THE ALGEBRA PROJECT'S MIDDLE SCHOOL INTERVENTION IN 1997-98: AN EVALUATION REPORT

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EXECUTIVE SUMMARY

INTRODUCTION

The Algebra Project is a middle-school project that aims to increase the proportion of students who complete algebra successfully in late middle school or high school and enter college preparatory studies. The project is using a broad strategy to address this goal, including curriculum development, teacher professional development, community development, and youth leadership development.

During 1996 and 1997, the project expanded its activities due to several major grants: funding to rural sites from the Annenberg Rural Challenge ($600,000 for 1996-97, renewable annually); an unrestricted grant from the Soros Foundations' Open Society Institute (OSI) ($12 million over three years[1]); and the NSF grant focusing on professional development in six sites ($2.5 million for four years). The NSF's interest in the project was known in May 1996 and helped to leverage the

[1] The project recently decided to extend the expenditure of the last $4 million over several years.

other large grants. During 1997-98, about 280 teachers were participating in the project in about 100 schools, located in 18 sites across the country.[2]

The new funding was used to expand and intensify site and program activities for teacher training and support, community development, and two technology initiatives, as well as to establish new youth initiatives. The NSF grant supported site-based professional development teams, including Algebra Project trainers, teachers, and mathematics specialists from local colleges to train and support teachers in Cambridge, New York City area, and Mississippi. The OSI funding supported similar work in other sites. The NSF funds partially supported the development of a national teacher network to address teachers' professional development interests. The OSI funding supported the Training of Trainers (TOT) program, which produces all of the training and support personnel for the Algebra Project. This program also developed a "Model of Excellence for Algebra Project Training and Teaching" with behavioral indicators and a performance assessment system. It is expected that the model will be used to certify trainers, as well as for coaching and supporting teachers in the classroom.

Several youth projects were initiated to develop "math literacy workers." Young people in high school, college, or post-college, provided workshops, mentoring and tutoring in several sites, through after-school programs or by assisting in the classroom or in school "math labs."

The project also enhanced its administrative capacity, adding core staff who facilitate a variety of services and communication across the Algebra Project network. This administrative capacity building was essential since the Algebra Project is not based in a university or school system.

With OSI funding, the network developed a “Framework for the Evaluation of Student Outcomes” based on input from project members and discussions with a national advisory committee jointly selected by the Algebra Project and the OSI, and coordinated by the evaluators at Lesley College. As a result, the project will develop internal evaluation capacity, rooted in work already begun in the south. The opportunity for new and expanded activities also led the project to reflect on its efforts and to revise strategies based on lessons learned.

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[2] A listing of names of participating teachers reported by NSF-supported sites was included in the project's annual report of December 1997.

FOCUS OF THE EVALUATION REPORT

The report presents recent data on student outcomes, and documents the philosophy, goals, structures and activities of the project's approach to teacher and trainer professional development. (The NSF requested extensive documentation of professional development as an activity of the grant.) Although many sites are not ready for evaluation of student outcomes because they are only a few years old, or have not established a significant presence, there is evidence in some of the older sites of positive student outcomes, including enrollment and success in college preparatory mathematics courses, and performance on major tests of algebra.

Professional development activities are being revised and expanded, based on discussions among trainers, teachers, mathematicians and mathematics educators who are associated with the project. Teachers report many positive views of them in evaluation surveys conducted for internal use, or by the Lesley evaluators. The goals and strategies are consistent with those currently identified nationally as effective for professional development for mathematics and science educators. However, it is too soon to assess the impact of the new and revised structures and activities on teachers' beliefs and practices, or on student achievement.

STUDENT OUTCOMES

There is evidence of the project's potential to reach its goals in the older sites where students have had support from the project in grades 6 through 8.
In the Martin Luther King, Jr. Middle School Open Program in Cambridge, MA, where the project developed its instructional materials during the mid 1980s, students who were in the project in between 1984 and 1995 are being tracked. A follow-up of Algebra Project students during 1993-94 found that 36 out of 54 students were attending college (67%). This rate stands as a low estimate since some of the students who could not be located may have been attending colleges. (It does exceed the district's reported college attendance rate for this period of 60%.) In high school during 1995-96, 92% of King Open Algebra Project graduates in ninth grade were enrolled mathematics courses above Algebra I (geometry or higher level courses) compared with a 47% rate for the entire district.

In the Brinkley Middle School in inner-city Jackson, MS, the project has moved about half of the students from Grade 6 through 8 for the last several years. Although the project was not implemented school-wide, Brinkley students enrolled and succeeded in grade 8 Algebra I at the highest rate of any middle school in Jackson (41%). Brinkley students also went on to high school geometry at the highest rate of any middle school: 38% of the Grade 8 class and 92% of the Algebra I class were taking Geometry in Grade 9.

At the Martin Luther King Academic Middle School in San Francisco, the principal and grade 6-8 teachers are involved in the project. Students have enrolled and succeeded in algebra and geometry (or an equivalent college preparatory integrated mathematics sequence) at a higher rate (58%) than a random sample of San Francisco students with the same demographic characteristics (25%) or the district (23%). Although the schools in Cambridge and Jackson both had, at times, the direct involvement of the project's founder Bob Moses, the San Francisco site did not have this involvement.

Data on student achievement in Algebra I are available from the state of Mississippi Algebra I test. Brinkley Middle School students who took Algebra I in grade 8 performed at the district average on a state Algebra I test, even though they were a year younger than most students studying algebra in the district (and state). In the small rural district of West Tallahatchie, MS, Algebra Project students who took Algebra I in grade 9 performed above the district average. Students who had also attended an after-school workshop series led by older youth who were graduates of the project, or project-trained, performed above the state average.
NSF requested that a sustainable database on the progress of the Cambridge students be established. Substantial progress has been made in building this database with the assistance of the Cambridge Public Schools and the Cambridge Algebra Project.

DOCUMENTATION AND EVALUATION OF TEACHER ENHANCEMENT AND SUPPORT

GOALS, PHILOSOPHY, AND STRUCTURES FOR PROFESSIONAL DEVELOPMENT

The project has developed a set of experientially-based pre-algebra materials for use in grades 5 through 7, called the *Transition Curriculum.* They address the addition and subtraction of integers, as well as concepts of displacement,

proportionality, vectors, multiple representations, and parametricization (OSI Advisory Committee, 1997). The materials have also been described by Comfrey and Lachance (1995) as developing algebra as language, the structure of algebra, algebra as modeling, and touching upon algebra as functions and relations.

An expert panel that evaluated the Algebra Project in Mississippi in 1993-94 noted that the materials are not a complete curriculum, but a "curricular intervention for bringing about systemic reform in education" (Davis et al, 1995). The nature of the Algebra Project teacher development program is closely related to the nature of the instructional materials—especially the need for teachers to think about how best to integrate the materials with their local curriculum.

While site activities for professional development differ somewhat, due to curricular and logistical differences, all sites are addressing the following general goals:

- to introduce and support teachers in using the *Transition Curriculum* and other Algebra Project materials;
- to support teachers in using the Algebra Project pedagogy and the "five step curricular process"; that is, to foster their ability to apply the five-step process inside and outside of the *Transition Curriculum* to adapt other instructional materials, design their own extensions or new lessons, and apply it to subjects other than mathematics;
- to assist teachers in integrating the *Transition Curriculum* with their local curriculum objectives and frameworks, including developing extensions where needed;
- to strengthen teachers' understanding of relevant mathematics;
- to involve teachers in the development of a community of support for schools, teachers and students;
- to enable teachers to become "life-long learners;"
- to engage teachers and other stakeholders in a set of beliefs and practices, often referred to as "Algebra Project culture", which includes positive expectations for student achievement, cooperative learning, and other values.

The Algebra Project's approach to professional development arises out of two core orientations: beliefs about the psychology and efficacy of experiential learning, and a philosophy of organizing. The instructional materials and professional development workshops are based on the "five step curricular process", which is the Algebra Project's embodiment of experiential learning. The national and local structures for professional development are designed to facilitate teachers and trainers in organizing themselves and addressing their needs.

Three structures are entailed in the training and supporting of teachers to prepare students for success in algebra: (1) the newly established national teacher network; (2) a previously established national trainer development program; and (3) local or regional professional development teams that guide local professional development activities. The project sees the two national structures as forums for two constituencies – trainers and teachers respectively -- to discuss their needs and to develop appropriate programs and practices. These two structures are also expected to provide an important national level of quality assurance. Locally, in the NSF-supported sites (Cambridge, the New York City area, and the southern sites operating as a region), professional development teams are being formed that include teachers, trainers and mathematics specialists from local colleges (and some high schools). All of the math specialists have attended the introductory teacher training and some have attended Trainer Training as well. Many of them are intensively involved in developing programs and activities. Teacher enhancement and support consist of introductory teacher training (usually ten days), followed by workshops, meetings, and classroom visitations. The balance of workshops, meetings, and classroom visitations varies somewhat from site to site, depending on the training personnel available, school system support, and logistics.

Since the NSF grant was awarded in April 1997, the NSF sites report teacher enhancement and support to 181 teachers. The total number of teachers involved across the 18 sites is about 280.

Professional Development Activities of the Past Fifteen Months

National Teacher Network

The national teacher network is being established to link Algebra Project teachers and to create a forum for developing a "teacher-driven" professional development program. Through teachers' participation in the national and site-level activities, it is hoped that teachers will "empower themselves" around their work and develop a higher level of professional vision and practice. Since the award of the NSF funds, two national teacher conferences have been held based on surveys of teachers' interests and needs. Discussions and workshops were held to address these interests, and subgroups were formed to follow up on key areas.

National Training of Trainers (TOT) Program

Most Algebra Project trainers are experienced Algebra Project teachers who have been through a special program that started in 1992. The program begins with a two-week intensive workshop, after which trainer candidates practice as apprentices. When they are ready, they can apply to be observed and assessed for certification at three levels: Assistant, Associate, or Full Trainer. The program has produced the 42 trainers who are now active. These individuals conduct all teacher trainings and facilitate all local and national professional development activities, as well as other project meetings. The program has developed its own management team.

This year, with the assistance of Hay/McBer Group in Boston, MA, the program developed a "Model of Excellence for Algebra Project Teaching and Training." The model was created using data from focus groups, "behavioral event interviews" with 47 teachers and trainers, and extensive small group analysis of these data to identify key "competencies" and their behavioral indicators. A system for assessing performance on the competencies (in transcripts, videotaped or live performances) has also been developed, and teams of "assessment observers" have been trained for coding transcripts. In the future, it is expected that these observers will learn to code from videos and live observations. Also, in response to trainers' request for additional training to improve their ability to "coach" and support teachers in the classroom, the program developed and held two workshops on coaching. Finally, several committees have worked to re-design the introductory training workshop, and to study the latest version (v.6) of the *Transition Curriculum.*

Site and Regional Activities

In all sites, new teachers entered the project through the introductory workshop, and some new formats were tried out. Sites varied in the nature of follow-up support. In the Delta, teachers are meeting with trainers every Saturday. In Cambridge, teachers meet less often but are visited often in the classroom—usually from two to six times per month. In New York, the trainer holds after-school meetings, dinners, and special workshops. In Cambridge and Mississippi, a special mathematics workshop has been held. Many teachers have also participated in national-level meetings for the trainer program, national teacher conference, or development of the national evaluation framework.

Establishing Professional Development Teams in Sites

Teams are being established and are providing professional development services to teachers. All teams include at least one individual with the responsibility to provide expertise in mathematics, who has attended the *Transition Curriculum* training. Sites are at different points in developing ways to integrate mathematics specialists. The southern regional team (which serves Mississippi and other states) stands out for its long-term collaboration with math specialists and their immersion in ongoing project work. Some of the math specialists have attended trainer training, and each contributes in an ongoing way to some aspect of the professional development program.

Providing Services to Teachers

According to site reports, 181 teachers have been served in the NSF sites, and a total of about 280 are participating nationally.
Strengths include: in Mississippi, a teacher workshop on the mathematics of multiplicative structures, and discussions of how trainers should assess teaching in the classroom; in New York, a series of half- and full-day workshops that included assisting teachers in translating "traditional" textbook materials into materials using the project's "five-step process;" participation by the New York project in the school district's planning for an inclusive grade 2-8 professional development program for mathematics; in Cambridge, a mathematics workshop geared around teachers' interests, and a working group of veteran teachers who built classroom assessment tools.

Weaknesses: A shortage of teacher support personnel exists, in spite of the past two years of funding. Some Algebra Project trainers are classroom teachers who have limited release time to support others outside of their building. Even in Cambridge, where the school system fully supports the project and employs two Algebra Project trainers as system staff developers, the support personnel has not increased in proportion to the site's recent growth. Trainers feel they do not have enough personnel to give the ideal amount of support. The minimum amount and form of support that "works" is an unanswered and worthy evaluation question.

Quality of Teacher Support and Enhancement

The trainer program has produced teacher leaders who have successfully developed the project to the current level. They have facilitated the project's development not only in the classroom but also in their schools and communities, and in the Algebra Project network. Their skill in working with small groups and guiding adult learning has successfully engaged teachers in reflecting on their teaching skills and knowledge. Trainers have also served as "role models." They are dedicated individuals, whose training has enabled them to address difficult challenges in the schools, the community, and the Algebra Project network.

Weaknesses in the trainer program are: (1) sites have to bear a very high cost to train and certify a trainer; (2) as noted, many of the trainers remain classroom teachers who do not have enough free time to serve the site's recent or future growth. The extent of the "shortage" depends on the intensity of the program that a site aims for. The Cambridge Algebra Project, for example, envisions a very intensive program of workshops and classroom visitations.
With a combination of NSF and OSI funding, the project is establishing a new national teacher network, which has the potential to strengthen professional development. (Research shows that teacher networks can be an effective vehicle for teacher change.) The Algebra Project culture expects teachers to be active participants--as leaders, planners and learners--at both national and local levels. The national conferences have reinvigorated teachers' local work and have connected them to new cross-site tasks. For example, a group of teachers is working with Carne Barnett of WestEd, Oakland, CA, to write teaching case studies for use in Algebra Project professional development. The added value of the national (and southern regional) teacher networks is an important and unanswered evaluation question.

Providing a Network-wide Vision of Effective Teaching

The opportunity of the OSI funding enabled the trainer program to take on an intensive development effort—to develop the "Model of Excellence of Algebra Project Teaching and Training." The new model provides an explicit vision for professional development that was developed with extensive input from project members. It is more closely tailored to the project than the model previously used for trainer certification. Since it consists of explicit statements and a performance assessment system, it has the potential to shape professional development strongly. Its influence will depend on how it will be implemented,

which was not known at the time of this report. (In the past, these competencies were applied to the training of trainers, but not teachers.)

We believe that the development of the Model of Excellence should continue to involve mathematicians, math educators and experienced Algebra Project teachers who can insure that it contains useful standards and criteria for mathematics teaching. Algebra Project teachers' task of integrating the *Transition Curriculum* with local curriculum and using the "five step process" throughout their teaching requires a much deeper understanding of mathematics than elementary teachers usually acquire in their training.

Revising the Introductory Teacher Training

Regional and national meetings were held to review the latest version of the *Transition Curriculum* and to re-design the introductory training for teachers. These meetings have engaged teachers, trainers and mathematics specialists in identifying the mathematics in the materials, and in developing network-wide standards for the introductory teacher training. Sites have also experimented with new schedules for the training which are better suited to teachers' availability.

One dilemma that trainers are addressing is how much of the *Transition Curriculum* should be covered in the workshop in order for teachers to grasp the key mathematics concepts. Teachers often become productively engaged in debating concepts and their representations, and trainers are caught in a "depth versus breadth" dilemma. Currently there is no network-wide resolution to this issue.

Potential to Improve Teaching

With the recent funding, teachers and trainers have revised the introductory workshop, developed new workshops, and developed a Model of Excellence for Algebra Project Teaching and Training. Since these materials are relatively new and just being put in place, we did not attempt to systematically assess their impact on teachers' beliefs and practices at this time. There are three kinds of evidence, however, of potential for impact:

(a) Comparison with nationally recognized professional development practices: The program components of Algebra Project professional development work have been compared with two documents that have identified national standards for professional development in mathematics and science education, based on a synthesis of various national efforts: Loucks-Horsley,

Stiles & Hewson (1996). Principles of effective professional development for mathematics and science education: A synthesis of standards. National Institute for Science Education; and Loucks-Horsley et al., (1998); and Ideas that work: Mathematics professional development. Eisenhower National Clearinghouse for Mathematics and Science Education.

The first document identifies seven characteristics of effective professional development activities, and Algebra Project efforts can be found that express all of these characteristics. The second document outlines fifteen strategies for professional development, and the Algebra Project is found to practice eleven of these: immersion in solving mathematical problems; learning to use a set of instructional materials; implementing units of instruction; creating new instructional materials; case discussions; study groups; coaching and mentoring; professional networks; workshops/seminars; using technology to learn content and pedagogy; and developing professional developers. The Algebra Project has an unusually wide array of practices, since many teacher enhancement projects use only one or two of these. The practices and components of Algebra Project professional development clearly fall within the scope of practices that have been identified nationally as effective approaches.

(b) Participants' opinions of the current program are generally high. Teachers and trainers have reported high opinions of various parts of the program in interviews and questionnaire surveys conducted by PERG/Lesley College, as well as by internal evaluators and program leaders.

(c) In the older sites, a core-group of committed Algebra Project teachers has emerged. Many teachers who have committed themselves to the project in Mississippi are among those we met in 1993-94 while doing the previous NSF evaluation work. Many of these teachers were originally trained in very traditional practices and their adoption of the Algebra Project is a major shift in teaching practice. Many of them now testify to the value of the project for their teaching, including some who originally doubted its methods. Many have stuck with the project despite weak support from school systems and lack of stipends. Many of these individuals are taking leadership roles in their districts and in the Algebra Project network.

LESSONS LEARNED BY THE PROJECT AND NEXT STEPS

The influx of funding in 1997 enabled the project to expand rapidly, to intensify professional development activities, and to try out new youth initiatives. By trying out initiatives, sites and programs have reflected on lessons learned and have revised some strategies. For example, the Algebra Project Board held a planning retreat in April 1998. The Board decided to stretch out the expenditure of remaining $4 million OSI funds, and to focus in the future on depth and quality of implementation, rather than growth. Similarly, some sites found that rapid expansion into more schools could outstrip capacity to support teachers, and that certain kinds of school system support are essential. The Cambridge, MA, and New York City Algebra Projects, for example, have decided to limit implementation to schools that show certain commitments. The project is planning to discuss with NSF the nature of these shifts in strategy.

LESSONS LEARNED FOR EVALUATION AND NEXT STEPS

Although work by Lesley College evaluators this year was focused on the NSF's request for documentation of professional development, and on developing a framework for evaluating student outcomes, the Algebra Project now has a critical need for student outcome data that can demonstrate its achievements to potential funders. Evaluators are therefore proposing to prepare several site case studies of student achievement that will document student outcomes and how they are related to project components. These studies will track the progress of Algebra Project students into algebra and college preparatory courses, and will examine the project components in the site and how they are assisting students' progress. Data on non-Algebra Project students will be collected as appropriate. We believe the project staff at the Training of Trainers program, the Southern Initiative of the Algebra Project, and the Mathematics Community Collaborative can supply NSF with additional documentation around professional development and community development that may interest the NSF.