X	S	G	D	X	S	G	D	X	S	G	D	X	S	G	D	X	S	G	D
SEED, 1983-84 (N = 72)																								
Concepts	5.41	1.46	4	-	7.25	1.85	5	-	8.52	1.93	6	.09	8.53	2.29	7		9.47	1.90	8		-	-		
Problem Solving	5.14	1.46		-	6.65	1.73		-	7.62	1.99			7.98	2.04			8.82	2.17			-	-		
Computation	5.46	1.09		-	7.26	1.41		.27	8.21	1.45		.23	8.49	1.57			9.26	1.29		.03	-	-		
Total	5.34	1.24		-	7.05	1.57		-	8.12	1.69		.04	8.33	1.87			9.19	1.65			10.49	3.15	9	
Comparison, 1983-84 (N = 72)																								
Concepts	5.57	1.43	4	.16	7.38	1.92	5	.13	8.43	1.85	6		8.83	1.97	7	.30	9.52	2.07	8	.05	-	-		
Problem Solving	5.48	1.38		.44	6.79	1.62		.14	7.83	1.73		.21	8.41	1.73		.43	9.12	2.03		.30	-	-		
Computation	5.50	1.01		.04	6.99	1.31		-	7.98	1.33			8.59	1.53		.10	9.23	1.58			-	-		
Total	5.52	1.18		.18	7.06	1.50		.01	8.08	1.55			8.61	1.64		.28	9.29	1.76		.10	11.05	3.14	9	.56

where:

X = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

Table A4

Two Year Cohort Achievement Trends, SEED and Comparison Students, Grade 4, Spring, 1983 and 1984

	Spring, 1982				Spring, 1983				Spring, 1984			
	X	S	G	D	X	S	G	D	X	S	G	D
SEED, 1982-83 (N = 43)												
Concepts	4.71	1.26	3	.20	6.07	1.33	4	.25				
Problem Solving	4.36	1.08		-	5.70	1.32		.31				
Computation	4.60	0.79		.08	6.15	1.00		.67				
Total	4.56	0.96		.08	5.97	1.13		.40				
Comparison, 1982-83 (N = 43)												
Concepts	4.51	1.15	3	-	5.82	1.25	4	-				
Problem Solving	4.40	1.16		.04	5.39	1.54		-				
Computation	4.52	0.91		-	5.48	1.01		-				
Total	4.48	0.98		-	5.57	1.18		-				
SEED, 1983-84 (N = 71)												
Concepts					5.07	1.20	3	.07	6.57	1.35	4	.46
Problem Solving					4.79	1.19		.04	5.84	1.43		.18
Computation					4.79	0.73		-	5.85	0.96		.15
Total					4.89	0.94		.01	6.08	1.14		.25
Comparison, 1983-84 (N = 71)												
Concepts					5.00	1.15	3	-	6.11	1.55	4	-
Problem Solving					4.75	1.18		-	5.66	1.27		-
Computation					4.89	0.74		.10	5.70	1.01		-
Total					4.88	0.91		-	5.83	1.20		-

where:

X = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

Two Year Cohort Achievement Trends,
SEED and Comparison Students
Grade 5, Spring, 1983 and 1984

	Spring, 1982 X	S	G	D	Spring, 1983 X	S	G	D	Spring, 1984 X	S	G	D
SEED, 1982-83 (N = 115)												
Concepts	5.42	1.43	4	-	7.15	1.63	5	.58				
Problem Solving	5.36	1.30		.12	6.43	1.27		.40				
Computation	5.42	0.90		.05	6.97	1.00		.32				
Total	5.40	1.10		.02	6.85	1.17		.40				
Comparison, 1982-83 (N = 115)												
Concepts	5.52	1.36	4	.10	6.57	1.65	5	-				
Problem Solving	5.24	1.44		-	6.13	1.67		-				
Computation	5.37	0.94		-	6.65	1.26		-				
Total	5.38	1.15		-	6.45	1.42		-				
SEED, 1983-84 (N = 84)												
Concepts					6.19	1.76	4	.33	7.73	1.63	5	.52
Problem Solving					5.60	1.54		-	6.90	1.52		.13
Computation					5.67	1.29		-	7.20	1.21		.07
Total					5.82	1.45		.03	7.28	1.34		.24
Comparison, 1983-84 (N = 84)												
Concepts					5.86	1.62	4	-	7.22	1.87	5	-
Problem Solving					5.66	1.58		.06	6.77	1.61		-
Computation					5.83	1.13		.16	7.13	1.29		-
Total					5.79	1.33		-	7.04	1.49		-

where:

X = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

Table A6

Two Year Cohort Achievement Trends, SEED and Comparison Students, Grade 6, Spring, 1983 and 1984

	Spring, 1982				Spring, 1983				Spring, 1984			
	X	S	G	D	X	S	G	D	X	S	G	D
SEED, 1982-83 (N = 137)												
Concepts	6.84	1.76	5	.04	8.91	1.69	6	.99				
Problem Solving	6.33	1.52		-	7.77	1.79		.34				
Computation	6.69	1.22		.06	8.48	1.13		.82				
Total	6.62	1.36		.03	8.38	1.38		.71				
Comparison, 1982-83 (N = 137)												
Concepts	6.80	1.64	5	-	7.92	1.85	6	-				
Problem Solving	6.35	1.61		.02	7.43	1.86		-				
Computation	6.63	1.25		-	7.66	1.44		-				
Total	6.59	1.38		-	7.67	1.62		-				
SEED, 1983-84 (N = 90)												
Concepts					7.16	1.87	5	-	8.39	1.92	6	.08
Problem Solving					6.61	1.76		-	7.56	1.98		-
Computation					7.12	1.45		.19	8.13	1.39		.25
Total					6.97	1.60		.01	8.03	1.66		.06
Comparison, 1983-84 (N = 90)												
Concepts					7.25	1.94	5	.09	8.31	1.92	6	-
Problem Solving					6.70	1.68		.09	7.69	1.78		.13
Computation					6.93	1.32		-	7.88	1.35		-
Total					6.96	1.54		-	7.97	1.60		-

where:

X = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

Two Year Cohort Achievement Trends, SEED and Comparison Students, Grade 4, Spring, 1983 and 1984, Free Or Reduced Lunch

	Spring, 1982 X	S	G	D	Spring, 1983 X	S	G	D	Spring, 1984 X	S	G	D
SEED, 1982-83 (N = 19)												
Concepts	4.22	1.15	3	.20	5.39	1.22	4	.23				
Problem Solving	3.99	0.97		.09	4.98	1.24		.50				
Computation	4.23	0.83		.08	5.64	1.02		.67				
Total	4.15	0.89		.12	5.34	1.08		.47				
Comparison, 1982-83 (N = 19)												
Concepts	4.02	1.03	3	-	5.16	0.74	4	-				
Problem Solving	3.90	1.09		-	4.48	1.01		-				
Computation	4.15	0.88		-	4.97	0.60		-				
Total	4.03	0.88		-	4.87	0.65		-				
SEED, 1983-84 (N = 37)												
Concepts					4.68	1.42	3	-	6.69	1.21	4	.75
Problem Solving					4.46	1.36		-	5.91	1.31		.51
Computation					4.73	0.85		-	6.05	1.05		.56
Total					4.63	1.13		-	6.21	1.10		.57
Comparison, 1983-84 (N = 37)												
Concepts					4.80	1.19	3	.12	5.94	1.45	4	-
Problem Solving					4.58	1.26		.12	5.40	1.27		-
Computation					4.80	0.85		.07	5.59	1.04		-
Total					4.72	0.92		.09	5.64	1.16		-

where:

X = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

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Table A8

Two Year Cohort Achievement Trends, SEED and Comparison Students, Grade 5, Spring, 1983 and 1984, Free Or Reduced Lunch

	Spring, 1982				Spring, 1983				Spring, 1984			
	X	S	G	D	X	S	G	D	X	S	G	D
SEED, 1982-83 (N = 53)												
Concepts	4.88	1.20	4	-	6.81	1.66	5	.85				
Problem Solving	4.92	0.88		.14	6.23	1.22		.75				
Computation	5.16	0.90		.07	6.78	1.00		.41				
Total	4.98	0.88		0	6.61	1.16		.67				
Comparison, 1982-83 (N = 53)												
Concepts	5.05	1.15	4	.17	5.96	1.61	5	-				
Problem Solving	4.78	1.13		-	5.48	1.53		-				
Computation	5.09	0.78		-	6.37	1.28		-				
Total	4.98	0.91		0	5.94	1.34		-				
SEED, 1983-84 (N = 63)												
Concepts					5.85	1.84	4	.56	7.50	1.76	5	.90
Problem Solving					5.27	1.55		.24	6.67	1.62		.49
Computation					5.36	1.30		-	7.07	1.20		.44
Total					5.49	1.48		.21	7.08	1.40		.58
Comparison, 1983-84 (N = 63)												
Concepts					5.29	1.72	4	-	6.56	1.77	5	-
Problem Solving					5.03	1.57		-	6.18	1.47		-
Computation					5.50	1.27		.14	6.77	1.26		-
Total					5.28	1.42		-	6.50	1.39		-

where:

X = mean grade equivalent

S = standard deviation

G = [illegible]ade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

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6[illegible]

Table A9

Two Year Cohort Achievement Trends, SEED and Comparison Students, Grade 6, Spring, 1983 and 1984, Free Or Reduced Lunch

	Spring, 1982 X	S	G	D	Spring, 1983 X	S	G	D	Spring, 1984 X	S	G	D
SEED, 1982-83 (N = 66)												
Concepts	6.41	1.86	5	.15	8.65	1.77	6	1.44				
Problem Solving	5.79	1.29		.09	7.17	1.55		.41				
Computation	6.30	1.12		.14	8.25	1.13		1.24				
Total	6.16	1.27		.12	8.02	1.30		1.06				
Comparison, 1982-83 (N = 66)												
Concepts	6.26	1.73	5	-	7.21	1.88	6	-				
Problem Solving	5.70	1.50		-	6.66	1.77		-				
Computation	6.16	1.24		-	7.01	1.36		-				
Total	6.04	1.35		-	6.96	1.57		-				
SEED, 1983-84 (N = 48)												
Concepts					6.52	1.99	5	-	7.79	1.90	6	.05
Problem Solving					5.90	1.90		-	7.01	1.71		-
Computation					6.75	1.55		.05	7.71	1.50		.22
Total					6.39	1.72		-	7.50	1.61		.04
Comparison, 1983-84 (N = 48)												
Concepts					6.79	1.90	5	.27	7.74	2.02	6	-
Problem Solving					6.27	1.65		.37	7.15	1.96		.14
Computation					6.70	1.39		-	7.49	1.51		-
Total					6.59	1.53		.20	7.46	1.76		-

where:

X = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

Table A10
Longitudinal Achievement
Trends of SEED and
Comparison Students, Grades 4-6,
Spring, 1984 To Spring, 1987

	Spring, 1984				Spring, 1985				Spring, 1986				Spring, 1987			
SEED, 1985-87 (N = 517)	X	S	G	D	X	S	G	D	X	S	G	D	X	S	G	D
Concepts	3.75	.98	3	-	4.85	1.09	4	.15	6.03	1.34	5	.50	7.26	1.54	6	.93
Problem Solving	3.53	.97		-	4.33	1.07		.21	5.20	1.19		.32	6.17	1.51		.59
Computation	4.03	.81		-	5.03	.87		.20	6.28	1.10		.41	7.41	1.40		.81
Total	3.77	.80		-	4.74	.88		.19	5.84	1.08		.41	6.95	1.36		.78
Comparison, 1985-87 (N = 517)																
Concepts	3.80	.98	3	.05	4.70	1.10	4	-	5.53	1.34	5	-	6.33	1.50	6	-
Problem Solving	3.56	.95		.03	4.12	1.09		-	4.88	1.34		-	5.58	1.53		-
Computation	4.08	.77		.05	4.83	0.92		-	5.87	1.17		-	6.60	1.21		-
Total	3.81	.77		.04	4.55	0.90		-	5 43	1.15		-	6.17	1.26		-

where:

X = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental and comparison groups with the difference being tabled with the statistic that is the highest

APPENDIX B

Tables From the 1989 Evaluation
Of Project SEED

These studies suggested:

1. immediate impact of one semester of SEED instruction on mathematics achievement, and

2. a cumulative impact of two and three semesters of SEED instruction on mathematics achievement, and

3. continued high mathematics achievement two years after SEED (we only had samples that have progressed through the eighth grades), and

4. long-term impact on attitude toward mathematics as measured by enrollment patterns of SEED and Comparison students in advanced mathematics courses at the middle and early high school levels.

Table B1
Longitudinal Achievement Trends Of SEED
And Comparison Students, Grades 4-6, Spring, 1985 to Spring, 1987,
and Follow-Up, Spring, 1989
(Study A)

SEED, 1985-87, 1989	Spring, 1985				Spring, 1986				Spring, 1987				Spring, 1989			
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D
Concepts	4.89	1.08	4	.13*	6.08	1.31	5	.61**	7.31	1.52	6	.86**	8.44	1.64	8	.36**
Problem Solving	4.36	1.08		.10*	5.26	1.19		.29**	6.24	1.50		.44**	7.70	1.52		.22
Computation	5.04	0.89		.19**	6.30	1.10		.45**	7.45	1.41		.69**	8.55	1.24		.30**
Total	4.76	0.89		.14**	5.88	1.07		.45**	7.00	1.36		.61**	8.24	1.29		.30**
Reading	4.29			.20**	5.50			.24**	6.01			.28**	7.17			.12
	N = 479				N = 475				N = 475				N = 375			
Comparison, 1985-87, 1989																
Concepts	4.76	1.11	4	-	5.47	1.26	5	-	6.45	1.49	6	-	8.08	1.65	8	-
Problem Solving	4.26	1.07		-	4.97	1.29		-	5.80	1.48		-	7.48	1.55		-
Computation	4.85	0.86		-	5.85	1.15		-	6.76	1.25		-	8.25	1.23		-
Total	4.62	0.89		-	5.43	1.11		-	6.34	1.27		-	7.94	1.32		-
Reading	4.09				5.26				5.73				7.05			
	N = 479				N = 446				N = 410				N = 331			

Where:

$\bar{X}$ = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental (SEED) and comparison groups with the difference being tabled with the statistic that is the highest

* = $p \leq .05$

** = $p \leq .01$

Note: Groups were matched on Spring, 1984 data. In Spring, 1984, there were no differences between the groups on the aforementioned matching variables. Students in the experimental group had three semesters of SEED, one in the fourth grade, one in the fifth grade, and one in the sixth grade.

Table B2

Longitudinal Achievement of SEED And Comparison Students,
Grades 4-6, Spring, 1986, To Spring, 1988, and Follow-Up, Spring, 1989
(Study B)

SEED, 1986-88, 1989	Spring, 1986				Spring, 1987				Spring, 1988				Spring, 1989			
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D
Concepts	4.91	1.01	4	.34**	6.82	1.34	5	.89**	7.47	1.63	6	-	7.89	1.67	7	.52**
Problem Solving	4.22	1.11		.15*	5.48	1.30		.41**	6.45	1.64		-	7.44	1.53		.51**
Computation	5.34	0.94		.41**	6.58	1.09		.60**	7.74	1.19		-	8.19	1.38		.52**
Total	4.82	0.90		.30**	6.29	1.12		.63**	7.22	1.35		-	7.85	1.36		.52**
Reading	4.71	0.97		.19**	5.11	1.19		.09					6.64	1.41		.32**
	N = 329				N = 329				N = 329				N = 274			
Comparison, 1986-88, 1989																
Concepts	4.57	1.00	4	-	5.93	1.30	5	-	Data not available				7.37	1.56	7	-
Problem Solving	4.07	1.16		-	5.07	1.26		-					6.95	1.44		-
Computation	4.93	0.86		-	5.98	1.01		-					7.67	1.27		-
Total	4.52	0.90		-	5.66	1.04		-					7.33	1.26		-
Reading	4.52	1.10		-	5.02	1.25		-					6.32	1.49		-
	N = 329				N = 329								N = 274			

Where:

$\bar{X}$ = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental (SEED) and comparison groups with the difference being tabled with the statistic that is the highest

* = $p \leq .05$

** = $p \leq .01$

Note: Groups were matched on Spring, 1985 data. In Spring, 1985, there were no differences between the groups on the aforementioned matching variables. Students in the experimental group had three semesters of SEED, one in the fourth grade, one in the fifth grade, and one in the sixth grade. Data are not available for the comparison group in Spring, 1988, because the systemwide testing program was temporarily interrupted.

Table B3

Longitudinal Achievement of SEED And Comparison Students, Grades 4-6, Spring, 1987 To Spring, 1989 (Study C)

SEED, 1987-89	Spring, 1987				Spring, 1988				Spring, 1989			
	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D	$\bar{X}$	S	G	D
Concepts	5.22	1.22	4	.52**	6.68	1.42	5	-	7.69	1.43	6	1.04**
Problem Solving	4.29	1.22		.29**	5.70	1.21		-	6.73	1.43		.65**
Computation	5.29	0.97		.52**	6.55	0.99		-	7.61	1.27		.82**
Total	4.94	1.00		.45**	6.31	1.07		-	7.34	1.26		.83**
Reading	4.07	1.07		-	5.46	1.19		-	6.23	1.61		.23**
	N = 545				N = 545				N = 545			
Comparison, 1987-89												
Concepts	4.70	1.17	4	-	Data not available				6.65	1.48	6	-
Problem Solving	4.00	1.22		-					6.08	1,54	-	-
Computation	4.77	0.99		-					6.79	1.29		-
Total	4.49	1.00		-					6.51	1.30		-
Reading	4.16	1.08		.09					6.00	1.45		-
	N=545								N=545			

Where:

$\bar{X}$ = mean grade equivalent

S = standard deviation

G = grade

D = difference between experimental (SEED) and comparison groups with the difference being tabled with the statistic that is the highest

* = $p \leq .05$

** = $p \leq .01$

Note: Groups were matched on Spring, 1986 data. In Spring, 1986, there were no differences between the groups on the aforementioned matching variables. Students in the experimental group had three semesters of SEED, one in the fourth grade, one in the fifth grade, and one in the sixth grade. Data are not available for the comparison group in Spring, 1988, because the systemwide testing program was temporarily interrupted.