The Long-Term Impacts of Direct Instruction and the Maple Model: College Preparation and Readiness

Technical Report 2015-2

Jean Stockard, Director of Research and Evaluation, NIFDI
with Linda Carnine, Caitlin Rasplica, Stan Paine and Erin Chaparro

July 6, 2015

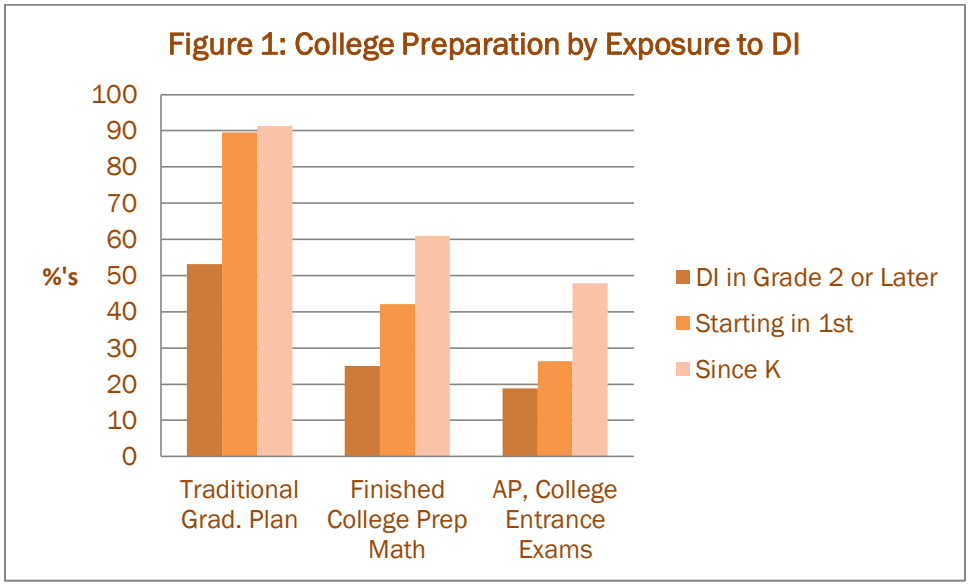
Table of Contents

List of Tables

List of Figures

Executive Summary

This report examines the high school accomplishments and preparation for college of students from a high poverty school in the northwestern United States who had varying degrees of exposure to Direct Instruction in elementary school. Data were gathered from cumulative school records several years after the students would have completed high school. The results indicate that students taught with Direct Instruction early in their school career were significantly more likely to be prepared to enter higher education – enrolling in a traditional academic program, finishing a college prep mathematics class, and taking Advanced Placement courses and/or college entrance examinations (Figure 1). Among those enrolled in traditional academic programs, those with early exposure to Direct Instruction also ranked higher in their high school graduating class and were more likely to have a GPA high enough to qualify for college admission (Figure 2).



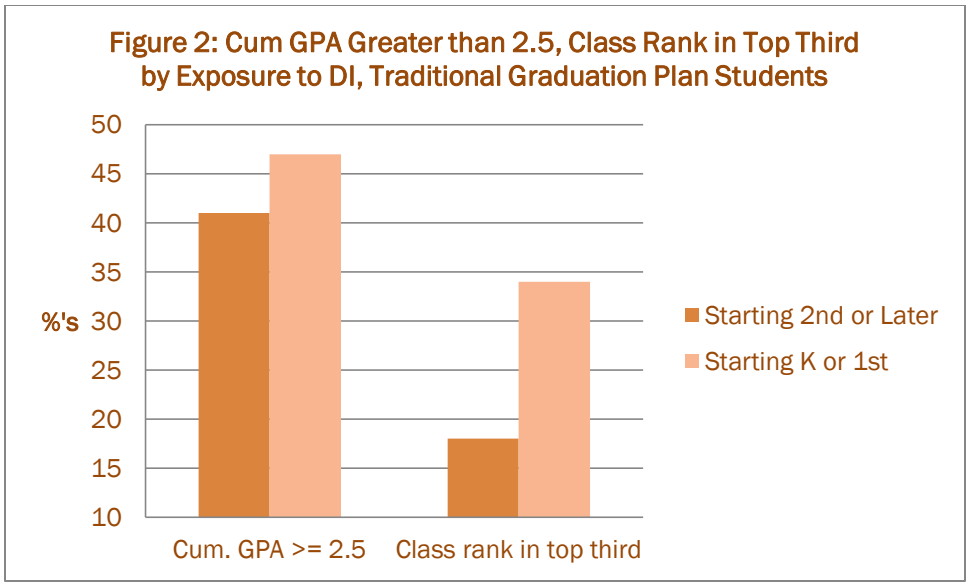


Figure 2: Cum GPA Greater than 2.5, Class Rank in Top Third by Exposure to DI, Traditional Graduation Plan Students
50
45
40
35
%'s 30
25
20
15
10
Cum. GPA >= 2.5
Class rank in top third
Starting 2nd or Later
Starting K or 1st

The Long-Term Impacts of Direct Instruction and the Maple Model: College Preparation and Readiness

The educational research literature provides substantial evidence of the positive impact of the Direct Instruction (DI) curricula on students' academic success. Studies have documented the effectiveness of DI programs in a wide variety of geographic settings, with students with a range of socio-demographic characteristics and ability levels and across all grade levels (See Coughlin, 2014, for summaries of these works.) While many of these efficacy studies have examined growth in student achievement for a relatively short period of time, such as one school year, those that have examined impacts through the end of the elementary years have consistently documented long-term positive effects (Becker & Gersten, 1982; Stockard, 2008, 2010). The positive impact of the DI programs is strongest when students begin work with the curriculum in the earliest years of school, as in pre-school or kindergarten (Gersten, Darch, & Gleason, 1988; Stockard, 2011b, Stockard & Engelmann, 2010).

While there are many studies of the impact of Direct Instruction on student achievement in the elementary schools, studies of the long-term outcomes in high school years are rare. Notable exceptions are studies by Linda Meyer (1984) and Russell Gersten and associates (Gersten, Keating, & Becker, 1988), who compared high school achievement and college entrance of students who had received Direct Instruction in the elementary grades with control groups with similar demographic characteristics. The results, involving students from three different areas of the country, indicated that the students exposed to DI in the early grades were significantly more likely than other students to complete high school and to enter higher education and less likely to be retained or to dropout. Again, the long-term positive impact of DI was strongest with those who began instruction in the program while in kindergarten.

This report replicates the work of Meyer and Gersten, et al. It examines the high school accomplishments and preparation for college of students from a high poverty school in the northwestern United States who had varying degrees of exposure to Direct Instruction from kindergarten through the elementary years. Data were gathered from cumulative school records several years after the students would have completed high school. The results indicate that those who were exposed to DI beginning in kindergarten were significantly more likely to have accumulated accomplishments that would enhance their probability of success in higher education.

Methodology

Setting, Sample, and Research Design

The study focuses on students who attended a high poverty elementary school in a small western city in the late 1980s and early 1990s. Through most of the 1980s, the school had a history of very low achievement levels and high rates of referrals to special education. In 1990 a new Director of Special Education with extensive experience with Direct Instruction joined the district. In the fall of 1991, she assigned a special education teacher who was highly experienced in DI to the school. This teacher then used the Direct Instruction program, *Reading Mastery*, with all the students who were referred to her classroom. An analysis of the achievement of these students indicated strong increases in their reading skills relative to other students in the school (Brumbley, 1998).

In the fall of 1992 a principal who was also highly experienced in Direct Instruction was assigned to the school. He fostered school-wide adoption of the curriculum, in both reading and mathematics, using the Direct Instruction programs *Reading Mastery*, *Language for Learning*, and *Connecting Math Concepts*. He also established a system of strong behavioral supports, paralleling the pattern of student reinforcement and high expectations embodied with the DI programs. A key element of the approach, called the "Maple Model," was early identification of high need students and providing them with very intensive instruction, much like the contemporary RtI model. However, unlike many applications of the contemporary RtI approach, the school used Direct Instruction programs throughout the school, in both general education and special education settings. Students referred for special education received more intensive instruction with the curriculum. Most importantly, when students referred for special education returned to their general education classrooms they could easily fit into the on-going instruction and did not have to adapt to a different curriculum.

Observers familiar with the school at that time report that the Maple Model was highly successful. It resulted in substantially higher student achievement (Brumbley, 1998). It also resulted in a dramatic decline in the number of special education referrals from the school. Before implementation of the Maple model, one-quarter or more of the students had been referred for special education. As a result, the district allocated two full-time special education teachers to the school. After establishment of the model the numbers were much lower, and the decline was so great that the district reduced the budget for special education help for the school.

This report examines the high school careers of four cohorts of students exposed to the Maple Model – those beginning kindergarten in 1989, 1990, 1991 and 1992, termed, respectively, Cohorts 1, 2, 3, and 4. Table 1 summarizes the potential exposure of students in each cohort to Direct Instruction. Cohort 1 would not have been exposed to DI until

second grade (if assigned to special education) or third grade (if in general education). Those in cohort 2 would not have been exposed to DI until either first or second grade, depending on their special education status; those in cohort 3 would have been exposed in Kindergarten or first grade, while those in cohort 4 would have been exposed beginning in Kindergarten. Based on the studies cited above, it was expected that those with more exposure to DI (cohorts 3 and 4) would have greater success in their high school years, including stronger preparation for higher education.

Table 1

Cohorts in the Analysis and Exposure to Direct Instruction

Cohort and Year Started K	First Exposure to DI	School Use of DI
1, 1989	2nd grade (if SPED), otherwise 3rd grade	None
2, 1990	1st grade (if SPED), otherwise 2nd grade	None
3, 1991	K (if SPED), otherwise 1st grade	One DI Teacher (SPED)
4, 1992	K	All Teachers used DI

The study design, which compares cohorts of students who attended the school at different time points, is commonly termed a "cohort-control group" (CCG) or "recurrent institutional cycle design" (Campbell & Stanley, 1963, pp. 56-61; Cook and Campbell, 1979, pp. 126-127; Shadish, Cook, and Campbell, 2002, pp. 148-149), and is seen as especially appropriate for examining changes in organizations such as schools (Stockard, 2013). There is no reason to expect that members of the four cohorts differed in demographic characteristics or academic skills at entry to elementary school.

Measures

Data were obtained from the district's cumulative files on students in these cohorts who remained in the district for their high school years. Six measures, all related to the potential for success in higher education, were the focus of the analysis. Five were individual indicators of potential future success and one was a scale that combined these five items.

Three of the measures were dichotomous in nature. The first was the type of high school program in which the students were enrolled, distinguishing between a traditional high school program that provided a college preparatory curriculum and alternative programs designed for students who were having difficulties in the regular classroom environment and less likely to provide college preparation. The second measure indicated whether or not the student appeared to have completed courses that were college preparatory in nature. If the highest math class that the student completed was sufficient to gain admission to a state college, this variable was coded yes. The third measure indicated whether the student had completed Advanced Placement (AP) courses or college entrance examinations such as the PSAT, SAT, or ACT. Cases in which students had done any of these actions were coded yes.

Two variables were continuous in nature. One was the cumulative GPA, measured on a 4 point scale with 4.0 equaling an A. The second was the percentile ranking of the student within the high school graduating class, with a score of 100 indicating being at the top of the class. Each of these variables was examined individually, with the expectation that students with more exposure to DI (those in cohorts 3 and 4) would be more likely to have better preparation for successful college experiences – in a traditional high school program, taking college preparatory classes, completing college entrance exams, having a higher grade point average, and ranking higher within their graduating class.

While each of these individual measures would be expected to contribute to future success, their cumulative impact would, presumably, be more important than any single element. To capture this cumulative nature of preparatory high school experiences, the five indicators were combined into an additive scale. The two continuous measures were converted to dichotomies. Cumulative GPA was categorized with values greater than or equal to 2.5 scored as one and lower GPAs as zero. (The value of 2.5 was chosen because it is a common cut-off point for admission to a state college.) The measure of class rank was categorized with those in the top third of the class given scores of one and those with lower values given scores of zero. The resulting scale could range from zero to five, with the maximum value indicating that a student had pursued a traditional graduation plan, completed a mathematics class needed for college admission, taken AP classes and/or college entrance exams, had a cumulative GPA of at least 2.5, and ranked in the top one-third of the high school graduating class. In addition to being conceptually sound, the scale had acceptable inter-item reliability (Cronbach's alpha = .79).

Analysis

A simple descriptive analysis was used, comparing the high school experiences of students in the cohorts. To increase sample size within groups, data for the two "pre-DI" cohorts were grouped together. One set of comparisons contrasted three groups (cohorts 1 and 2, cohort 3, and cohort 4), highlighting the experiences of the cohort that had the most exposure to DI. Another set of comparisons grouped cohorts 3 and 4 together, comparing those with any exposure in the earliest grades (K and 1) with those with less exposure. Descriptive statistics and appropriate inferential tests (F-ratios for the three group comparisons and t-ratios for the two group comparisons) are reported. Effect sizes (Cohen's d) are given for the two group comparison.

To ensure that the results were comparable across analyses, the results presented are limited to cases for which data were available for all measures (n=74). When all of the students were included (n ranging from 74 to 143) the results were substantively identical to those reported here.

Results

Table 2 summarizes results with the comparison between three groups (cohorts 1 and 2, cohort 3, and cohort 4), and Table 3 summarizes results with the two-group comparison (cohorts 1 and 2 versus cohorts 3 and 4). In all comparisons the cohorts with more exposure to DI had higher scores. Students in Cohort 4 (with DI since kindergarten) had the highest values on each measure, followed by those in Cohort 3 (with DI since first grade).

Table 2

High School Preparatory Experiences by Cohort, Three Groups (N=74)

	Cohorts 1 and 2	Cohort 3	Cohort 4	F-ratio
Traditional Graduation Plan (% yes)	53.1	89.5	91.3	13.30***
Finished College Prep Math (% yes)	25.0	42.1	60.9	7.17*
AP and/or College Entrance Exams (% yes)	18.8	26.3	47.8	5.56[a]
Cumulative GPA (mean)	2.24	2.26	2.32	0.04
Cumulative GPA > = 2.5	40.6	42.1	47.8	0.30
Class percentile rank (mean)	35.5	36.7	51.2	2.03
Class percentile rank in top third (%)	15.6	26.3	39.1	3.88
Cumulative Scale of Preparation (mean)	1.53	2.26	2.87	4.50**
N	32	19	23	

a, p<.10; *, p<.05; **, p<.01; ***, p<.001

Over 90 percent of those in cohort 4 had a traditional graduation plan, three-fifths of those in cohort 4 had finished a college preparatory math class, and almost half had taken AP classes and/or college entrance exams. In contrast, only about half of those in cohorts 1 and 2 had a traditional graduation plan, only one-fourth had completed a college preparatory math class, and less than one-fifth had taken an AP class and/or a college entrance exam. Similarly, those in cohort 4 had the highest scores on the cumulative scale of preparation, with, on average, positive responses on almost three of the five items, compared to an average of only 1.5 for those in cohorts 1 and 2. All of these differences were statistically significant, and all of the associated effect sizes surpassed the .25 level traditionally used to denote educational significance. While students in cohorts 3 and 4 had higher grade averages and class ranks than those in cohorts 1 and 2, the comparisons were not statistically significant and the associated effect sizes were substantially lower than with the other three measures.

Table 3

High School Preparatory Experiences by Cohort, Two-Group Comparison, (N=74)

	Cohorts 1 and 2	Cohorts 3 and 4	t-ratio	Effect Size
Traditional Graduation Plan (% yes)	53.1	90.5	3.97***	1.26
Finished College Prep Math (% yes)	25.0	52.4	2.44**	0.54
AP and/or College Entrance Exams (% yes)	18.8	38.1	1.82*	0.39
Cumulative GPA (mean)	2.24	2.29	0.23	0.05
Cumulative GPA > = 2.5	40.6	45.2	0.39	0.09
Class percentile rank (mean)	35.5	44.6	1.27	0.28
Class percentile rank in top third (%)	15.6	33.3	1.74*	0.37
Cumulative Scale of Preparation (mean)	1.53	2.6	2.75**	0.61
N	32	42		

Note: All probabilities are one-tail, reflecting the research hypothesis that students with DI would have higher scores. *, p<.05; **, p<.01; ***, p<.001

By definition, a measure of class rank is a within-school calculation, and it is logical to assume that grading patterns involve within-school comparisons. Thus, a more accurate comparison of grade averages and class ranks would involve students within similar high school programs. As would be expected, when the analysis is limited to students within a traditional academic program, the results are strikingly different with these two measures.

Table 4 summarizes differences in grade point average and class rank for those in a traditional academic high school program. (The sample size for cohorts 3 and 4 was too small for valid comparisons for those in an alternative program, for only 4 of the students in these cohorts were in such an alternative program.) With this sub-sample, the students in cohorts 3 and 4 are more likely than those in earlier cohorts to have a cumulative GPA over 2.5, and to rank higher in their graduating class. While none of the differences were statistically significant, the effect sizes associated with class rank surpassed the .25 level traditionally used to denote educational significance. The one remaining deviation from the expected pattern involved differences in the continuous measure of cumulative GPA, for the value for students in cohorts 1 and 2 was higher. Inspection of the data indicated that five of the 38 students in traditional graduation plans in cohorts 3 and 4 had very low cumulative grade averages, but that none of the 17 students in the traditional plan had such a low average. When these outliers were omitted from the analysis the differences between the two groups were all in the expected direction, although only those associated with class rank were substantial.

Table 4
Grade Point Average and Class Rank by Group, Only Students with Traditional Graduation Program/Plan (N=55)

All Students with Traditional Plan (n=55)				
	Groups 1 and 2	Groups 3 and 4	t-ratio	Effect Size
Cumulative GPA (mean)	2.50	2.36	-0.51	-0.15
Cumulative GPA > = 2.5	0.41	0.47	0.42	0.12
Class percentile rank (mean)	35.6	45.4	1.07	0.31
Class percentile rank in top third	0.18	0.34	1.24	0.36
N	17	38		
Students with Traditional Plan and Outliers Omitted (n=50)				
	Groups 1 and 2	Groups 3 and 4	t-ratio	Effect Size
Cumulative GPA (mean)	2.50	2.65	0.64	0.19
Cumulative GPA > = 2.5	0.41	0.55	0.88	0.26
Class percentile rank (mean)	35.6	51.9	1.84*	0.54
Class percentile rank in top third	0.18	0.39	1.57[a]	0.46
N	17	33		

Note: a, p<.10; *, p< .05

Conclusion

The findings reported above indicate that students taught with Direct Instruction early in their school career were significantly more likely to be prepared to enter higher education: enrolling in a traditional academic program, finishing a college prep mathematics class, and taking Advanced Placement courses and/or college entrance examinations. Among those enrolled in traditional academic programs, those with early exposure to Direct Instruction also ranked higher in their high school graduating class and were more likely to have a GPA high enough to qualify for college admission.

One could hypothesize that the results reported in this analysis are conservative in nature. Cohort 4, which had the highest scores on all of the measures, began kindergarten in the first year that the school began its school wide implementation of Direct Instruction. Other studies have shown that teachers become more skilled in teaching DI and their students' achievement becomes progressively greater over time (Stockard, 2011a; Vitale & Joseph,

2008), a process termed "stabilization" (Engelmann & Engelmann, 2004). Thus, it would be expected that students who experienced the Maple Model for most of their elementary years and when the program was well established and stabilized in the school would have higher rates of achievement and be more likely to have successful preparation for college. Additional research, using data from later cohorts, could explore this hypothesis.

Additional research could also examine variations in the achievement of students in the school over more extended time periods. The principal with extensive DI experience was moved to another elementary building in the district in the fall of 1997, and the special education teacher who began the innovation left the school in 2002. While elements of the Maple Model remained for a few years, it gradually disappeared as the new administrator advocated a very different curricular approach. One would expect that average achievement scores of cohorts within the school would vary depending upon the extent to which each cohort had been exposed to Direct Instruction, with a gradual drop after the change in administration and key teaching staff.

Although such additional research would certainly be informative, it is important to stress that the results given here replicate those reported by Meyer (1984) and Gersten, et al. (1988) regarding the relationship of exposure to Direct Instruction and high school achievement and college preparation and extend these results to yet another area of the country. Like Meyer and Gersten, et al. we found that students exposed to DI were more likely to be prepared for higher education and that the impact of DI was strongest for those who began the program in kindergarten rather than first grade. The results also replicate those cited above regarding the impact of Direct Instruction on students' achievement until the end of the elementary years (Becker & Gersten, 1982; Stockard, 2008, 2010). Finally, the results replicate those that show the strongest impact of DI occurs when students begin the program in kindergarten (Gersten, Darch, & Gleason, 1988; Stockard, 2011b, Stockard & Engelmann, 2010). All of these studies involved different time periods and samples. Such replication of results over time periods and settings provides substantial evidence to support the conclusion of long-term positive benefits to students of early exposure to Direct Instruction.

References

Becker, W. C., & Gersten, R. (1982). A follow-up of Follow Through: The later effects of the Direct Instruction model on children in fifth and sixth grades. American Educational Research Journal , 19(1), 75-92.

Brumbley, S. A. (1998). The effects of a first grade phonological awareness intervention in reducing special education referrals. Unpublished Masters thesis, University of Oregon, Eugene, OR.

Campbell, D.T. & Stanley, J.C. (1963). *Experimental and Quasi-Experimental Designs for Research*. Chicago: Rand McNally.

Cook, T.D. & Campbell, D.T. (1979). *Quasi-Experimentation: Design and Analysis Issues for Field Settings*. Chicago: Rand McNally.

Coughlin, C. (2014). Outcomes of Engelmann's Direct Instruction: Research Syntheses. Pp. 25-54 in *The Science and Success of Engelmann's Direct Instruction*. Eugene, OR: NIFDI Press.

Engelmann, S.E. & Engelmann, K.E. (2004). Impediments to scaling up effective comprehensive school reform models. Pp. 107-133 in *Expanding the reach of education reforms: Perspectives from leaders in the scale-up of educational interventions*, ed. T.K. Glennan, Jr., S.J. Bodilly, J.R. Galegher, K.A. Kerr, Santa Monica, CA: Rand.

Gersten, R. M. Darch, C., & Gleason, M. (1988). Effectiveness of a Direct Instruction academic Kindergarten for low-income students. *The Elementary School Journal, 89* (2), 227-240.

Gersten, R., Keating, T., & Becker, W. C. (1988). The continued impact of the Direct Instruction model: Longitudinal studies of Follow Through students. *Education and Treatment of Children, 11*(4), 318-327.

Meyer, L.A. (1984). Long-term academic effects of the direct instruction project follow through. *The Elementary School Journal, 84*(4), 380-394.

Shadish, W.R.. Cook, T.D. & Campbell, D.T. (2002). *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Boston: Houghton Mifflin.

Stockard, J. (2008). *Reading achievement in a Direct Instruction school and a "three tier" curriculum school*. NIFDI Technical Report 2008-5. Eugene, Oregon: National Institute for Direct Instruction.

Stockard, J. (2010). Promoting reading achievement and countering the "fourth-grade slump": The impact of Direct Instruction on reading achievement in fifth grade, *Journal of Education for Students Placed at Risk,* 15, 218-240.

Stockard, J. (2011a). Direct Instruction and first grade reading achievement: The role of technical support and time of implementation, *Journal of Direct Instruction*, 11 (1), 31-50.

Stockard, J. (2011b). Increasing reading skills in rural areas: An analysis of three school districts, *Journal of Research in Rural Education*, 26 (8), 1-19.

Stockard, J. (2013). Merging the accountability and scientific research requirements of the No Child Left Behind Act: Using cohort control groups, *Quality and Quantity: International Journal of Methodology*, 47, 2225-2257

Stockard, J. & Engelmann, K. (2010). The development of early academic success: The impact of Direct Instruction's *Reading Mastery. Journal of Behavioral Assessment and Intervention for Children,* 1 (1), 2-24.

Vitale, M. R., & Joseph, B. L. (2008). Broadening the institutional value of Direct Instruction implemented in a low-SES elementary school: Implications for scale-up and reform. *Journal of Direct Instruction, 8*(1),1-18.