Studies of the Efficacy of Direct Instruction Mathematics Programs

Written by

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An Analysis of Achievement Scores of Arthur Academy Schools, 2007-2013

Affiliation

Arthur Reading Workshop, National Institute for Direct Instruction and University of Oregon

Design

Pretest-Posttest Norm Comparison Design

Participants

Students enrolled in Arthur Academies, a system of six charter schools in the greater Portland, Oregon metropolitan area. The study included over 4,000 students ranging from kindergarten to fifth grade.

Description of Study

This study examined the impact of the Direct Instruction program, *SRA Connecting Math Concepts*, on mathematics achievement for six consecutive school years, 2007–2008 through 2012–2013. The Stanford Achievement Test measured math skills for students in grades kindergarten and higher and the Oregon Assessment of Knowledge and Skills for students in grades three to five.

Results

At the start of kindergarten, Arthur students had achievement scores that were similar to or slightly lower than students in the nation as a whole. By the end of their kindergarten year, the average Arthur student scored much higher than the national average for their grade. In all years, the changes over time, relative to the national norms, were statistically significant. This high level of achievement persisted, and even increased, through later grades. In all years and grades, the percentage of students scoring at high levels was substantially greater than expected given national norms.

(Arthur and Stockard, 2014)

Table 1

Percentage of Kindergarten Students At or Above the 40th Percentile

	Fall	Spring	Nation
2008-09	23	83	60
2009-10	30	85	60
2010-11	30	85	60
2011-12	62	86	60
2012-13	53	86	60

Table 2

Percentage of Kindergarten Students At or Above the 80th Percentile

	Fall	Spring	Nation
2008-09	3	35	20
2009-10	6	44	20
2010-11	6	44	20
2012-13	10	29	20

Note: Data were not available for 2011-12 for this measure

> *By the end of their kindergarten year, students scored much higher than the national average. This high level of achievement persisted, and even increased, through later grades.*

Figure 1

Percentage of Kindergarten Students At or Above the 40th Percentile

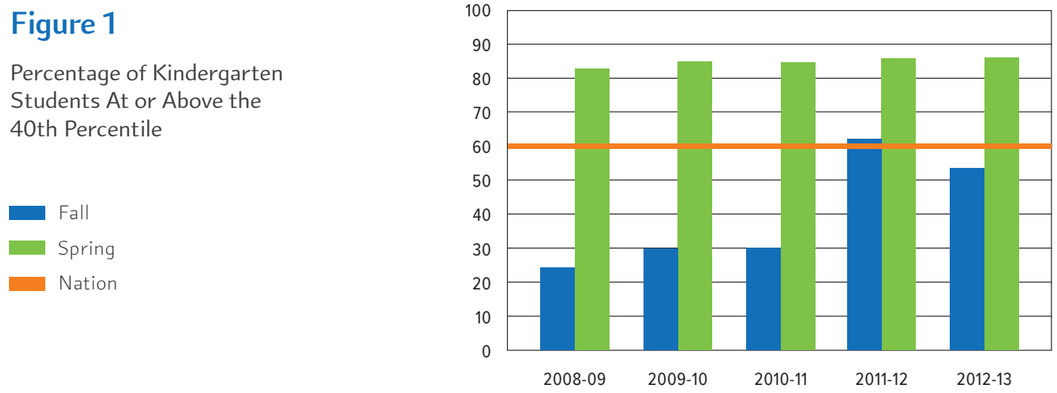


Figure 2

Percentage of Kindergarten Students At or Above the 80th Percentile

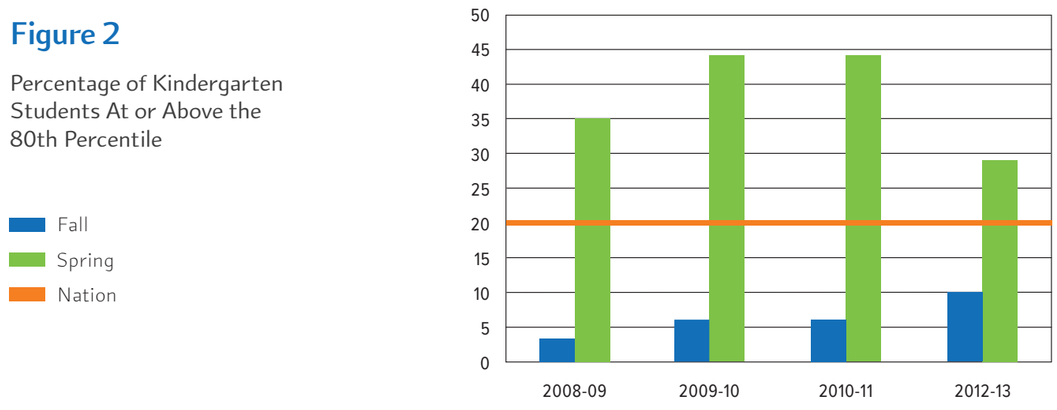
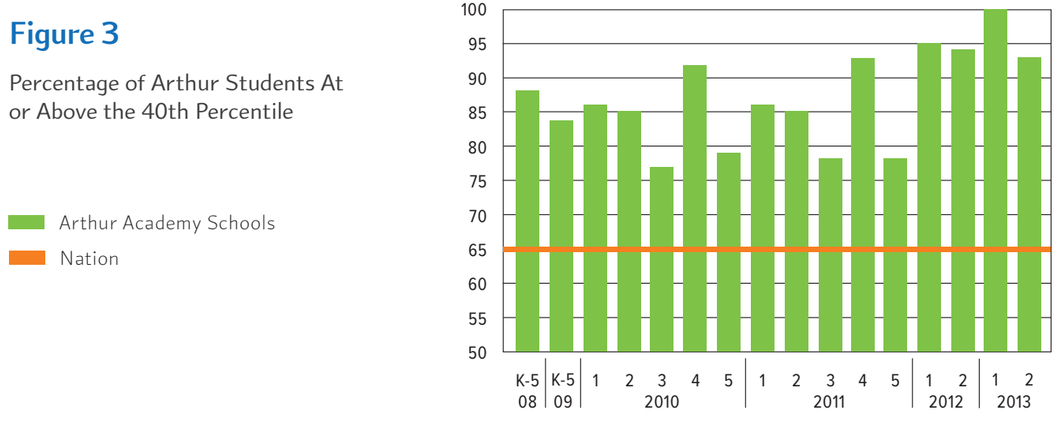


Figure 3

Percentage of Arthur Students At or Above the 40th Percentile



Improving Elementary Level Mathematics Achievement in a Large Urban District: The Effects of Direct Instruction

Affiliation

National Institute for Direct Instruction and University of Oregon

Design

Posttest Only Control Group Design (Study A) and a Longitudinal Panel Design (Study B); both with statistical controls

Participants

Two analyses were reported. The first (Study A) looked at 45,000 first-grade students enrolled from 1997–1998 to 2002–2003 in the Baltimore City Public School System (BCPSS). The second (Study B) looked at 4,800 students who were in first grade in 1997–1998 or 1998–1999 and were in the same schools five years later, in fifth grade. BCPSS is a very diverse school system, with high proportions of students receiving free or reduced-price lunch and from minority groups.

Description of Study

This study examined changes in mathematics achievement over time in the BCPSS by comparing achievement of students in schools that used Direct Instruction (DI) programs with those that did not. Two DI programs were used, depending on students' level and needs: *DISTAR Arithmetic* and *Connecting Math Concepts*. Mathematics achievement was assessed with the nationally normed Comprehensive Test of Basic Skills (CTBS) in the spring of each year, with subtests regarding 1) computations and 2) concepts and applications. Study A examined changes in the average achievement of first-grade students over time. Study B looked at changes in individuals' scores from first grade to fifth grade. Statistical models assessed the extent to which changes could be attributed to exposure to the DI programs, adjusting for differences in the average socio-economic level of the students' schools. Results for the panel study were reported for both the full set of schools and for a smaller sample in which schools were matched on socio-economic characteristics.

> *The largest differences appeared in the later years of the study as Direct Instruction became fully implemented and incorporated within the schools.*

Results

The average achievement of first-grade students increased throughout the BCPSS in the study period. However, the increases were substantially larger for students in the DI schools than in the control schools. These differences were both statistically and educationally significant. The largest differences appeared in the later years of the study as Direct Instruction became fully implemented and incorporated within the schools. On average, the computational scores of first graders were 54 percentile points higher at the end of the study for the DI students and 41 percentile points higher for the control students. For the concepts and applications subtest, the average scores of the DI students were 46 points higher, and the average scores of the control students were 20 points higher than at the start of the study.

Results with Study B found that students in all groups had similar gains in computational skills from first to fifth grade. With the measure of concepts and applications, scores of students also increased over time, but the increase was significantly larger for the DI students. The effect size associated with the change was twice as large for the DI students as for the reduced sample of control students (.61 compared to .32).

(Stockard, 2010)

Table 3

Percentile Scores of Average First Grader, by Year, Group, and CTBS Subtest

Results Unadjusted for Socio-Economic Status of School

	Computations		Concepts and Applications	
Year	Direct Instruction	Control	Direct Instruction	Control
1998	12	21	16	29
1999	17	20	20	27
2000	41	42	32	33
2001	56	50	42	41
2002	63	54	56	44
2003	66	56	60	46
Change	54	35	44	17

Adjusted for School Level Socio-Economic Status

	Computations		Concepts and Applications	
Year	Direct Instruction	Control	Direct Instruction	Control
1998	24	20	21	27
2003	78	61	67	45
Change	55	41	41	20

Table 4

Study B: Percentile Score of Average Student, First Grade and Fifth Grade, DI, Full Control Sample, and Reduced Control Sample (Not Statistically Adjusted)

Results Unadjusted for Socio-Economic Status of School

Percentiles:	Grade	Direct Instruction	Control - Full Sample	Control - Reduced Sample
Computations	1st	21	32	18
	5th	50	56	52
Concepts and Applications	1st	26	42	30
	5th	45	46	41
Change				
Computations		29	24	34
Concepts and Applications		19	4	11

Direct Instruction Mathematics Programs: An Overview and Research Summary

Affiliation

Eastern Washington University

Design

Narrative Literature Review

Description of Study

This article provides a comprehensive overview of Direct Instruction mathematics programs. It compares the programs to a constructivist approach and shows how the DI programs meet the principles for improving mathematics instruction developed by the National Council of Teachers of Mathematics (NCTM). Results of studies of the efficacy of the DI mathematics programs are summarized, focusing on a meta-analysis of studies published before the early 1990s and 12 individual studies published from the 1990s to the date of the article.

> *"Of the 12 individual studies reviewed, 11 found the Direct Instruction programs to be effective."*

Results

The meta-analysis of 37 studies published before the mid-1990s found an average effect size of 1.11 in favor of the DI programs, more than four times the level traditionally seen as educationally significant. Of the 12 individual studies reviewed, 11 found the DI programs to be effective. The results appeared in a variety of settings with a range of students. The only exception involved a study of five students that employed a slight modification of a DI mathematics program and assessed achievement with a test designed by the teachers in the study.

(Przychodzin, Marchand-Martella, Martella, and Azim, 2004)

Teaching Basic Math Skills to Preschoolers Using *SRA Connecting Math Concepts Level K*

Affiliation

Eastern Washington University

Design

Pretest-Posttest Norm Comparison Design

Participants

Sixteen children (six boys and ten girls) with ages ranging from three to five. All children attended an integrated university preschool five days a week. Eleven of the students were identified as Caucasian, four as Hispanic, and one Asian-American. Five students had developmental delays.

Description of Study

This study examined the effectiveness of the *Connecting Math Concepts – Level K* program in teaching basic math skills to preschool children with and without developmental delays. Children in each session were placed in small groups based on instructional level. All students received 10–20 minutes of math instruction per instructional day for a total period of six-and-a-half weeks. Each day's instruction focused on completing one lesson, and all students completed 30 lessons. Children were assessed before and after the introduction of the intervention using the curriculum-based placement test for the first-grade program of *Connecting Math Concepts* and the Battelle Developmental Inventory (BDI), a measure of cognitive skills.

Results

The authors presented results separately for the typically developing children and the children with developmental delays. Both groups of students had substantial gains over the study period relative to national norms of the BDI. Scores on the grade one placement test at the end of the study indicated that all of the students were ready to begin the first-grade level of the program or higher.

(Cross, Rebarber, and Wilson, 2002)

Table 5

Percentile of Average Student, Pre, Post, and Increase, Batelle Developmental Inventory

	Perceptual Discrimination	Memory	Reasoning and Academic Skills	Conceptual Development	Total Cognitive Domain
Typically Developing					
Pretest	49	55	58	41	55
Posttest	50	77	69	67	76
Increase	1	22	10	27	21
Children With Developmental Delays					
Pretest	16	34	3	14	12
Posttest	50	50	35	23	32
Increase	34	16	32	9	20
Total Group					
Pretest	37	48	33	31	39
Posttest	50	69	58	53	63
Increase	13	21	25	22	24

Authors calculated the percentiles from the NCE scores given in the article.

The Effects of a Direct Instruction Program on the Fraction Performance of Middle School Students At-Risk for Failure in Mathematics

Affiliation

The University of Texas at San Antonio

Design

Pretest-Posttest Design

Participants

Thirty seventh-grade students at risk of failing mathematics from a culturally and linguistically diverse school in a rural district outside of a large southwestern city. Student ages ranged from 12 to 14 years. There were 11 females and 19 males. Eighteen of the students were Hispanic, six African American, and six white. None were identified as having a learning disability, but all had failed the annual state-designated assessment in mathematics two or more times and had demonstrated deficits in basic fractions.

> *Students appeared to be more engaged in the Direct Instruction teaching procedures than in the traditional approach.*

Description of Study

This study was designed to examine the effects of the Direct Instruction program, *Corrective Mathematics, Basic Fractions.* Students were divided into three classes, each with 10–12 students. Instruction lasted seven weeks and covered 14 lessons. The course was an elective, taken in addition to the students' regular seventh-grade math course. Each class period lasted 50 minutes, with the first 20 minutes devoted to review, and the remaining time spent on either instruction with the Direct Instruction program or the traditional program. Students were divided into two groups and would alternate the form of instruction based on the day of the week. Fidelity was monitored, and the authors reported procedural fidelity at 90 percent. Students' knowledge of fractions was tested before starting the program (pretest) and after finishing the program (posttest) with a curriculum based assessment.

Results

Results indicated the intervention had a strong positive effect, with statistically significant differences between pretest and posttest scores on both the total measure and the measures of individual skills. The mean performance on the pretest was 20 percent, with scores ranging from zero to 57 percent. The mean performance on posttest was 77 percent with scores ranging from 36–100 percent. Only three students scored below 75 percent correct on the posttest. The authors did not formally test student behaviors during this study, but noted that students appeared to be more engaged in the Direct Instruction teaching procedures than in the traditional approach.

(Flores and Kaylor, 2007)

> *Results indicated the intervention had a strong positive effect, with statistically significant differences between pretest and posttest scores on both the total measure and the measures of individual skills.*

Table 6

Comparison of Pretest and Posttest Percentage Correct by Item Type

	Pretest	Posttest
Total	20	77
Translating a whole number into a fraction	4	80
Translating a fraction into a whole number	22	90
Multiplication of fractions with like denominators	30	93
Addition/subtraction of fractions with like denominators	14	84
Addition/subtraction of mixed numbers with like denominators	3	57
Multiplication of whole numbers and fractions	.02	67
Range of total scores	0 to 57	36 to 100

Effective Mathematics Instruction: The Importance of Curriculum

Affiliation

Western Washington University, University of Wisconsin–Eau Claire

Design

Year One: Pretest-Posttest Control Group Design With Randomized Assignment; Year Two: Cohort Control Group Design

Participants

Fourth-grade students in one school in a small Wisconsin community over a two-year period. Forty-six students were in the study in year one and 38 in year two. Classes were heterogeneous, including students with learning disabilities as well as gifted students.

Description of Study

In year one, fourth graders were randomly assigned to a classroom using the Direct Instruction program, *Connecting Math Concepts*, or to a classroom using a basal mathematics text, *Invitation to Mathematics* (Scott Foresman). In year two, the teacher who had been using *Invitation to Mathematics* used *Connecting Math Concepts*. The scores of the teacher's students in year two were compared to the scores of his students in year one, thus controlling for teacher effects. At the start and end of both school years, students were administered the National Achievement Test (NAT), a group administered normed achievement test with two subtests and a total score: two curriculum-based measures based on the content of the two programs and a multiplication facts fluency test.

Results

Results with the pretest-posttest control group design (year one) indicated no differences between the groups in pretest scores. However, at posttest, the *Connecting Math Concepts* students had significantly higher scores on five of the six measures and the differences were statistically significant in four of the comparisons.

Results with the cohort control group design indicated that the *Connecting Math Concepts* group had larger gains over the school year in five of the six measures. These differences were statistically significant in three of the comparisons.

(Crawford and Snider, 2000)

Table 7

Randomized Control Test

	Pretest		Posttest	
Test	**M**	**SD**	**M**	**SD**
NAT Computation				
Connecting Math Concepts	26	8	36	4
SF	26	8	29	7
NAT Concepts and Problem Solving				
Connecting Math Concepts	31	12	37	13
SF	32	9	39	12
NAT Total				
Connecting Math Concepts	56	19	72	16
SF	58	15	69	18
Connecting Math Concepts - Concepts Test				
Connecting Math Concepts	6	6	41	8
SF	7	3	15	8
Scott Foresman				
Connecting Math Concepts	12	3	19	2
SF	13	4	16	4
Multiplication Facts				
Connecting Math Concepts	15	7	66	7
SF	22	11	48	12

N = 23 in each group

Table 8

Cohort Comparison Design

	Pretest		Posttest		
Test	**M**	**SD**	**M**	**SD**	**Gain**
NAT Computation					
Before (no *Connecting Math Concepts* cohort)	26	9	39	12	13
After (*Connecting Math Concepts* cohort)	26	8	33	7	7
NAT Concepts and Problem Solving					
Before (no *Connecting Math Concepts* cohort)	32	9	39	12	7
After (*Connecting Math Concepts* cohort)	30	11	41	13	11
NAT Total					
Before (no *Connecting Math Concepts* cohort)	58	15	69	18	11
After (*Connecting Math Concepts* cohort)	56	17	74	19	18
Connecting Math Concepts - Concepts Test					
Before (no *Connecting Math Concepts* cohort)	7	3	15	8	8
After (*Connecting Math Concepts* cohort)	4	3	33	14	29
Scott Foresman					
Before (no *Connecting Math Concepts* cohort)	13	4	16	4	3
After (*Connecting Math Concepts* cohort)	10	4	18	3	8
Multiplication Facts					
Before (no *Connecting Math Concepts* cohort)	22	11	48	12	26
After (*Connecting Math Concepts* cohort)	17	10	54	12	37

N =23 for the no *Connecting Math Concepts* cohort and n=19 for the *Connecting Math Concepts* cohort

Research on the Effectiveness of Direct Instruction Programs: An Updated Meta-Analysis

Affiliation

National Institute for Direct Instruction and University of Oregon

Design

Meta-Analysis of Pretest-Posttest Control Group Designs with Random Assignment

Description of Study

A comprehensive literature review was conducted to identify published and unpublished studies of the effectiveness of Direct Instruction programs. The analysis was limited to studies in which students were randomly assigned to receive a Direct Instruction program or an alternative program, and that included enough statistical information to calculate effect sizes. Five studies of mathematics met these criteria. Effect sizes were estimated with Hedges' *g*, using a correction for small sample sizes as appropriate.

> ...Connecting Math Concepts *students had significantly higher scores on five of the six measures...*

Results

The average effect size for the studies of mathematics was 1.03, indicating that the students who received Direct Instruction had average scores at pretest that were more than one standard deviation greater than the comparison group. This value is more than four times greater than the level typically used to denote educational significance (.25).

(Coughlin, 2011)

An Exploratory Evaluation of Dynamic Assessment and The Role of Basals On Comprehension of Mathematical Operations

Affiliation

Lehigh University, University of Oregon

Design

Posttest Only Control Group Design

Participants

Twenty-four students, 12 from a school using *Connecting Math Concepts* and 12 from a school using the *Open Court Mathematics* series were randomly selected for participation. Both schools were public elementary schools from the same area of the county. Equal numbers of students designated by their teachers as being high-, medium-, or low-functioning were chosen. Students in both groups were predominantly Caucasian. One student in the comparison group and two students in the *Connecting Math Concepts* group were identified as having learning disabilities. Groups were almost evenly divided between males and females.

Description of Study

The study was designed to evaluate the relationship of the curricular programs to students' comprehension of mathematical concepts and procedures. Dynamic assessments were used in which students were given specific directions for working math problems and were then observed in doing the work and asked questions about their process and thinking. Three areas were examined:

- Conceptual understanding of borrowing
- The procedural connections between different mathematical concepts, such as addition and subtraction or multiplication and division
- Solving a two-step word problem

The latter two assessment problems were unfamiliar material to the students.

Results

The *Connecting Math Concepts* group outperformed the other group in all three areas. The scores of the two groups were similar in only two of the twelve sub-areas examined. In some areas the differences were so large that the students in the *Connecting Math Concepts* group who were termed low performing had higher scores than students in the Open Court group who were termed high performing.

(Jitendra, Kameenui, and Carnine, 1994)

Table 9

Percentage Correct by Dimension and Group

	Connecting Math Concepts	*Open Court Mathematics*
Conceptual Understanding	71	63
Connections	57	34
Word Problem Solving	38	21

Effects of a High School-Based, Peer-Delivered *Corrective Mathematics* Program

Affiliation

Eastern Washington University

Design

One-Group Pretest-Posttest Norm Comparison Design

Participants

Students in grades 10 to 12 from a suburban high school in the Pacific Northwest. Ten students, termed "learners," had failed Integrated Algebra, the lowest level mathematics course at the high school. Nine students, all of whom had completed Algebra II with a B grade or higher, were assigned as peer tutors. The majority of the students were Caucasian. None of the learners received special education services for mathematics, and this was the only mathematics course in which they were enrolled.

Description of Study

This study was designed to investigate the effects of the *Corrective Mathematics* program on high school students with low mathematics performance when the instruction was provided by their peers. Peer tutors instructed the learners as individuals or in groups of two for 80 minutes each day over a period of 10 weeks. Both the learners and the peer tutors were tested before and after implementation with the Woodcock-Johnson—Revised Tests of Achievement (WJ-R ACH) Calculation and Applied Problems subtests.

Results

Results indicated that the learners and the peer tutors had higher scores on both subtests of the WJ-R ACH after 10 weeks. The associated effect sizes ranged from 0.59 to 1.30; substantially greater than the 0.25 level used to denote educationally significant effects. Even though the sample size was relatively small, three of the four changes were statistically significant. The exception was the test of calculation for peer tutors.

(Parsons, Marchand-Martella, Waldron-Soler, Martella, and Lignugaris/Kraft, 2004)

> *Results indicated that the learners and the peer tutors had higher scores on both subtests.*

Table 10

Pretest and Posttest Scores, WJ-R ACH, Learners and Tutors

	Calculation		Applied Problems	
	Pretest	Posttest	Pretest	Posttest
Learners	86	98	93	99
Peer tutors	113	120	105	118

Effects of Using a Scientifically and Evidence-Based Mathematics Curriculum to Teach Fifth-Grade Math Skills

Affiliation

University of Portland

Design

Pretest-Posttest Norm Comparison Design

Participants

Twenty-five fifth-grade students from a private Catholic school in the Pacific Northwest. All were from one academically diverse classroom (14 males and 11 females). Iowa Test of Basic Skills (ITBS) scores before implementation indicated that three students had high-level math skills in math, 17 were at grade level, and the remaining five were below grade level. Two of the students were diagnosed with Attention Deficit Hyperactivity Disorder (ADHD), two with Fetal Alcohol Syndrome (FAS), one qualified as an English Language Learner (ELL), and two were placed on Individualized Education Plans (IEP): one for behavior, and the other for a reading learning disability.

Description of Study

This study examined the effects of implementing *SRA Connecting Math Concepts Level E* for a five-month period (January to June of 2012). Pre-assessment and post-assessments were conducted with the curriculum-based easyCBM, including a total score as well as subtest scores related to number and operations thinking; number, operations and algebra thinking; and geometry, measurement, and algebra thinking. Data on a national sample were available for the total score.

> *Students had significantly higher scores on all measures at the end of the study... In addition, the students reported enjoying the program and becoming more confident with mathematics.*

Results

Students had significantly higher scores on all measures at the end of the study than they had at the beginning. At the start of the study, *SRA Connecting Math Concepts* students' total easyCBM scores were markedly lower than the national sample. But, by the end of the study, their scores were equivalent to those in the nation. The increases over time for the study sample were significantly greater than gains found in the nation as a whole, and the associated effect size was educationally significant. In addition, the students reported enjoying the program and becoming more confident with mathematics.

(Stockard, 2010)

Table 11

Average scores on easyCBM Mathematics Test

	Pretest	Posttest
Study Students	33	40
Nation	37	40

Evaluating a Mathematics Program for Adoption: *Connecting Math Concepts*

Affiliation

Upper Darby School District, Pennsylvania

Design

Pretest-Posttest Control Group Design

Participants

Students in first and fourth grade in eight elementary schools in a suburban Pennsylvania school district. Slightly more than 300 first graders and 350 fourth graders were included, with slightly more students in the control group.

Description of Study

One teacher from the first and fourth grade in each school volunteered to implement *Connecting Math Concepts* in their classrooms. The remaining classrooms in this district were instructed with a traditional basal program and served as the control group. Students received pretesting from the *Connecting Math Concepts* program. Posttests were designed by the teachers involved in the study. Teachers were instructed to include concepts that were common to both groups and to present them in a neutral format. The authors noted some problems with fidelity, especially with the first-grade teachers.

> *Results for fourth graders, where teachers exhibited much better fidelity to the program, were different. The* Connecting Math Concepts *students had significantly lower pretest scores than those in the control group, but significantly higher posttest scores.*

Results

For first graders, pretest results revealed no significant differences between the means of comparable classes, although the *Connecting Math Concepts* students had slightly lower scores. Posttest results revealed a small, but insignificant, advantage for the *Connecting Math Concepts* students. Results for fourth graders, where teachers exhibited much better fidelity to the program, were different. The *Connecting Math Concepts* students had significantly lower pretest scores than those in the control group, but significantly higher posttest scores. Strong increases occurred in all but two of the eight schools. In these two schools, the *Connecting Math Concepts* groups began the year significantly below the control groups, but were reported to be making substantial progress in closing the gap.

(Wellington, 1994)

Table 12

Average Scores Pretest and Posttest by Grade

	First Grade		Fourth Grade	
	Pretest	Posttest	Pretest	Posttest
Connecting Math Concepts	10	29	27	50
Control	10	28	29	43

Student Gains in A Privately Managed Network of Charter Schools Using Direct Instruction

Affiliation

Advantage Schools

Design

Pretest-Posttest Norm Comparison Design

Participants

Over 5,000 students in kindergarten to seventh grade enrolled in 14 charter schools in 11 different states. Over 70 percent of the student body qualified for free or reduced lunch.

Description of Study

This study examined the effect of Direct Instruction programs on the academic achievement of students in Advantage Schools, a privately managed network of charter schools. For mathematics instruction, both *DISTAR Arithmetic* and *Connecting Math Concepts* were used with students placed in these programs according to their skill levels. Data came from the 1999–2000 school year. Students were tested twice a year, once in the fall and once in the spring, with the mathematics subtest of the Stanford Achievement Test-Ninth Edition (SAT-9).

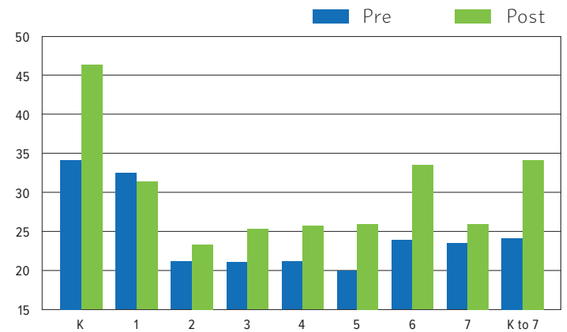
Results

On average, students in the Advantage Schools learned at an accelerated rate in comparison to national norms. Across all grades, the average student moved from the 25th percentile at the beginning of the year to the 29th percentile in the spring. The greatest gains were seen among kindergarten students, where the average student moved from the 34th to 46th percentile. All changes, except for those in grades one and seven, were statistically significant.

(Wellington, 1994)

Figure 4

Percentile of Average Student on the SAT-9 Mathematics Subtest By Grade



> *The greatest gains were seen among kindergarten students, where the average student moved from the 34th to 46th percentile.*

Accelerating Cognitive Growth: The Edison School Math Project

Affiliation

Kalamazoo Public Schools, Portage Public Schools, Edison School, and Galesburg-Augusta Public Schools

Design

Pretest-Posttest Control Group Design, and Posttest Only Control Group Design

Participants

Students in Michigan elementary schools. Students in two third-grade classrooms and one fifth-grade classroom in a high-poverty school (87 percent free lunch rate) used *Connecting Math Concepts*. Students in the comparison group were from the high-poverty school and a comparison low-poverty school (less than ten percent free lunch rate). There were three comparison third-grade classrooms (one at the high-poverty school) and two comparison fifth-grade classrooms (one at the high-poverty school).

Description of Study

This study compared the mathematics achievement of students who used *Connecting Math Concepts* with those in the comparison classrooms, all of whom used the Addison-Wesley mathematics program. The third graders in the low-poverty school were in their first year with the Addison-Wesley program. In the first and second grade, their mathematics instruction involved extensive work with "hands on," manipulative-type activities. Three measures were examined:

- A problem-solving test based on items covered in the two curricula administered in the spring as a posttest
- The norm-referenced Iowa Test of Basic Skills (ITBS) every year, which yields a total score and scores on three subtests – Computation, Concepts, and Problem-Solving – and was given in the spring of each year
- The Kaufman Test of Educational Achievement-Comprehensive Form, with a group-administered Computations test given to all *Connecting Math Concepts* students in the fall and spring and an individually administered Applications subtest, given to six students of varying ability in each *Connecting Math Concepts* classroom in the fall and spring.

> *These high-poverty students were performing at an eighth-grade level by the conclusion of the fifth grade.*

Results

Results indicated that third-grade students instructed with *Connecting Math Concepts* outperformed students in the control group from the same schools on the problem-solving test and had scores that were similar to or higher than students from the low-poverty school. Results from the ITBS revealed that students instructed with *Connecting Math Concepts* maintained their achievement status from the previous year while the comparison students, in both the high-poverty and low-poverty schools had declining scores. On average, the *Connecting Math Concepts* students gained more than one year in grade equivalent scores on both the calculation and applications subtests of the KTEA-C. Students deemed academically talented had, on average, gains of over two years. Results with fifth graders also showed clear advantages for the *Connecting Math Concepts* students.

On the problem-solving test, the *Connecting Math Concepts* students in the high-poverty school had much higher scores than the Addison Wesley students in the same school and slightly higher scores than the Addison Wesley students in the low-poverty school. Results on the KTEA indicated the more than a year's growth in grade equivalent scores on the calculation subtest for students in all ability categories. For the applications subtest, growth was substantially stronger for the academically talented.

These high-poverty students were performing at an eighth-grade level by the conclusion of the fifth grade. The slower rate of growth for the lower ability students was attributed to scheduling issues within the school and the inability to place students at their appropriate level. The strong performance of the *Connecting Math Concepts* students continued into the next academic year, with differences between the *Connecting Math Concepts* students and the Addison Wesley students becoming larger. Additionally, all of the *Connecting Math Concepts* teachers reported very positive experiences teaching with *Connecting Math Concepts*, specifically mentioning the high student success rate, increased on-task behavior, sophisticated problem-solving skills, and improved student confidence.

(Vreeland, Vail, Bradley, Buetow, Cipriano, Green, Henshaw, and Huth, 1994)

Table 14

Problem Solving Test - Third Grade	Percent Correct	Percentage of students eligible for free or reduced lunch
Connecting Math Concepts High-Poverty School, Classroom One	64	87
Connecting Math Concepts High-Poverty School, Classroom Two	75	87
Addison Wesley, High-Poverty School	33	87
Addison Wesley, Low-Poverty School, Classroom One	69	3
Addison Wesley, Low-Poverty School, Classroom Two	46	8

KTEA-C, Third Graders, Fall and Spring	Grade Equivalent		
***Connecting Math Concepts*, High-Poverty School, Classroom One**	**Fall**	**Spring**	**Gain**
Math Calculations	3	4.5	1.5 Years
Math Applications	2.9	4.1	1.2 Years
***Connecting Math Concepts*, High-Poverty School, Classroom Two**			
Math Calculations	3.1	5.1	2.0 Years
Math Applications	3.1	4.5	1.4 Years
***Connecting Math Concepts*, Academically Talented Students (n=4)**			
Math Calculations	3.5	5.7	2.2 Years
Math Applications	4.1	6.1	2.0 Years

Table 14 (cont.)

ITBS, Math Percentile Rank, Second and Third Grade Students	Second Grade	Third Grade	Percentile Rank
Connecting Math Concepts High-Poverty School, Classroom One	52	49	-3
Connecting Math Concepts High-Poverty School, Classroom Two	60	64	1
Addison Wesley, High-Poverty School	65	50	15
Addison Wesley, Low-Poverty School, Classroom One	26	22	-4
Addison Wesley, Low-Poverty School, Classroom Two	34	22	-12

Fifth-Grade Problem Solving Test	Percent Correct	Percentage of students eligible for free or reduced lunch
Connecting Math Concepts High-Poverty	82	87
Addison Wesley High-Poverty	36	87
Addison Wesley Low-Poverty	79	8

ITBS, Math Percentile Rank, Third Graders	Fourth Grade	Fifth Grade	Change
Connecting Math Concepts High-Poverty	46	46	None

KTEA-C Performance by Ability Level	Grade Level		
Academically Talented	**Pretest**	**Posttest**	**Gain**
Math Calculations	6	8	2 Years
Math Applications	6	9	2.2 Years
Average and Above Average			
Math Calculations	5	7	1.6 Years
Math Applications	5	6	0.7 Years
Low			
Math Calculations	4	5	1.4 Years
Math Applications	5	5	0.2 Years

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