

Appendix 2

A Users' Guide to Programs Serving Underrepresented Students in Pre-K-12 Mathematics and Science, Volume 1, Spring 2004

Introduction

Policymakers, educators, students and parents can all benefit from more information when making decisions about what programs to fund, what teaching methods to adopt or which school to choose. Reliable information becomes all the more important when the need is urgent, as it clearly is in America's search for science and engineering talent. This Users' Guide to the programs evaluated by Building Engineering and Science Talent and the American Institutes of Research is intended to help fill the information gap in the near term, and propose a template of questions and evaluation criteria for use in the longer term.

This guide presents in greater detail the 34 programs evaluated using the research protocol developed by BEST and AIR.

To systematically evaluate the 34 programs, we developed and tested a protocol to appraise the research-based evidence on the effectiveness of programs on student outcomes. The BEST/AIR protocol provides an explicit set of standards to improve the quality of the research evidence that will be brought to bear on assertions of program effectiveness in future years. In short, we have assessed the strength of designs of existing studies of program effectiveness.

We have rated the research evidence of the programs into three broad categories:

I. Research-based evidence

- a) Verified: based on the results of five high-quality studies, of which two meet the highest level of rigor
- b) Probable: based on the results of two acceptably rigorous studies
- c) Potential: based on one acceptably rigorous study

II. Descriptive evidence

- a) Data suggests that the program is reaching underrepresented populations meeting its main objectives
- b) Data suggests that program could benefit from further research

III. Insufficient information

For these profiles, we are including those that meet the criteria for the first two categories: research-based evidence and descriptive evidence.

Summary Ratings

The following is a summary of the rating of programs that we reviewed.

No programs had research-based evidence indicating that their effectiveness is **Verified**.

Two programs had research-based evidence indicating that their effectiveness is **Probable**:

- Direct Instruction in Mathematics
- Project SEED (Special Elementary Education for the Disadvantaged)

Seven programs are **Notable** based on available research evidence:

- Advancement Via Individual Determination (AVID)
- The Algebra Project
- Foundational Approaches in Science Teaching (FAST)
- Gateway to Higher Education
- Project GRAD (Graduation Really Achieves Dreams)
- Puente High School Program
- Yup'ik Mathematics

According to the available descriptive evidence and less-than-rigorous research evidence, 11 programs would **Benefit from Further Research**:

- American Chemical Society's Project SEED
- Detroit Area Pre-College Engineering Program (DAPCEP)
- Disabilities, Opportunities, Internetworking and Technology (DO-IT)
- El Paso Collaborative for Academic Excellence (EPCAE)
- Family Math
- MATHCOUNTS
- Mathematics, Engineering Science Achievement (MESA)
- University of North Carolina's Mathematics and Science Education Network (MSEN)
- Operation SMART
- Texas PreFreshman Engineering Program (TexPREP)
- Xavier University Summer Science Academy

Direct Instruction (in Mathematics)

Summary Rating PROBABLE

General Description *Direct Instruction (DI) is an instructional approach that features carefully specified and sequenced knowledge and skill development, primarily in basic skills for elementary school students. The DI model aims to provide intense, efficient lessons that will allow all children—even the lowest performing—to master academic skills. The instructional approach applies a “single interpretation” rule to the way in which a teacher presents material to students: if the presentation is consistent with one-and-only one interpretation, the student will learn the concept that is being presented.*

DI evolved from work on teacher-directed instruction by Siegfried Engelmann and his colleagues, first at the University of Illinois and later at the University of Oregon. Currently, several organizations contract with schools and districts to assist in implementing the program. Particular emphasis is given to training teachers to deliver instruction in the scripted manner specified by the developer. Printed (paper-based) curriculum materials are published and commercially marketed. Videodisc versions of DI mathematics curricula have also been produced. Although DI has been applied to a variety of subjects and grade levels, reading and mathematics curricula for students in kindergarten through grade six are by far the most widely used and researched. This review examines the research evidence for DI mathematics.¹ The program appears as different versions under the Direct Instruction label, including the arithmetic component of Direct Instruction System for Teaching Arithmetic and Reading (DISTAR) for kindergarten through third grade students and Connecting Math Concepts for first through sixth grade students.²

Purpose/Objective To deliver instruction in a manner that enables elementary students in a variety of ability levels and socio-economic circumstances to master academic content in mathematics.

Reach First developed in the late 1960s in a few classrooms, DI’s reach expanded when it was included as one of a number of instructional programs in Follow Through, a federally funded nationwide evaluation from 1968 to 1976 that assessed several different approaches to educating economically disadvantaged students from kindergarten through third grade. While precise counts are not available, a DI representative estimated that between 600 and 650 schools currently use DI as part of a comprehensive school reform, with math being integral in about 400. The number of schools using DI on any basis for grades K-3 (e.g., perhaps just one classroom or one resource teacher) is much larger (roughly estimated as 10,000 by the DI representative) and most of those schools include the math program.

Evaluation Summary

Methods Impact studies of mathematics include statistical analysis of data from the national evaluation of Project Follow Through during the 1970s, follow-up studies of Follow Through students as they progressed through elementary and secondary schools, and more recent experimental or quasi-experimental studies contrasting the performances of students in DI classes with those taught via other methods and/or curricula. Independent evaluators conducted the original Follow Through Study. However, individuals connected with the Association for Direct Instruction and/or the University of Oregon where the Association is headquartered conducted many of the analysis on those data and have been responsible for a number of subsequent studies.

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Program Components

- Highly structured content organization and instructional delivery.
- Professional development for teachers.
- Commercially published curriculum materials.
- Homogeneous grouping of students by ability.
- Initial testing for assigning students to groups and frequent assessment of student progress to maintain grouping by ability.
- No required family or community involvement, but does recommend involving parents by having them use a guide to work with their child’s skills at home.

Target Population

Although marketed for all students at all ability levels, DI has been widely used among low-performing schools in high poverty areas, in regular and special education classrooms.

Direct Instruction (in Mathematics) Profile *continued*

Reaching the targeted population DI instructional programs have been widely used in low-performing schools in high-poverty areas. For instance, Follow Through districts using Direct Instruction included urban and rural districts with predominantly African American enrollments and rural districts serving predominantly Hispanic and low-income white families.

Subject matter focus Mathematics

Evidence Base

Outcomes examined Numerous analysis from the Follow Through study and four more recent studies from the 1990s examine the immediate effects of DI mathematics instruction based on standardized tests of mathematics computation, concepts and problem-solving, criterion-referenced tests created by teachers and university researchers, and measures of students' self-esteem and self-efficacy. Three follow-up studies of students who received DI instruction in the 1970s as part of Project Follow Through have examined intermediate effects (standardized mathematics scores in grades 5, 6 or 9) and longer-term effects (high school graduation, high school dropout, application to college and college admissions). Students' choices of college majors and success in college have not been studied.

Results Regarding immediate program effects, there is substantial research evidence indicating that DI has a positive effect on mathematics performance of students on standardized tests, although the strongest evidence is dated. That evidence comes from analysis conducted from the highly rigorous Follow Through study of the 1970s that indicated that DI students outperformed students exposed to regular curriculum and to other instructional approaches. More recent studies of students attending school in the 1990s are more varied in rigor and have tended to be narrower in scope (e.g., small studies comparing DI with one other instructional approach), but several of them do provide additional evidence that DI students perform better than comparison students on standardized tests. One study suggests that DI students compared to non-DI students had a more positive attitude toward mathematics and their own mathematical abilities. The research evidence on intermediate and longer-term effects, although positive, is more limited and less rigorous than analysis of the immediate effects. The studies suggest that mathematics performance gains of DI students compared to non-DI students are retained into middle school, and that DI students have higher graduation and college admission rates. However, only one of the three follow-up studies on which this evidence is based is considered to be independent of the developer, and all of the studies were generally of low to moderate rigor because the comparisons did not match individual students or statistically control for differences in student characteristics. Rather, non-DI comparison students were drawn from students who had attended schools with similar demographic and performance profiles prior to Follow Through.

Implications for further research Although published in the 1980s and 1990s, much of the research on DI is based on cohorts of students who were exposed to DI in the early 1970s. More recent studies have been smaller, more narrowly focused and often less well-controlled. Additionally they have not examined longer-term outcomes. For the effectiveness of this program to be considered verified in meeting the goals of interest to BEST, studies conducted by researchers who are clearly independent of the developer need to demonstrate that the academic advantages of DI persist into high school, as evidenced by performance in mathematics and enrollment in advanced mathematics and college preparatory courses.

Project SEED (Special Elementary Education for the Disadvantaged)

Summary Rating PROBABLE

General Description *Project SEED (Special Elementary Education for the Disadvantaged) is a supplementary mathematics program for urban students in grades three through six. Students in participating classrooms receive an additional period of mathematics instruction four days per week for one semester. Professional mathematicians and scientists provide students with instruction in basic algebraic concepts while the students' regular teachers observe the instructional practices. Project SEED specialists provide professional development for teachers and workshops designed to help parents work with students at home.*

Purpose/Objective To improve students' critical thinking and problem-solving skills, mathematics achievement levels and academic self-confidence and, in the long term, to increase the number of minority and educationally disadvantaged students who attain academic degrees and careers in mathematics and related fields.

Reach Begun in Berkeley, Calif., in 1963, *Project SEED* now operates in several large urban school districts in Dallas; Detroit; Philadelphia; Camden, N.J.; Indianapolis; Milwaukee; and the San Francisco Bay Area, and serves over 10,000 students per year.

Evaluation Summary

Methods External evaluators have typically assessed program effectiveness by comparing samples of *SEED* and matched non-*SEED* students on the following:

- standardized mathematics test scores
- evaluator-developed algebra tests
- mathematics courses taken later on by students in middle school and high school.

Samples of comparison students are selected from schools comparable to those in which *SEED* is taught and matched to *SEED* students on individual demographic characteristics and prior test scores in mathematics and reading. Surveys of *SEED* students, teachers, parents and administrators have also been used.

Reaching the targeted population *Project SEED* operates in urban school districts with high proportions of minority and disadvantaged students. Research reports did not provide complete information on the students in their studies, but did indicate that all or most of the students in many of the classrooms studied were African American or Hispanic.

Subject matter focus Mathematics

Evidence Base

Outcomes examined Both immediate and intermediate outcomes have been examined. Immediate outcomes include students' performance on norm-referenced standardized mathematics tests as well as on evaluator-developed tests of algebraic concepts. Evaluations in one site have examined intermediate and longer term outcomes, including standardized test scores up to four years after students last participated in *SEED* and enrolled in college preparatory mathematics courses in middle and high school.

Results A series of six studies of moderate to high rigor conducted over the past 10 or more years by one evaluator and his collaborators show positive outcomes for different cohorts of

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Program Components

- Augmented mathematics instructional time during the school day.
- Teaching by professional mathematicians and scientists.
- Exploration through questions (Socratic group teaching methodology).
- Instruction routines to ensure that all students in the classroom participate.
- Modeling of instruction for classroom teachers.
- Programs to involve parents.

Target Population

Although the program was originally intended for disadvantaged students, it is now seen as a program for all children in regular elementary school classes. However, low socio-economic status and ethnic minority students make up a high proportion of the students in the urban school districts where the program has been implemented.

Project SEED (Special Elementary Education for the Disadvantaged) *continued*

students in a number of urban school districts.^{3,4} These studies compared students in *SEED* to samples of non-*SEED* students in other schools who were matched on the basis of demographic and pre-program mathematics and reading test scores. All of the studies explored the immediate effects of *SEED* participation on students' performance on standardized mathematics tests and found that virtually all student cohorts that had one semester of *SEED* instruction outscored their non-*SEED* counterparts on tests administered the same year. One high-rigor study of longer-term effects found that while differences in test scores from one semester of *SEED* did not persist beyond two years, students who had participated in one semester of *SEED* enrolled in a larger number of higher level mathematics classes throughout their high school years than did their comparison group. Studies of moderate rigor that examined intermediate program effects found that students who had received three semesters of *SEED* continued to outperform their non-*SEED* counterparts on standardized mathematics tests for at least four years and took more higher level mathematics classes in middle school and high school. No studies have examined *SEED* students' college enrollment or choice of majors.

Implications for further research Future studies of high rigor need to replicate the finding of studies of moderate rigor that indicate a lasting difference in mathematics performance among those students who participate in three semesters of the program. To determine the extent to which the impact of such an early intervention persists into early adulthood, studies should also examine differences in the longer term outcomes, such as high school graduation, college enrollment and choice of majors. One evaluator and his colleagues conducted all of the studies reviewed here. The case for the effectiveness of the program needs to be strengthened by replicating these results in studies conducted by other investigators. Finally, as the evaluator points out, existing studies examine the effect of *Project SEED* as a whole, but do not investigate which components of the program (e.g., additional instructional time, specialized content and special pedagogical methods) are having an impact. Future studies should assess the extent to which particular program features are responsible for the program's effectiveness.

Advancement Via Individual Determination (AVID)

Summary Rating NOTABLE

General Description *AVID is an in-school, elective-class program designed to help promising but underachieving middle and high school students to undertake and succeed in a college-preparatory program and ultimately to enroll in college.*

Program Components

- Recruitment through teacher recommendation (based on test scores and academic performance).
- Elective class taken every year during the regular school day.
- Support for college-preparatory coursework including focus on writing, inquiry, study skills and collaborative work groups.
- Tutors (college students, often *AVID* graduates).
- Guest speakers and field trips (e.g., to college campuses).
- Staff development through summer institutes for about 8,500 educators annually.

Purpose/Objective To increase the number of underachieving students who are eligible for and enter college. Although *AVID* does not focus specifically on assisting students to qualify for majors and careers in science, technology, engineering and mathematics, it engages students in college-preparatory mathematics and science courses that are a prerequisite for entering these fields.

Reach The program began in one San Diego high school in 1980. As of 2002, according to the developer, the program is in over 1,500 schools in 21 states and has reached over 30,000 students. The Department of Defense Dependent Schools is also using the program in 14 countries.

Evaluation Summary

Methods The program maintains a central database to which its affiliates contribute aggregated information about *AVID* students (enrollment in college-preparatory courses, college applications and admissions) and their schools (e.g., numbers of *AVID* classrooms and participants, advanced courses offered). Studies by external evaluators, implementing school districts and other researchers have examined students' self-reported enrollment in college the year after high school graduation, completion of college-preparatory courses, grades, test scores, attendance and discipline records, and attitudes. Some of these evaluations included comparisons to non-*AVID* students.

Reaching targeted population Local studies are based on programs in which roughly two-thirds or more of *AVID* participants are African American or Latino.

Subject matter focus The program does not focus on BEST's targeted fields of science, technology, engineering and mathematics. However, it explicitly aims to increase the college enrollment of low-income students, many of whom are from underrepresented minority groups.

Target Population

Middle and high school students, with a particular emphasis on low-income students, who are average academic performers and have the potential to attend college.

Evidence Base

Outcomes examined Immediate outcomes addressed by the research included standardized test scores, grades and attendance of middle and high school students. Intermediate outcomes included course-taking patterns that put students on track to meet college eligibility requirements (algebra in middle school and college preparatory courses in high school) when they graduate from high school. One study of sufficient rigor included an analysis of college enrollment (a long-term outcome).

Results The research included one study of moderate rigor, three of low overall rigor, and descriptive data from implementation reports and the developer. The moderately rigorous study provides evidence that *AVID* graduates, particularly Latino and African American students, have matriculated to college at higher rates than *AVID*-eligible students who did not remain in the program throughout high school. Although this study attempted to compare students who have similar academic and demographic profiles (all the students met *AVID* eligibility criteria), it did not control for factors that may have been responsible for differences that led one group to stay in *AVID* while the other dropped out. The three other studies focused on middle school and high school students who had not yet graduated from high school. These studies compared *AVID*

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Advancement Via Individual Determination (AVID) *continued*

students to demographically similar non-*AVID* students in the same school or school district. Two of the studies further attempted to select comparison students who were average academic performers. Taken together, these studies found that although *AVID* students did not outperform non-*AVID* students in terms of grades and test scores, they did take more college-preparatory courses (including algebra in middle school) needed to meet college eligibility requirements than did their non-*AVID* counterparts.

Implications for future research To verify the program's effectiveness, more controlled, comparative studies of *AVID*'s long-term outcomes (college enrollment and graduation) are needed. To address BEST's concerns, such studies should also attend to students' preparation for and subsequent choice of college majors in science, technology, engineering and mathematics. Because students who are eligible for *AVID* cannot be randomly assigned to the program, the challenge facing researchers will be to construct comparative studies that adequately control for selectivity of students entering *AVID* (i.e., control for motivation as well as prior academic performance).

<p>The Algebra Project</p>	<p>Summary Rating NOTABLE</p>
<p>General Description <i>The Algebra Project, a long-standing supplementary curriculum intervention, is designed to increase students' access to mathematical literacy, and in particular to support the transition from arithmetic to algebraic thinking. Using activities based on everyday experiences that students understand intuitively, the curriculum focuses on basic algebraic concepts such as displacement, equivalence, equality and proportion. The project also includes teacher-training support and community-organizing components.</i></p>	<p>Program Components</p> <ul style="list-style-type: none"> • Curriculum addressing the conceptual leap from arithmetic to algebra. • Inquiry-based teaching strategies that build on a child's experiences. • Integration of mathematics, music and cultural ideas. • High expectations for academic achievement. • Multistage teacher training system which provides direct instruction and guided practice in implementing the program, as well as ongoing support in further curriculum development. • Capacity-building (trainer-of-trainers program) to allow the professional development aspect of the program to be taken over by local practitioners and made responsive to local conditions. • Community organizing in some locales to build a constituency of parents and other community members to advocate for and support strong mathematics literacy programs in their schools. • Peer-group support (i.e. recruits, trains and deploys youth as Math Literacy Workers).
<p>Purpose/Objective To provide all students with the conceptual understanding of mathematics necessary to complete algebra successfully and enter the high school mathematics sequence required for college entrance.</p>	
<p>Reach The <i>Algebra Project</i> was initiated in 1982 by a parent at a Cambridge, Mass., school. The developer reports that the project reaches approximately 10,000 students and 300 teachers each year in 10 states and 28 local sites. Nine of these sites (in five states) compose the project's Southern Initiative, which began in 1991.</p>	
<p>Evaluation Summary</p> <p>Methods The developer reports on the number of sites and the reach of the program. The evaluation of student outcomes is by an external evaluator supported by the National Science Foundation (NSF) and the Soros Foundation.</p> <p>Reaching targeted population Descriptive information and samples of students in studies indicate that the program reaches upper elementary and middle school students of color in inner city and rural schools.</p> <p>Subject matter focus Mathematics</p>	
<p>Evidence Base</p> <p>Outcomes examined The research base included limited comparative evaluations of immediate performance outcomes and intermediate outcome of college preparatory course enrollment. No studies of long-term outcomes such as college attendance or college majors have been conducted.</p> <p>Results The research evidence included two studies. One narrowly focused study of moderate rigor reported a greater improvement in performing operations with negative numbers for a small class of ninth grade inner-city students introduced to algebra through the <i>Algebra Project</i> curriculum, compared with a younger, gifted-and-talented class of suburban students who were taught with a traditional curriculum. A second study of low rigor conducted in several school districts reported that larger proportions of high school students who had attended <i>Algebra Project</i> middle schools were enrolled in college-preparatory math courses above introductory algebra compared with other students in the district. For one of the sites, evaluators reported greater enrollment in college preparatory courses by African Americans compared with demographically equivalent students in the district.</p> <p>Implications for future research Given the objectives of the program, further studies are needed using larger samples of students and more rigorously controlled comparisons than in the current studies. Future studies need to examine a broader range of students' math performance than the range reviewed in this study; future studies also need to examine intermediate outcomes of high school math performance, college preparatory course enrollment and college plans.</p>	<p>Target Population</p> <p>Inner-city and rural students in the upper elementary/middle school grades, particularly in traditionally under-resourced communities of color.</p>



<p>Foundational Approaches in Science Teaching (FAST)</p>	<p>Summary Rating NOTABLE</p>
<p>General Description <i>FAST is an inquiry-based science curriculum series for students in grades six through 10. FAST consists of a three-year sequence of courses focused on physical science, ecology and relational study (i.e., interrelationships among science, technology and society), but some sites implement only one or two years of the program. The program provides 10 days of required training in science content and teaching methods as well as follow-up support for teachers who are adopting the curriculum.</i></p>	<p>Program Components</p> <ul style="list-style-type: none"> • A complete curriculum intended to provide three years of core science instruction. • Emphasis on inquiry-based instruction: 60–80 percent of class time is spent in laboratory or in field trips. • Students practice all stages of scientific research: data collection and analysis, literature search and writing reports. • Students work in small teams. • Professional development mandatory for teachers.
<p>Purpose/Objective To increase students’ understanding of basic science concepts and provide essential skills needed for further study in the sciences, including inquiry, laboratory skills, scientific process skills (formulating hypotheses, interpreting data), and communication through words, graphs and diagrams.</p> <p>Reach The program was first implemented in 1971 in a few schools in Hawaii. According to the developer, <i>FAST</i> is now used by over 6,000 teachers in 36 states and 10 foreign countries.</p>	
<p>Evaluation Summary</p> <p>Methods Evaluations initiated by the developer and other researchers have examined the science knowledge, laboratory and science process skills, and science learning orientations of <i>FAST</i> and non-<i>FAST</i> students. These studies used a combination of widely available standardized tests and instruments designed by the developer and other researchers to measure other skills and orientations that the <i>FAST</i> curriculum is intended to foster.</p> <p>Reaching the targeted population <i>FAST</i> does not specifically target girls, underrepresented minorities or students with disabilities. However, the developer indicates that <i>FAST</i> has been implemented in schools serving diverse student populations including underrepresented minorities, English language learners, disadvantaged students, gifted students and students with a variety of learning styles. Research reports generally have not provided specific information about the racial-ethnic composition of the classes.</p> <p>Subject matter focus Science</p>	
<p>Evidence Base</p> <p>Outcomes examined Immediate outcomes examined include students’ science knowledge, science thinking skills, creative thinking and expression, and science process and laboratory skills while in the program. Intermediate outcomes include students’ interest in science, grades in science and cognitive orientations toward science learning (i.e., active inquiry versus rote learning) in high school. Long-term outcomes were not examined in any of the studies.</p> <p>Results The available studies include one of highest rigor, two of moderate rigor, and one of low rigor.⁵ Researchers affiliated with the developer conducted all but one study. The study of highest rigor and the two of moderate rigor examined immediate effects for middle school students. The highest rigor study reported mixed results: <i>FAST</i> students outperformed non-<i>FAST</i> students on measures of basic thinking in science, laboratory skills, and basic science process skills (graphing and data interpretation) that had been part of the <i>FAST</i> instruction. However, they performed no better than the control group on tests of science knowledge and mastery of an integrated set of science process skills (e.g., generating hypotheses and designing experiments) for use in new contexts. One study of moderate rigor also had mixed results: <i>FAST</i> students outperformed a control group on basic science thinking and some measures of creative thinking.</p> <p style="text-align: right;"><i>(continued)</i></p>	<p>Target Population</p> <p><i>FAST</i> does not explicitly address issues of science instruction for girls, underrepresented minorities or students with disabilities.</p>

Foundational Approaches in Science Teaching (FAST) *continued*

but did no better on a test of science concept recall or on additional measures of creative thinking. Both studies were conducted after only partial implementation of the *FAST* program, which could account for the mixed results. A third study that examined basic thinking skills and laboratory skills reported positive effects on both measures. The study of low rigor provides descriptive evidence of intermediate effects of *FAST*. Students enrolled in *FAST* in middle school tended to be more interested in science, had higher grades in high school biology, and were more likely than their non-*FAST* counterparts to favor active inquiry over rote learning of biology content.

Implications for further research Both immediate and longer term student outcomes of the program for underrepresented groups need to be verified in comparative studies conducted by evaluators and independent researchers on the full implementation of the program.

Gateway to Higher Education

Summary Rating **NOTABLE**

General Description *Gateway to Higher Education is a high school program in New York City public schools that provides an environment of high expectations, academic support and college and career awareness to prepare students for college studies and careers, particularly in science, technology, engineering, medicine, health and teaching. Participants are selected for the program in ninth grade on the basis of prior academic achievement and interest. They attend special classes consisting only of Gateway students and take a four-year program of college preparatory and advanced placement classes with a particular emphasis on mathematics and laboratory sciences. They also participate in summer classes, internships and a variety of activities to familiarize themselves and their parents with postsecondary education and technical careers.*

Purpose/Objective To prepare low- and middle-income high school students for higher education and careers in science, medicine and technology and to increase the number of minority professionals in these fields.

Reach The program began in 1986 with 100 freshmen in four New York City high schools. By 2002, the developer reported that about 2,000 students were being served in two Gateway schools and Gateway programs in nine public high schools.

Evaluation Summary

Methods Developers have maintained a database of *Gateway* students. They have also surveyed *Gateway* alumni up to four years after high school graduation. The database includes high school grades, scores on the New York Regents Exams and college aptitude tests, career interests, placements, demographic information and baseline test scores. Information on alumni includes college attended, grades, time to graduate, expected degree and career choice. The sponsoring organization funded an external evaluation.

Reaching the targeted population *Gateway to Higher Education* operates in New York City schools with high minority enrollments. In 1998, the population participating in the program was 62 percent African American, 19 percent Hispanic, 13 percent Asian, and 5 percent other.

Subject matter focus Science and mathematics

Evidence Base

Outcomes examined One study examines immediate outcomes (course- and test-taking and high school graduation). The developer provides descriptive information on long-term outcomes such as enrolling in college and graduation rates as well as participants' fields of study.

Results The research base included one study of moderate rigor conducted by an external evaluator commissioned by the program. It found positive outcomes for a cohort of *Gateway* students who were matched with non-*Gateway* students on gender, race/ethnicity, and seventh-grade academic achievement (all the non-participants met *Gateway* admission criteria). Paired student comparisons showed that the *Gateway* students had a higher rate of high school graduation (93 percent versus 73 percent) and were two to five times more likely to take end-of-course Regents examinations in mathematics and science subjects than non-participants. *Gateway* students were also much more likely than their non-*Gateway* counterparts to take (and retake) the SAT test and to achieve higher scores. Descriptive evidence from the study and the developer suggests that these patterns have persisted over the program's 10-year history and that *Gateway* students have higher rates of enrolling in college relative to state and national averages. The

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Program Components

- Selection of students performing at or above grade level.
- Separate, reduced size classes for Gateway students.
- School-based faculty team and coordinator who monitor student development and provide guidance to parents.
- Required enrollment in college preparatory courses.
- Additional class periods in mathematics and laboratory science.
- Weekly tutorial sessions in all subjects.
- A one-month summer session for entering ninth and tenth grade students.
- Summer internships in medical and technical settings, field trips and college tours.
- SAT and PSAT coaching classes and financial assistance to take SAT tests.

Target Population

Low- and middle-socioeconomic status high school students, particularly minority students, who performed at or above grade level on standardized achievement tests and middle high school course work and who have demonstrated high motivation through academic performance and regular attendance.

Gateway to Higher Education *continued*

evaluator reports that over 75 percent of the students who entered the program during its first five years (and 92 percent of those who graduated from the program) had gone on to college. Results of a follow-up survey of the college-goers from *Gateway's* first three graduating classes (with a 79 percent response rate) indicate that a substantial proportion (59 percent) of *Gateway* students have remained in science-based fields including medicine, health, engineering and computer science. Because admission to *Gateway* is selective, such uncontrolled comparisons remain suggestive of the longer term impact of the program.

Implications for further research To verify the program's effectiveness, more controlled, comparative studies of *Gateway's* long-term outcomes (college attendance, college graduation, and continued study and careers in scientific, technological and medical fields) are needed.

Project GRAD (Graduation Really Achieves Dreams)

Summary Rating **NOTABLE**

General Description *Project GRAD is a K–12 school reform model that incorporates a comprehensive dropout prevention and college attendance program. The project uses the school feeder patterns (i.e., the elementary and middle schools that supply students to a particular high school) within a district to introduce grade K–12 interventions. The major interventions include research-based curriculum in mathematics (MOVE IT Math, or MIM) and reading (Success for All, or SFA, in elementary schools and Cooperative Integrated Reading and Composition, CIRC, in secondary schools), a research-based program in discipline and classroom management (Consistency, Management and Cooperative Discipline, CMCD), a high school program to promote and support college attendance and programs to develop parental/community involvement. The high school program informs parents of college scholarships and recruits incoming freshman to a scholarship program. To participate in the scholarship program, students and parents sign a contract of expectations and meet with teachers to review the student’s progress. Students in the scholarship program attend a four-week summer instructional program at a local university to familiarize them with university expectations. Project GRAD in Houston provides scholarships of \$1,000 per year for four years to eligible graduating seniors to attend any college or university. Professional development includes training of teachers in MIM, SFA, CIRC and CMCD.*

Purpose/Objective The objective of the program is to raise the performance levels and aspirations of public school children in economically disadvantaged communities. The goal of the program is to decrease dropout rates and increase the college enrollment rates of students in those communities.

Reach A former business executive in collaboration with the University of Houston began Project GRAD in 1989 as a college scholarship program for eligible graduates at the lowest performing high school in Houston. By 2002, Project GRAD had been adopted in five feeder systems in Houston that enroll more than 51,000 students in 73 schools. Project GRAD also has expanded nationally with sites in Atlanta, Brownsville, Cincinnati, Columbus, Akron, Knoxville, Los Angeles, Newark, and Roosevelt, N.Y. The developer reports that Project GRAD currently serves more than 130,000 children in 198 schools.

Evaluation Summary

Methods The developer began evaluating the Houston program’s first feeder system of nine schools in the 1994–1995 school year. The developer compared student outcomes, such as test scores of Project GRAD elementary students in mathematics and reading and graduation rates and college enrollment rates of GRAD high-school students, to data for demographically similar groups. An evaluator at the University of Houston compared standardized mathematics and reading test scores of elementary and middle school students in the GRAD program to students in matched comparison schools. Matched comparison schools in the district were identified for each Project GRAD school based on student demographic and performance characteristics, promotion rates and teacher characteristics.

Reaching targeted population The project serves primarily high-minority, low-income inner-city schools. In Houston where the project originated, over 80 percent of students in schools served by the project are Hispanic, and 10 percent are African American. In Newark, the student population in Project GRAD schools is primarily African American, with 77 percent of students in elementary and middle schools and 61 percent of students in high school receiving free or reduced-price lunches.

(continued)

Program Components

- Early intervention by implementing reforms within the existing feeder schools serving a particular high school.
- K–6 grade mathematics program (MIM) that uses manipulatives as learning tools, introduces algebra in the early grades, emphasizes understanding and discovery of “rules” of mathematics rather than memorization, and recognizes alternative ways of problem solving.
- Reading and writing programs for elementary (SFA) and secondary students (CIRC).
- Classroom management program based on shared responsibility for learning and classroom organization between teachers and students.
- Social service agency to provide guidance, counseling, community outreach and family case-management services to at-risk children.
- High school scholarship program that involves parents, students and teachers in monitoring a student’s progress toward college matriculation throughout high school and provides promising sophomores and juniors with summer college experience.
- Community collaboration, an avenue for local businesses, foundations, universities and individuals to contribute financially or through direct involvement.

Target Population

Low socio-economic status, ethnic minority students in grades K–12.

Project GRAD (Graduation Really Achieves Dreams) *continued*

Subject matter focus Math and reading for elementary and middle school students, and college attendance preparation for high school students.

Evidence Base

Outcomes examined Comparative research on reading and math scores at the elementary and middle school level from a five-year longitudinal study. Although some descriptive longitudinal data are available on high school graduation and college enrollment, no comparative research has been conducted on these outcomes of the program.

Results The findings from one study of moderate rigor provide some research evidence of the effectiveness of the program at the elementary and middle school level and some descriptive evidence of its effectiveness at the high school level. Controlling statistically for performance prior to exposure to Project *GRAD*, elementary and middle school students in Project *GRAD* schools outperformed students in non-*GRAD* schools in mathematics and reading. Longitudinal data from the same study for the first Project *GRAD* high school indicate that the rate of college enrollment increased from 12 percent of graduating seniors in 1989, when scholarships were first offered to graduates, to an annual rate of 50 percent in 1998. The developer also reports a 65 percent increase between 1989 and 2001 in the number of students graduating from the high school where the program began, although no data is reported on the rate of dropout or percentage of students graduating.⁶ The developer also reports improvement in reading and math test scores at some of the elementary schools in other cities in which Project *GRAD* has been implemented.

Implications for future research Further research by MRDC, an independent evaluator, is being conducted at several sites other than Houston. The study will measure the effects of Project *GRAD* on school and student outcomes (e.g., mathematics and reading achievement) at the elementary and middle school levels. Longitudinal studies comparing students from Project *GRAD* and non-*GRAD* high schools are needed to determine whether the project is reducing dropout rates and increasing rates of college attendance among disadvantaged students. Longitudinal studies should also examine college majors and rates of college graduation to determine whether the program is promoting underrepresented minorities in mathematics and science-related fields.

<p>Puente High School Program</p>	<p>Summary Rating NOTABLE</p>
<p>General Description <i>Puente – Spanish for “bridge” – is a college access program designed to provide a bridge for Latino students from high school to college. The program emphasizes instruction in critical thinking and writing, intensive counseling to prepare students for college and mentoring of students to introduce them to opportunities they might not otherwise envision. The program model engages parents and the Latino community in the college-entry process of Latino youth.</i></p>	<p>Program Components</p> <ul style="list-style-type: none"> • Two-year college preparatory English class in ninth and 10th grade. • Several weeks of teacher training in Latino literature, cultural awareness, writing process. • Counseling of students and parents on college-preparatory requirements and progress. • Community mentor liaison program trains Latino professionals to be mentors. • Long-term mentor relationship with students (two-plus years). • Peer-partner program that pairs ninth and 10th grade students with 11th and 12th grade students.
<p>Purpose/Objective To increase the proportion of Latino adolescents who enter four-year colleges, earn college degrees and return to the community as leaders and mentors.</p>	
<p>Reach The program began in a California community college in 1981 and a pilot program was implemented in seven high schools in 1993. In 2002, the program was operating in 36 high schools and 54 community colleges in California. The external evaluator reports that more schools are scheduled to adopt the program in the near future.</p>	
<p>Evaluation Summary</p> <p>Methods An external evaluator conducted a four-year study of the 1993 pilot program that examined high school retention, postsecondary educational aspirations, college preparation (e.g., records of college course requirement and entrance exams taken) and matriculation to four-year college.</p> <p>Reaching the targeted population <i>Puente</i> is designed specifically for Latino students.</p> <p>Subject matter focus The program does not focus explicitly on BEST’s targeted fields of science, technology, engineering and mathematics. However, it explicitly aims to increase Latino student enrollment in college.</p>	
<p>Evidence Base</p> <p>Outcomes examined One longitudinal study evaluates immediate outcomes through high school retention, grades, completion of preparatory course requirements for college, completion of college entrance exams and the longer-term outcome of entrance into a four-year college. A follow-up analysis examines persistence in college.</p> <p>Results One longitudinal study of high rigor analyzed the records of a matched sample of 75 <i>Puente</i> and 75 non-<i>Puente</i> students.⁷ The principal result was positive. <i>Puente</i> students were more likely than non-<i>Puente</i> students to matriculate to a four-year college, which is consistent with the major objective of this program. Other findings were mixed. While <i>Puente</i> students were more likely to have taken college entrance examinations, completion of college preparatory courses was more prevalent for <i>Puente</i> as compared to non-<i>Puente</i> students only among the higher achieving students. <i>Puente</i> and non-<i>Puente</i> students did not differ with respect to high school retention rates and grade point average. A follow-up analysis on 31 pairs of the matched sample two years after high school graduation found that <i>Puente</i> students were more likely to be enrolled in some form of college than non-<i>Puente</i> students. Although no differences were observed in persistence in four-year colleges per se, attrition of the original sample makes it difficult to draw an inference. The researcher suggests that the lack of a difference in persistence at four-year colleges may reflect the social isolation Latino students experience at those institutions and points to the need for campus support programs.</p> <p style="text-align: right;">(continued)</p>	<p>Target Population</p> <p>The program targets non-immigrant, English-speaking Latinos, particularly Mexican American students, as they enter high school. <i>Puente</i> is selective of students who are motivated to improve or excel and to buy into college-preparatory ideology.</p>

Puente High School Program *continued*

Implications for further research Because the program is focused generally on college entrance rather than on the specific fields of study targeted by BEST, comparative studies are needed to determine whether high school students in *Puente* in the long run are more likely than their non-*Puente* counterparts to graduate from college with a major in science, mathematics, engineering or technology.

Yup'ik Mathematics

Summary Rating **NOTABLE**

General Description *Yup'ik mathematics seeks to change the teaching of elementary school mathematics by incorporating within it Yup'ik knowledge, culture, language and everyday experiences. For example, the curriculum applies Yup'ik knowledge of what is required to survive and live a long life in the harsh subarctic environment to the representation of problem solving in more formal mathematical terms. The program stems from the voluntary collaboration among tribal elders, bilingual aides and university faculty who organized into a study, research and school change group in 1987. In 1998, the developers reported that work had begun on developing curriculum in mathematics and science.*

Purpose/Objective To improve students' mathematical thinking and performance while reinforcing Yup'ik culture.

Reach Yup'ik Eskimos are primarily located in rural villages and urban areas of southwestern Alaska. The number and proportion of Yup'ik children receiving instruction from this program is not reported. However, reported use of a formalized curriculum is limited to a recent study from fiscal year 2000–2001 in which 160 students received training in one three-week module of the program.

Evaluation Summary

Methods The developer conducted an experimental evaluation of student performance based on one of the modules of the program.

Reaching targeted population The evaluation targeted both urban and rural Yup'ik students in southwestern Alaska.

Subject matter focus Mathematics

Evidence Base

Outcomes examined One evaluation examines immediate performance outcomes following exposure to one three-week module focused on the concepts of perimeter and area. No studies are available on intermediate or long-term effects, but development and implementation of the curriculum appears to be fairly recent.

Results One fairly rigorous experimental study by the developer used a pretest and posttest design with random assignment of the treatment to classrooms in both rural and urban districts. The objective was to test the effect of one three-week module designed to improve the student's understanding of the properties of a rectangle, perimeter and area. The module incorporated the principles of *Yup'ik* mathematics with an emphasis on culturally relevant content. Pretest to posttest comparisons showed that students in the treatment group scored significantly higher gains in performance than the control group in both rural and urban schools. Although the treatment group outperformed the control group, the authors reported that the posttest also suggested ways to modify the curriculum in response to a "considerable weaknesses" that remained in students' understanding of perimeter and area, indicating that the curriculum is still under development.

Implications for future research Formalization of the curriculum appears to be recent and ongoing, so there may not yet be an opportunity to consider more than the most immediate effects

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Program Components

- Culturally based curriculum.
- Use of everyday and practical knowledge.
- Inclusion of vernacular language.
- Hands-on approach linking intuitive understandings to formal mathematical reasoning.
- Community-based input into curriculum.
- Emphasis on elder knowledge in an expert-apprentice model of learning.

Target Population

Elementary school Yup'ik students in southwestern Alaska.

Yup'ik Mathematics *continued*

of the program. For now, continued study by the evaluator may help to further shape the curriculum. Although the Yup'ik Eskimos, to whom the program is specifically targeted, are a fairly small group, the principles of cultural relevance that have guided the design of the curriculum may be applicable to other groups. Future studies by independent evaluators or researchers of the longer term impacts of elementary school interventions on students' interest and performance in mathematics in middle school and beyond might consider combining an evaluation of this program with other programs that emphasize culturally relevant curriculum.

American Chemical Society (ACS) Project SEED

Summary Rating
FURTHER RESEARCH

General Description Project SEED was established in 1968 by the American Chemical Society (ACS) as a social program to expose talented, economically disadvantaged high school students to scientific careers, particularly in chemistry and chemistry-related fields. High school students from groups that are historically underrepresented in science are placed in academic, industrial and government research laboratories for eight to 10 weeks during the summer to experience “hands-on” research. Each student completes a chemical research project under the supervision of a scientist/mentor (called a preceptor) and receives a stipend. The sponsoring institutions identify local sources of matching funds for student stipends, identify eligible students from local high schools and apply to the ACS to participate in Project SEED.

Project SEED is designed to encourage economically disadvantaged high school students to pursue career opportunities in the chemical sciences. Students who have not graduated from high school are eligible for the Summer I program, and those returning for a second summer of research may participate in the Summer II program. College scholarships are available for SEED students who have graduated from high school and plan to attend college.

Purpose/Objective To foster minority low socioeconomic status students’ interest in and self-confidence in pursuing careers in chemistry and chemistry-related science and to promote scientific knowledge and laboratory skills.

Reach Over 35 years, a total of 6,300 students and 350 institutions have participated in the program. There are roughly 400 students per year in the program, about 75 percent of whom are participating for their first summer and 25 percent for their second. In 2002, 87 institutions sponsored 296 students in the first-year summer program, and 45 institutions sponsored 86 students in the second-year summer program. A total of 30 students received nonrenewable college scholarships.

Evaluation Summary

Methods The ACS sponsored two sample surveys of student alumni. Graduate students in a career information science program conducted the first survey in 1980. An independent polling company conducted a survey of student and preceptor alumni in 1996 in an evaluation of the Summer I program. Currently, all Project SEED participants have to complete a short on-line survey about the impact of the program and future plans before they can receive the final stipend payment.

Reaching targeted population The program developers report that in 2002, 82 percent of the students were from ethnic groups historically underrepresented in science, and 60 percent were females. The respondents to an alumni survey conducted by an independent polling company in 1996 were 47 percent female and 60 percent ethnic minority students. The National Academy of Science reports that typically, around 65 percent of students in this program are minority, and 62 percent are female.

Subject matter focus Chemistry and chemistry-related sciences.

Evidence Base

Outcomes examined No research studies have been conducted comparing ACS Project SEED participants to non-participants. Descriptive data from developer-funded surveys con-

(continued)

Program Components

- Summer internship programs with hands-on research experience.
- Mentoring by scientist in academic, industrial and government laboratory settings.
- Exposure to professional networking by presenting research at ACS local and national meeting (Summer II program students).
- College scholarships for students who major in chemistry or science-related fields.

Target Population

High school students from economically disadvantaged backgrounds who have expressed an interest in scientific research. To participate, students must have completed one year of high school chemistry be entering their junior or senior year in high school meet financial guidelines. ACS defines low annual family incomes as below \$27,000 or not exceeding 200 percent of the federal poverty guidelines for family size. Exceptions can be made for incomes of up to \$34,000, depending on family size.

American Chemical Society (ACS) Project *SEED* continued

ducted by an independent pollster indicate longer-term outcomes in the form of educational degrees received, college majors and career fields.

Results Independent pollsters received responses from 397 out of 916 student alumni from the program's 1968 to 1994 cohorts. Of the respondents, over 80 percent had completed degrees beyond high school, including 6 percent reporting associate degrees, 63 percent with bachelor's degree, 13 percent with master's degrees, and 7 percent with Ph.D.s or medical degrees. About 66 percent of the respondents reported majors in science (e.g., chemistry) or science-related fields (e.g., engineering, mathematics), 55 percent have a science-related job and 36 percent participate in scientific societies.

Implications for future research To evaluate the effect of ACS Project *SEED* on educational and career outcomes, a longitudinal study would need to compare the ACS Project *SEED* participants to non-participants who have similar interests, abilities and sociodemographic characteristics when in high school.

Detroit Area Pre-College Engineering Program (DAPCEP)

Summary Rating
FURTHER RESEARCH

General Description DAPCEP offers a pre-college engineering program for students in grades 4-12. It was begun in 1976 by the University of Michigan and Michigan State University with Detroit public schools to develop enrichment activities for motivating middle and high school minority students' interest in science and engineering. The first activities of the program included sponsored seminars and field trips in which minority students could learn about careers in science and engineering. In the following years, the organizational base moved to Wayne State University and the program expanded in terms of population, funding and types of activities.

Today, DAPCEP consists of three program areas:

- In-school programs for 7th–12th graders, including pre-engineering classes in Detroit public middle schools during the academic year; class activities such as science fair projects, research on minority contributors and engineering projects (chemical, mechanical, electrical, civil).
- Saturday enrichment courses in science, mathematics, engineering, and computer science for 4th–12th graders during the academic year on university college campuses and industrial sites in the fall and spring.
- Summer program courses for 7th–12th graders on university campuses; four- to six-week classes, such as science, engineering, mathematics and computer science.

In addition to the main components, DAPCEP has a job preparation institute that offers workshops in resume writing, job interviewing, employer expectations and professional etiquette to prepare students in grades 10–12 for summer employment in the Detroit area. The program also has expanded from its original focus to include a pilot K–3 program and a program for 4th–6th graders. These programs require participation of parents and guardians in sessions designed to teach them how to be more effective educational partners for their children.

Program Components

- Accelerated classes.
- Continuous involvement through after-school classes.
- Saturday enrichment classes and summer programs.
- Emphasis on enrichment rather than remediation.
- Job preparation institute for high school students.
- Pilot, K–3 program.
- Pre-engineering curriculum guide for middle schools.
- Videotapes using peer and adult role models as a teaching, motivational and career awareness tool.
- Support systems for parents of K–6 students.
- Participation in areawide science fair competitions.

Purpose/Objective To increase the number of historically underrepresented minority students (African American, Hispanic, Native American) who are motivated and prepared academically to pursue careers in engineering-, science- and mathematics-related fields.

Reach During the first year of the program, DAPCEP served 245 middle and high school students. More recently, the developer reported enrolling nearly 6,000 student during the 2000–2001 school year, including 1,650 students in DAPCEP's in-school programs, 4,000 students in Saturday enrichment programs and over 200 participants in summer programs.

Target Population

DAPCEP originally targeted underrepresented ethnic minority middle and high school students (African American, Hispanic and Native American), but has expanded to include underrepresented minorities in grades K-6. DAPCEP recruits students who have a minimum of a C+ grade point average, have expressed interest in math and science and have been recommended by teacher or counselor.

Evaluation Summary

Methods According to the developer, DAPCEP conducts focus groups, interviews and assessments. The particular evaluation used depends on the course and grade. The most recent alumni survey was conducted in 2001 and gathered responses from 852 former DAPCEP students.

Reaching targeted populations Developer reports that in 2002, 99 percent of participants were minority students (predominantly African American), 50 percent female, and 54 percent low income (i.e., qualified for free or reduced-price lunch).

Subject matter Math, science and engineering.

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Detroit Area Pre-College Engineering Program (DAPCEP) *continued*

Evidence Base

Outcomes examined No comparative research-based studies have been identified. Descriptive evidence is available from the provider on college enrollment and course selection.

Results Descriptive evidence is available from a survey administered by the developers to all known program graduates in 1986. With a 68 percent response rate, the results revealed that 74 percent of the respondents who were in college were majoring in engineering, math or science. Of those who had graduated from college, 81 percent had pursued majors in those fields. Also according to the program developers, data from 852 respondents to a 2001 alumni survey suggests that 90 percent of all DAPCEP students go to college; 62 percent of those who attend college pursue technology degrees compared to 3 percent nationwide; and 72 percent of DAPCEP students who graduate from college are awarded technology degrees. Full copies of the reports were not available.

Implications for future research Comparative longitudinal research is needed to assess the impact of the program on college enrollment, field of study and other outcomes. Study would need to identify comparison group non-DAPCEP students with similar sociodemographic (e.g., race-ethnicity, socioeconomic) background, interest in math and science and GPA.

Disabilities, Opportunities, Internetworking and Technology (Do-It)

Summary Rating
FURTHER RESEARCH

General Description *Do-It promotes the use of information technology to maximize the independence, productivity and educational experience of students with disabilities. Computers, software and adaptive technology are loaned to Do-It high school students for home use so that they can access academic information and one another. Do-It activities extend beyond the classroom to include camps, summer programs, mentoring and exposure to various career fields. "Scholars" is Do-It's main program for high school students selected on the basis of grades and teacher recommendations. Participants attend a two-week summer-study program for up to three years at the University of Washington to help them prepare for independent life in a university setting; learn about careers in technical fields; receive mentoring to assist them with academic, career and personal achievement; and participate in Web-based networking with mentors and peers to enrich their education and to explore academic and career interests.*

Purpose/Objective To prepare and motivate students with disabilities to attend college and enter professional careers, particularly in science, mathematics, engineering and technology, and to enable students with disabilities to overcome barriers to independent living and achieve active participation in college and workplace settings.

Reach Nationwide potential, but a concentration of participation in the northwest states. Since it began in October 1992, 168 students who participated in the Scholars program have graduated from high school.

Evaluation Summary

Methods The developer has records on students in the program; these records include their educational attainment and their fields of study.

Reaching the targeted population Biographies of participants in the Scholars program indicate that Scholars are of both genders, include ethnic minorities, have a wide range of physical and cognitive disabilities, and began the program as high school students.

Subject matter focus The program's primary focus is on enabling academically promising students with disabilities to communicate and function effectively in higher education and work environments.

Evidence Base

Outcomes examined No research studies of *Do-It* have been conducted. The developer keeps track of Scholars' undergraduate and graduate enrollment and fields of study.

Results Comparative research studies have not been conducted on outcomes for participants in the Scholars program or other aspects of *Do-It*. Summer program agendas describe a range of career awareness and science-related activities in which the Scholars actively participate (learning how to work around their disabilities through social interaction and technology) and gain practical experience with adaptive and communications technologies. Descriptive evidence suggests that most high school graduates from the Scholars program do go on to college: in 2002 the developer reported that of the 168 Scholars who had graduated from high school since the inception of the program, 151 (90 percent) were attending or had attended college, and 26 (17 percent of college attendees) had graduated. Their areas of study included science, technology, engineering and mathematics as well as other subjects such as business and education. The numbers of students in the fields of study targeted by the BEST initiative were not reported.

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Program Components

- Selection of participants on the basis of achievement and teacher recommendation.
- Use of computers and the Internet.
- Use of adaptive technologies.
- Peer support.
- Mentoring.
- Training in self-advocacy.
- Work-based learning (internships, volunteer work, job shadows).
- Bridging program between high school and college.

Target Population

High school and college students with disabilities. *Do-It* hosts programs for pre-college and college students with disabilities and for their advocates, educators and administrators.

Disabilities, Opportunities, Internetworking and Technology (Do-It) *continued*

Implications for future research Well-controlled comparative studies are needed to demonstrate that the program is substantially responsible for enabling the transition to college of high students with disabilities and for directing them into the fields of science, engineering, math and technology. The challenge for such studies will be to establish control groups of students comparable in pre-program academic ability, disability and motivation. To the extent that a large number of students apply for the limited spaces in the program, such a comparison group might be identified from the pool of program applicants.

El Paso Collaborative for Academic Excellence (EPCAE)

Summary Rating
FURTHER RESEARCH

General Description EPCAE is a systemic reform organization established in 1991. The collaborative includes education, business and civic leaders from El Paso. Major educational institutions include the University of Texas at El Paso (UTEP), El Paso Community College and area school districts. UTEP draws 85 percent of its students from El Paso County schools, and an estimated 60 percent of the teachers in area schools are UTEP graduates. Recognition of this close relationship between UTEP and the area school districts was an important impetus for establishing EPCAE. In 1994, EPCAE and three area school districts received a five-year grant from the National Science Foundation (NSF) to implement the Urban Systemic Initiative (USI), a systemic reform program focused on providing major gains in science and mathematics learning of all students. In 1999 the program evolved into the Urban Systemic Program (USP).

Purpose/Objective EPCAE's seeks to ensure academic success among all students in the school system, from kindergarten through the university, and ensure that all students graduate from area high schools prepared to succeed in a four-year college or university. Focus is on improving student learning in mathematics and science, and more recently on literacy.

Reach The El Paso USP's 2000–2001 annual report maintains 123,000 students, or 90 percent of all students in the three districts, were taught by teachers who received training in mathematics and/or science content and pedagogy through USP.

Evaluation Summary

Methods Annual reports indicate that the USP has tracked the performance level of students on the Texas Assessment of Academic Skills (TAAS) in science, mathematics and reading from 1994 forward, as well as patterns of enrollment and pass rates for college-preparatory courses in mathematics and science from 1992 forward. More recently, USP has started reporting high school graduation rates and performance on college entrance examinations, including the SAT and ACT.

Reaching targeted population Latest annual report for 2001–2002 indicates program is serving 90 percent of students in three high-minority (predominantly Hispanic), low-income urban school districts.

Subject matter focus Mathematics, science and literacy.

Evidence Base

Outcomes examined Annual data used to describe cohort changes in student achievement on TAAS in science, reading and mathematics and in course completion and enrollment were examined; one comparative research study with combined data from El Paso and five other USI sites examined the impact of reported instructional practices on student achievement. Data on high school graduation are limited, and no data are available on longer term impacts, such as college entrance, college major, college graduation or careers.

Results Using annual data on student achievement and course-taking behavior, EPCAE reported that passing rates on the TAAS mathematics test increased from 55 percent in 1994 to 85 percent in 2002 with the gains for Hispanics and African Americans reducing the achievement gap when compared to white students; passing rates on the TAAS eighth grade science test from 1997 to 2002 have shown similar improvements. The proportion of students enrolling in higher level mathematics and science courses at the high school level increased substantially between 1992-1993 and 2001-2002, although the proportion passing has sometimes decreased. The
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Program Components

- Standards-based curriculum, instruction and assessment, that emphasizes inquiry-based instruction and hands-on learning.
- Policy support for professional development to improve teacher's content knowledge, pedagogic skills for inquiry-based learning, and methods of assessing student learning; equal access to high quality, challenging mathematics and science courses.
- Convergence of educational resources, with existing funds leveraging other resources.
- Buy-in from local educational leaders and involvement of higher education partners, business leaders, community officials and parents in promoting and supporting reforms and maintaining high expectations.
- Measures of effectiveness focused on student outcomes.
- Achievement for all students, including increased graduation requirements.

Target Population

All students in three high-minority, low-income, urban school districts that are part of the El Paso USP, including El Paso Independent School District (ISD), Socorro ISD and Ysleta ISD.

El Paso Collaborative for Academic Excellence (EPCAE) *continued*

descriptive data in the annual reports do not allow the outcomes to be directly linked to the reforms. For example, a review of TAAS results posted on the Texas Education Agency website show that Corpus Christi, a district with a high minority population, experienced improvements in mathematics performance similar to that reported by the three districts in the El Paso area.⁸

Implications for future research For determining whether the aggregate data reported by *EPCAE* reflects the impact of the program, a controlled comparison is needed. Following RAND Corporation's lead, the study could use prior test performance and demographic characteristics to provide a statistically controlled comparison and be designed to examine the impact of particular reform practices (e.g., type of instructional practice) by taking measures of teacher performance or other reform-related practices. The longer-term impact of the program (e.g., college entrance) could be assessed by follow-up student surveys.

Family Math

Summary Rating FURTHER RESEARCH

General Description *Family Math is an after-school program designed to teach parents how to help their children learn mathematics. Designed to serve underrepresented minorities and low-income students, Family Math evolved from the principles used in EQUALS, a program designed to interest girls in math-based curriculum and careers. EQUALS brought a problem-solving focus to curriculum and emphasized the idea that using the tools of manipulative materials and models to explain mathematics will build student's understanding, interest and self-confidence. The Family Math program added to these principles by bringing children and their parents together to learn strategies for solving problems and enjoy mathematics in a relaxed environment. Local schools and community organizations offer Family Math classes. Students and their parents are invited to participate together in up to eight weekly sessions of about two hours each that are guided by one or two facilitators trained in Family Math methods. Parents learn methods and activities to encourage children's interest in mathematics and to help them develop basic skills and problem-solving abilities at home.*

Purpose/Objective To help students develop problem-solving skills and the ability to talk about mathematics—the program tries to build positive student and parent attitudes towards mathematics and provide low socioeconomic status families with mathematics instruction and low-cost materials.

Reach *Family Math* was established in 1981, and a Spanish version, *Matematica Para La Familia*, in 1989. The developer reports that the program served over 40,000 families between 1981 and 1989. In 2002, parents and their children in grades K–8 took part in the program in 44 states and 10 countries. The *Family Math* program has been translated into eight languages.

Evaluation Summary

Methods Program developers, evaluators and local researchers have employed various qualitative methods, principally noncomparative interviews and satisfaction surveys administered to teachers, parents and students involved in *Family Math* programs. One study conducted by a school district implementing the program compared scores on standardized mathematics achievement tests, attitudes toward mathematics and parental involvement in school activities for students with different amounts of exposure to the *Family Math* program.

Reaching the targeted population Developers have disseminated the program through minority-based community organizations. The *Family Math* programs described in a variety of evaluations are operating in urban schools with high proportions of minority and low-income students including speakers of languages other than English. In some locations, sessions are conducted in Spanish.

Subject matter focus Mathematics

Evidence Base

Outcomes examined One comparative study examines a number of short-term outcomes (e.g. scores on mathematics tests, student attitudes toward mathematics and self-reported involvement of parents in school activities). Intermediate and longer term effects have not been studied.

Results The review included one study of low rigor that examined immediate effects of participation in *Family Math* for two cohorts of fourth- to seventh-grade students and their parents. The study compared student test scores as well as student and parent survey responses for three

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Program Components

- Standards-based curriculum, instruction and assessment, that emphasizes inquiry-based instruction and hands-on learning.
- Policy support for professional development to improve teacher's content knowledge, pedagogic skills for inquiry-based learning, and methods of assessing student learning; equal access to high quality, challenging mathematics and science courses.
- Convergence of educational resources, with existing funds leveraging other resources.
- Buy-in from local educational leaders and involvement of higher education partners, business leaders, community officials and parents in promoting and supporting reforms and maintaining high expectations.
- Measures of effectiveness focused on student outcomes.
- Achievement for all students, including increased graduation requirements.

Target Population

Low socioeconomic status, race-ethnic minority students in elementary and middle schools.

Family Math *continued*

groups: first-time *Family Math* participants, repeat participants and a comparison group who were non-participants during the study period, although some in this latter group had participated in *Family Math* prior to the study period. The results of the study were mixed. Repeat participants in one cohort outscored first-time participants and non-participants on one of two mathematics tests and showed no changes in attitudes about mathematics. Among parents, one cohort of repeat participants reported more involvement in school activities, but reported no differences on two other measures of program impact on parents. Some of the limitations of the design of this study included the lack of an adequate control group and the relatively small number of sessions (three or fewer) to which participants were exposed. The complete program involves six to eight sessions. No studies have examined intermediate or long-term effects of the program.

Implications for further research The program would benefit from better controlled comparisons that consider the number of sessions attended by the students and their parents to determine whether an impact from the program on parental support and student performance and attitudes is observed after some minimum amount of exposure. Intermediate and longer term follow-up would be needed to determine the extent to which such impacts persist.

<p>MATHCOUNTS</p>	<p>Summary Rating FURTHER RESEARCH</p>
<p>General Description <i>MATHCOUNTS is a mathematics enrichment program for middle school students built around a series of competitions. Teachers and volunteers use materials provided by the MATHCOUNTS Foundation to coach students as part of in-class instruction or as an extracurricular activity. Each year, selected students from participating schools (“athletes”) compete individually or as members of school teams in over 500 written and oral competitions held at the local, state and national levels.</i></p>	<p>Program Components</p> <ul style="list-style-type: none"> • Competitions to motivate students and to increase the status of mathematics study in schools. • Community volunteers (engineers and other professionals) provide coaching and familiarize students with math-related careers. • Coaching tailored to students’ needs. • Coverage of mathematics topics that are not always covered in middle school mathematics courses. • Development of teamwork skills. • Opportunities to meet other students who share an enthusiasm for mathematics. • Coaching materials developed by mathematics teachers and distributed to middle schools nationwide.
<p>Purpose/Objective To promote mathematics achievement by motivating students to develop mathematical knowledge and skills.</p> <p>Reach <i>MATHCOUNTS</i> was officially launched in 1983, with about 4,000 schools in 47 states participating. The developer estimates that currently about 500,000 students are exposed each year to <i>MATHCOUNTS</i> activities in their schools, and about 35,000 participate in local competitions. Nearly 6,000 schools register for competitions each year, with schools representing all 50 states as well as overseas Department of Defense and State Department schools.</p>	
<p>Evaluation Summary</p> <p>Methods The program maintains records on the schools that register to participate in <i>MATHCOUNTS</i> and uses this information to survey participants about their subsequent activities.</p> <p>Reaching the targeted population While <i>MATHCOUNTS</i> serves middle school students, it does not appear to gather or maintain data routinely on the demographic characteristics of all the students who participate. The developer reports having recently adopted two strategies to increase the participation of low-income and minority students: reduction of the registration fee for Title I schools and collaboration with the National Society of Black Engineers to recruit and coach underrepresented students from high-minority urban schools. Other outreach measures are in the planning stages.</p> <p>Subject matter focus Mathematics</p>	
<p>Evidence Base</p> <p>Outcomes examined Intermediate achievement and attitudinal outcomes are examined in a high school survey of former middle school <i>MATHCOUNTS</i> participants and non-participants. Longer term outcomes do not appear to have been studied.</p> <p>Results One research study of low rigor explored intermediate effects of <i>MATHCOUNTS</i> participation. A survey was administered to a sample of 11th and 12th grade students who had participated in <i>MATHCOUNTS</i> during middle school and to a comparison group of non-participating students enrolled in the same high school mathematics classes (most students were taking pre-calculus or a higher level mathematics class). Of the 618 students surveyed, 39 percent responded. <i>MATHCOUNTS</i> participants reported higher mathematics grades and test scores than non-participants and held more positive attitudes towards mathematics. As the research team itself acknowledges, the lack of controls in the study design does not allow differences between the two groups to be attributed to participation in <i>MATHCOUNTS</i>. Additionally, the low response rate to the survey and general recognition of the low reliability</p> <p style="text-align: right;">(continued)</p>	<p>Target Population</p> <p>Middle school students. Although only a small proportion of students are selected to participate in competitions, <i>MATHCOUNTS</i> encourages school-level participation by students of all abilities. <i>MATHCOUNTS</i> is not specifically designed for girls, minority students or students with disabilities. However, the program has recently initiated an outreach effort to recruit more teachers and students from inner-city and rural schools.</p>

MATHCOUNTS *continued*

of self-reported outcome data mean that the findings from this study should be treated as only descriptive evidence of possible positive outcomes of the program.

Implications for further research Well-controlled comparative studies are needed to gauge the immediate and longer term effects of participation in *MATHCOUNTS* on students' mathematics achievement and interest in mathematics (e.g., course-taking behavior). These studies should specifically consider outcomes for students from groups traditionally underrepresented in mathematics fields and for participants who do and do not become contestants.

Mathematics, Engineering, Science Achievement (MESA)

Summary Rating
FURTHER RESEARCH

General Description *MESA is an academic enrichment and support program intended to increase the numbers of students from underrepresented ethnic groups who pursue careers in mathematics-based professions. The pre-college component — MESA Schools Program (MSP) — assists students at middle and senior high schools (and some elementary schools) to excel in mathematics and science studies in order to become competitively eligible for college or university entrance. In comparison to the academic focus of the senior high program, activities at the middle school level are mostly small-group, hands-on science explorations. Organizationally, the program relies on collaborative partnerships with industry and higher educational institutions to provide opportunities for MESA students in the pre-college program. Businesses provide equipment, technical resources, internships, volunteers and cash rewards for academic performance.*

Purpose/Objective To develop academic self-confidence and motivation of students of African American, Native American, Mexican or Puerto Rican descent to study mathematics and science at each level of education from elementary school through college and to increase the number who graduate from a four-year university with a degree in mathematics, engineering, physical science or other mathematics-based field.

Reach The *MESA* pre-college program in California began in the 1970s with three high schools. In 2001–2002 the program had expanded to 450 elementary, middle and high schools, and 11 tribal collaborations serving over 24,000 students. Nationally, the program operated in more than 1,000 elementary, middle, and high schools in seven western states and Maryland. Pilot programs were being launched in additional states.

Evaluation Summary

Methods *MESA* site directors as well as California’s statewide office maintain records of participants’ demographic characteristics, course enrollment and grade performance. Some sites also survey their students regarding their attitudes and satisfaction with the program. Most analysis involve comparisons between summary statistics for *MESA* students and those of the general or minority student populations nationwide, statewide or in universities. In addition, a sample of *MESA* high school graduates in California was surveyed to estimate college-going rates.

Reaching the targeted population Program statistics for 1994 indicate that over 90 percent of students served were Latino, African American or Native American.

Subject matter focus Mathematics, science and engineering.

Evidence Base

Outcomes examined Immediate outcomes examined for high school students include grade point average, number of advanced mathematics and science courses completed, and plans for college attendance and field of study. Longer term outcomes include college matriculation, major, grade point average and rate of credit accumulation.⁹

Results A study of low rigor was conducted in 1982 to examine the immediate outcomes for a sample of *MESA* high school students in California. Overall, the *MESA* students had higher grades than their non-*MESA* counterparts, and the *MESA* seniors had taken more mathematics and science courses and had higher verbal (but not mathematics) scores on their college entrance examinations than did the non-*MESA* seniors.

More recent descriptive evidence (program statistics provided by the *MESA* statewide office in
(continued)

Program Components

- Selection based on academic potential and interest.
- Students encouraged to enroll in college-preparatory program (including mathematics and science courses needed for mathematics-based college majors).
- Academic tutoring and counseling.
- College entrance test preparation.
- Peer supports (study groups, scheduling into the same courses).
- Field trips and career presentations relating to mathematics/science careers.
- Summer internships, campus-based summer programs.
- Local and regional competition of student groups in innovative hands on mathematics/science activities.
- Continuing support—elementary through postsecondary education (pipeline approach).
- Partnership model—various sectors of the community, including universities, school districts, schools, industries and tribes.

Target Population

Low-socioeconomic status Latino, African American, and Native American students in middle and high schools who have an interest in and some facility with mathematics and science.

Mathematics, Engineering, Science Achievement (MESA) *continued*

the 1990s to the present) suggests that *MESA* students outperform California public high school students overall as well as African American and Latino students in particular in terms of completing advanced mathematics and physics courses, grades and performance on college entrance tests. Because these analysis do not control for the selective recruitment of *MESA* students, they must be regarded as suggestive, but not substantiated, evidence of the program's effectiveness. Other descriptive evidence of the effectiveness of *MESA* as reported by the developer include the following:

- About 70 percent of all California *MESA* graduating high school seniors go on to college compared to 49 percent of the state's graduating high school seniors.
- *MESA* students receive 74 percent of engineering baccalaureate degrees awarded to underrepresented students in California.
- Nationally, almost 12 percent of underrepresented students receiving engineering degrees are *MESA* students.

Implications for further research Research-based evidence for *MESA* is limited and dated. Studies with additional controls for preexisting differences are needed to demonstrate that the immediate and long-term outcomes reported in recent descriptive evidence are indeed attributable to the program. Additional comparative, longitudinal studies tracking outcomes for matched samples of *MESA* and non-*MESA* students in high school and college would help to substantiate the program's effectiveness.

Operation SMART—Girls Inc.

Summary Rating FURTHER RESEARCH

General Description *Operation SMART is an 8-12 week in-class and after-school program. Although the program is designed primarily for girls aged 6-18, boys also participate in some sites. Sessions are held once a week. Each session focuses on a different topic that primarily covers mathematics and science. Activities for younger girls focus on hands-on manipulation of materials and tools that promote scientific inquiry, demystification of mathematics and science, self-reliance and direction. Programs for students who are 15-18 years old focus on career awareness and provide in-depth exploration of architecture and engineering, environment and music, and science and technology.*

Purpose/Objective To build the interest and confidence of girls in science, mathematics and technology.

Reach Girls Inc. developed the nationwide program in 1985 in response to the underrepresentation of women in science, mathematics and technology. According to the developer, the program has now served nearly 250,000 girls in 35 states.

Evaluation Summary

Methods Students are asked to depict a scientist and complete an attitude survey to gauge their attitudes about mathematics, science and their own abilities at the beginning and end of the program activities. These measures have been used network-wide since 1988 when the *Operation SMART* research tool kit was distributed to all affiliates.

Reaching the targeted population The curriculum is embedded in Girls Inc., a program that serves ethnically diverse students in urban and rural areas, many of whom live in poverty. Local studies indicate that *Operation SMART* is serving girls aged 6-11 in both girls-only and co-educational settings.

Subject matter focus Informal mathematics and science activities.

Evidence Base

Outcomes examined Several noncomparative studies examine short-term changes in students' attitudes about science and mathematics and about their own capabilities in these areas for girls aged 6-11 soon after they had participated in *Operation SMART* sessions. One comparative study of low rigor examined somewhat longer-term changes in attitudes. To date, no studies examine longer term outcomes, such as participants' course-taking choices in high school.

Results The research included three studies without a comparison group and one comparative study of students who participated in *Operation SMART* when they were 6-11 years old. The three noncomparative studies, which do not meet the criteria of the protocol, showed short-term (pretest/posttest) changes in the attitudes of *SMART* participants toward greater confidence and comfort in dealing with mathematics and science immediately after participating in the program; however, these studies did not control for factors other than program participation that may have influenced students' attitudes. Qualitative data from these studies (e.g., classroom observations, interviews, focus groups, guardian surveys, student journals and teacher reports) add to the descriptive evidence that *Operation SMART* is accomplishing its immediate goals. The comparative study reported no significant differences in attitudes between *SMART* participants and comparison group students one-three years after participants' exposure to the program (an

(continued)

Program Components

- After-school and in-class program.
- Age-appropriate strategies.
- Voluntary participation, no selection criteria based on prior achievement.
- Girls-only, after-school setting (in-class programs also include boys).
- Structured sessions of 1–1.5 hours in math, science, and technology; sessions organized into modules containing 8–12 sessions.
- Hands-on activities.
- Common curriculum, evaluation and facilitator training materials developed by central organization
- Involvement of families.
- Use of community resources.
- Career exploration and awareness.

Target Population

K–12 girls in a variety of urban and rural locations.

Operation SMART—Girls Inc. *continued*

intermediate effect). However, the confidence that can be placed in this conclusion is limited by other features of the study, including the broad definition of “participation” as attending at least one of eight sessions.

Implications for further research To verify the program’s effectiveness, more controlled, comparative studies of immediate and intermediate outcomes for participants in age ranges from 6 to 14 years old and from 15 to 18 years old are needed. The limitations of the existing studies highlight the particular challenges facing evaluators of short-term, community-based interventions focused on attitudinal change. While such programs may contribute to an accumulation of environmental stimuli that encourage members of targeted groups to pursue studies and careers in science, technology, engineering and mathematics, designing studies that measure one program’s particular contribution to meeting those long-term goals is extremely difficult.

Texas Prefreshman Engineering Program (TexPREP)

Summary Rating
FURTHER RESEARCH

General Description *TexPREP provides free academic enrichment in mathematics, engineering and science to high-achieving students in grades 6–11 during a seven- or eight-week summer program in many sites across Texas. The faculty of the summer program is drawn from nearby colleges and high schools and also includes practicing mathematicians and scientists.*

Program Components

- Selection based on evidence of academic achievement.
- Intense, multiyear, college-campus, summer program.
- Combines mathematical reasoning with hands-on learning in engineering and science.
- Use of university faculty and professionals from industry.
- Emphasis on college preparation and career awareness.
- Communication skills training.

Purpose/Objective To provide additional academic support and career awareness to high-achieving middle and high school students with an interest in engineering, mathematics or science, so that they matriculate and successfully graduate from institutes of higher education with degrees in these fields.

Reach Started as a single site in San Antonio in 1979, the program has now been replicated in 14 Texas cities. The developer reports that over 20,000 students have completed at least one summer session of *TexPREP* since its inception in 1979. The developer's records indicate that the number of students graduating from high school who have participated in at least one year of the program has increased from 44 students in 1979 to over 2,300 students in 2001. Additionally, *TexPREP* is replicated by NASA in *Proyecto Access*, a program that operates at a number of colleges and universities in the United States and Puerto Rico and that are part of the Hispanic Association of Colleges and Universities.

Evaluation Summary

Methods The developer administered a follow-up survey in 2001 of college-age graduates of *TexPREP*. Students were surveyed about their college attendance, major and graduation. Overall, slightly more than 50 percent of the sample responded to the survey.

Reaching the targeted population The developer's records show that the program serves a large number of students and that females and members of underrepresented minority groups constitute large proportions of those students. More than 50 percent of *TexPREP* students are female, 50 percent are from economically disadvantaged homes and 81 percent are members of minority groups.

Subject matter focus Mathematics, engineering and science.

Target Population

High-achieving students in middle and high schools with an affinity for and interest in mathematics, science and related careers throughout the state are targeted. The developer identifies women and members of minority groups traditionally underrepresented in areas of science and engineering as special target groups.

Evidence Base

Outcomes examined The developer surveyed high school graduates of the program about enrollment in and graduation from college and about their major field of study at college.

Results Controlled comparative studies of *TexPREP* have not yet been conducted. Slightly more than 50 percent of *TexPREP*'s high school graduates responded to a descriptive survey in 2001, of which 88 percent reported being enrolled in or graduating from college. Of those graduating from college, 75 percent were members of underrepresented minority groups; and 71 percent of the science, mathematics and engineering graduates were members of minority groups. Thus, *TexPREP*'s own descriptive evidence is consistent with its intended goals.

Implications for further research The longer-term outcomes of the program, such as entry into college, choice of college majors and graduation from college need to be reexamined in studies comparing *TexPREP* and non-*TexPREP* students. To verify the program's effectiveness, the studies need to be designed to control for pre-program differences between *TexPREP* and non-*TexPREP* students in academic ability and motivation as well as demographic characteristics.



University of North Carolina Mathematics and Science Education Network (MSEN) Pre-College Program

Summary Rating:
FURTHER RESEARCH

General Description *The University of North Carolina (UNC) Mathematics and Science Education Network operates out of UNC-system campuses to provide statewide leadership in efforts to strengthen the quality and increase the size of the teaching base in mathematics and science education and to increase the pool of high school graduates pursuing careers requiring mathematics or science.¹⁰ The latter objective is pursued through MSEN's Pre-College Program that recruits and prepares North Carolina students of average to above-average ability in grades 6-12 who have not been sufficiently exposed to mathematics- and science-based courses and careers.*

Purpose/Objective To increase the number of students who have sufficient interest and preparation to pursue mathematics and science fields at the university level and to move into careers in science, mathematics, technology, engineering and teaching.

Reach The MSEN Pre-College Program began at the middle/junior high school level in 1986 and expanded to senior high school in 1989. According to the developer, program has grown from serving 427 students at four sites in 1986 to serving over 2,000 students in 2002 at six sites throughout North Carolina. A total of 2,132 students graduated from the program by 2002.

Evaluation Summary

Methods The developer collected data from participants about their demographics, educational status, curricular and extracurricular activities, educational goals and career interests. In 2000 and 2001, graduating seniors were also asked to complete a survey indicating their future educational plans and goals. The developer also surveyed alumni of the program.

Reaching the targeted population The developer reports that across the six sites over 2,000 students were enrolled in the pre-college program in the academic year 2000–2001. The majority of participants were in grades 6-8. The developer's data showed that 60 percent of participants were female and 78 percent were African American.

Subject matter focus Mathematics and science.

Evidence Base

Outcomes examined No comparative research studies of student outcomes have been conducted on either the immediate or long-term outcomes of the program. The developer provides descriptive data of achievement test scores, college enrollment and college majors from surveys of program graduates.

Results Data on students who graduated in 2001 indicate that the average SAT score earned by MSEN pre-college program graduates exceeded the statewide average for all North Carolina seniors and for North Carolina African American seniors. The developer reports that over 97 percent of MSEN pre-college program graduates are pursuing postsecondary education and that 82 percent are pursuing a mathematics- or science-based major with plans to pursue careers in mathematics and science. The developer's data indicate that about 66 percent of program graduates from the graduating classes of 1996 through 2000 enrolled in four-year UNC system institutions.

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Program Components

- Academic enrichment class and labs at individual schools emphasizes hands-on learning.
- Saturday Academy: classes on mathematics, science, communication skills and self-esteem are held at six university campuses along with field trips to businesses and museums.
- Summer Scholars Program: five weeks of science, math, English and computer curricula in a university setting.
- Academic, college and career advising.
- PSAT/SAT preparation classes.
- A statewide math/science competition day—MSEN Day.
- Recognition and scholarship awards.
- PIE clubs for parents to support student activities and assist in program planning.
- ACE clubs for high school students interested in achieving high academic performance in science and math.
- Two-day leadership retreats for high school students.

Target Population

Students of average to above average ability in grades 6-12 who have not been sufficiently exposed to mathematics- and science-based courses and careers.

University of North Carolina Mathematics and Science Education Network (MSEN) Pre-College Program *continued*

Implications for further research By starting with students in middle school, the program demonstrates a long-term or pipeline approach to increasing the number of students from underrepresented groups who are pursuing careers in mathematics and science. Comparative research on students participating in and not participating in the program is needed to determine the extent to which the program, per se, is responsible for the higher scores reported on college entrance exams, the high proportion of students attending postsecondary schools, and the high proportion of students with majors in mathematics and science-related fields. The challenge in conducting the comparative study will be to obtain samples of similarly motivated and performing students that can be followed for several years.

Xavier University Summer Science Academy

Summary Rating
FURTHER RESEARCH

General Description *The Summer Science Academy is a sequence of summer programs designed to prepare high school students to become successful undergraduate science majors at Xavier University of Louisiana by promoting development of their abstract reasoning skills.¹¹ The academy consists of four programs. MathStar is a two-week program for students who will enroll in their first algebra class in the fall (typically students entering ninth grade). BioStar and ChemStar are three-week programs designed for students who will be taking their first biology and chemistry classes during the following school year (typically students entering the 10th and 11th grades, respectively). Stress on Analytical Reasoning (SOAR) is a four-week program taken by students who will be high school seniors during the ensuing school year and who are interested in pursuing science degrees at Xavier University. The goal of the course is to enhance problem-solving and reading skills the students will need for college work and to serve as a bridge between high school and college.¹² In all of the programs, students are given exercises to build their general reading vocabularies and increase their analytical, problem-solving, and test-taking skills.*

The academy is operated by Xavier University, a historically African American university in New Orleans, as part of a skill-building and support system that extends from middle school through college. The SOAR program was created in the mid-1970s by a multidisciplinary science faculty group at Xavier University to serve as a summer bridge program for high school graduates in the New Orleans metropolitan area who were interested in science and were expected to enter Xavier University as freshmen in the fall. More recently, it has become a college-preparatory program for rising high school seniors. During the early 1990s, the faculty developed the MathStar, BioStar and ChemStar sequence based on the SOAR model.

Purpose/Objective To increase the number of minority students completing undergraduate science degrees and entering graduate programs and careers in medicine, science and mathematics; to raise students' mathematics and science achievement in high school; and to improve students' scientific reasoning skills.

Reach In 2001 the *Star* and *SOAR* programs enrolled 417 students from 220 schools in 24 states.

Evaluation Summary

Methods Xavier faculty responsible for the programs report performance data from students in the summer programs. Descriptive statistics on students' persistence in science majors and post-graduate educational placements are the measures that have most commonly been used to gauge the collective effectiveness of the Xavier's pre-college and college-support programs. It appears that separate evaluations of the impact on students have not been conducted.

Reaching the targeted population The developer reports that nearly all (98 to 99 percent) of the summer academy students are African American. Females make up 60 to 80 percent of the enrollment in the programs, reflecting the high dropout rate of African American males. About 75 percent of *SOAR* participants subsequently enroll at Xavier University.

Subject matter focus Science and mathematics.

Program Components

- System of programs that support students from the end of middle school through college.
- Multidisciplinary research science faculty engaged in managing and continuously improving the program.
- Integration of problem solving with content.
- At least two hours of homework every day.
- Daily quizzes that test the previous day's work.
- Rapid turnaround in grading to help students prepare for future quizzes.
- Peer tutoring.
- Socialization for academic teamwork and peer support (e.g., through competitions).
- Mentoring by faculty and program graduates.
- Engagement of parents by providing them with frequent feedback on student's progress.

Target Population

High school and middle school students in regular or honors academic classes from groups underrepresented in mathematics and science professions.

(continued)

Xavier University Summer Science Academy *continued*

Evidence Base

Outcomes examined Developers have assessed immediate effects of the program using standardized measures of reasoning skills, reading and general academic achievement as well as responses to student satisfaction surveys. Descriptive evidence of the longer term effectiveness of Xavier's multiple programs for recruiting, preparing and supporting minority students from middle school through the undergraduate years is inferred from the university's statistics on students' educational careers.

Results To date, systematic studies comparing immediate and longer term outcomes for summer academy participants and non-participants have not been conducted. Two descriptive studies conducted by the developer during the 1980s provide information on the immediate effects of participation in the *SOAR* program. The studies documented, through pre- and posttests, increases in critical reasoning and reading skills among program participants who scored at moderate or low levels on the pretest. However, comparative data on non-participants have not been collected. The developer has cited statistics suggesting that *SOAR* participants are more likely to persist in their science studies than are students who did not participate in *SOAR* prior to enrolling at Xavier. In addition, statistics on the subsequent educational experiences (e.g., persistence in science majors and placement in medical and pharmacy graduate programs) of Xavier's summer academy and undergraduate students are cited as evidence of indicators of the effectiveness of the university's multifaceted support system.

Implications for further research Historically, Xavier University has been a major producer of African American students in medical schools. It attributes this record to its pre-college and college-level curricula and support systems. The programs would benefit from carefully controlled research studies that examined outcomes of the individual programs separately. For instance, comparisons of the high school mathematics and science achievement and college matriculation of participants and non-participants in the *MathStar*, *BioStar* and *ChemStar* programs would help to establish the effectiveness of these programs. Analysis of the persistence in science majors and the postgraduate careers of *SOAR* and non-*SOAR* students have apparently been conducted but were not available.

APPENDIX 2 ENDNOTES

1. A wider-ranging review of the evidence for the effectiveness of the Direct Instruction model may be found in Herman, et al., 1999.
2. A remedial program for fourth graders to adults referred to as Corrective Math is available, and a series of video modules called CoreConcepts has also been produced.
3. Evaluations from the 1980s and earlier showed mixed results. Although some of these earlier studies reported positive student achievement outcomes for *SEED* compared to non-*SEED* students, others showed no significant or consistent differences. The mix of results from these earlier studies might be attributable to differences in the implementation of the program.
4. The evaluator is a deputy superintendent in one of the school districts in which the program was implemented. He works in the district's Division of Evaluation and Accountability.
5. The developer summarizes several other U.S. studies conducted within the same time frame. Documentation available on those studies was judged to be too incomplete to include in this review. One study of low rigor conducted on Slovakian students found that *FAST* students scored higher on Third International Mathematics and Science Study (TIMMS) than non-*FAST* students.
6. Reliable data do not appear to be available on dropout rates or high school graduation rates.
7. A few studies that are generally of low rigor have been conducted on the community college programs.
8. One research study of moderate rigor conducted for NSF by RAND included El Paso schools along with schools from five other USI sites. The study used a statistically controlled design to examine the impact of reform based instructional practices on student achievement. The study found a weak but positive relationship between the frequency with which a teacher used reform practices (i.e., inquiry-based, hands-on instruction) and student achievement. However, the results for El Paso schools, per se, are not identifiable.
9. Although the *MESA* Pre-College Program serves students in elementary, middle and high schools, studies have focused on high school participants.
10. *MSEN* also conducts professional development seminars, workshops and symposia in mathematics and science attended by approximately 5,000 teaching professionals annually.
11. Based on Piaget's theory of cognitive development, the program developer sees as the key to the success of students in college the transition from concrete to abstract reasoning before entering college. The developer maintains that abstract reasoning is a learned set of skills that can be taught to students.
12. Three *SOAR* programs focus on (1) biomedical sciences; (2) physics, engineering and mathematics; and (3) computer science.

Appendix 3

Program Addresses and Contact Information

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