The Algebra Project: Overview of Research & Evaluation 1991-2015

Background

The Algebra Project's founder and participants have worked in classrooms for two decades to develop classroom teaching methods, teacher professional development, and community development that will enable students to succeed in a typical Algebra I course in late middle school or early high school. While the project initially focused on supporting the transition in students' thinking from arithmetic to beginning algebra, it now includes high school materials developed in collaboration with a cadre of university mathematicians. These materials are designed to enable students who may enter high school performing in the lowest quartile to graduate from high school on time and succeed in credit-bearing college mathematics courses. Meantime, the youth initiative started by Algebra Project graduates and peers, the Young People's Project, has received NSF grants to develop college and high school "mathematics literacy workers" who lead out-of-school sessions for younger students upon invitation from community based organizations.

In the 80s and 90s, the project worked in over 350 classrooms in schools of predominantly African American students. Since 2000, the project has been invited to work in sites with large Latino/a populations with varying heritage (e.g. Yuma, AZ; Boston, Chicago, Los Angeles), with Asian students with varying backgrounds (San Francisco), Haitian-Americans (Miami), and rural Appalachia (Eldorado, IL), and the diverse other ethnicities present in urban districts today. The Young People's Project works with students from diverse backgrounds from elementary school through college.

The Algebra Project's high school initiative began when founder Robert Moses followed a group of successful project graduates from Brinkley Middle School, Jackson, MS, into their local high school, Lanier. At this historically low performing high school, Moses' team saw the critical need for new approaches to algebra and geometry. Work with several university mathematicians resulted in NSF grants in 2002 and 2006 in several sites to develop experientially-based instructional materials to serve students not being reached by existing approaches.

Currently the project is completing a test of these materials within a "cohort model" that keeps high school students together for all four years, with daily instruction in extended periods, and also returning to the middle grades. Nine high school teachers in four new sites participated, and cohorts have just graduated. Some early results are reported below, and detailed impact on sites, teachers and students will be reported in late Spring 2014.

Sample Results *(chronologically)*

• Seven cohorts of graduates (1991-1997) of the founding middle school in Cambridge, MA, were tracked into high school. Graduates entered Geometry in Grade 9 at roughly twice the rate of nonAlgebra Project peers (44% vs. 17% in 1992, and 92% vs. 47% in 1996) and the program was effective for African American students in particular (70% vs. 56%). Students also did well in Grades 10-12, with more than 60% passing Trigonometry by Grade 11. (At the time, 45% of students citywide qualified for free or reduced-cost lunch.)

• In 1992, the Cambridge, MA, Public Schools **mandated that all Grade 8 students be offered Algebra I**, largely as a result of the organizing efforts of the Algebra Project there.

• In 1994, **a national panel of experts** evaluated the Algebra Project in Mississippi, and concluded:

> The quality of life in AP classrooms is high in terms of the overall nature of instruction, and in teachers' and students' commitment and engagement. AP classes are fine examples of active and participatory classes where students' experiences are central to instruction…. The AP is having a major influence on teachers' beliefs about mathematics and how it should be taught. Students' verbal articulation around mathematical ideas, and the positive engagement in the project overall, are impressive….

• In 1994, **teachers in the Mississippi Delta** noted: (1) teachers and students begin to express themselves -- the project develops a "comfort zone" for this expression; (2) teachers are drawn into the project when they see students expressing themselves; (3) teachers learn and accept the facilitator's role because summer trainings, workshops, and community meetings provide continual modeling and practice; (4) "we can continue this hard work because we are not alone".

• Beginning in 1993, under the leadership of the principal and several Algebra Project teachers, **a middle school in San Francisco serving Latino/a, African American and Asian students reformed its math program so that all 8th graders take Algebra I.** This practice continues today, even though the Algebra Project teachers have now retired. The school's graduates were tracked and found taking (and passing) higher math courses in Grades 9 and 10 at about twice the rate of graduates of demographically similar middle schools. On the state Academic Performance Index, **the school has performed above the median for the 100 most demographically similar schools since the index began** in 1999, and rose from 628 in 2002 to 725 for 2006 (scale from 200-1000, with target of 800). The lead Algebra Project teacher, who became Assistant Principal in 2003, has now been assigned to "turn around" another underperforming middle school. (Note: Between 1990 and 2006, FRE increased from 50% to 70%, and percentage of English language learners increased from 10% to 25%, and Special Ed from 15-20%.)

• The Algebra Project developed **a competency-based program for Algebra Project teachers** to learn to facilitate the professional development of other teachers, and to lead groups in their schools, communities, or national-level Algebra Project activities.

Candidates attended intensive workshops, served as apprentices to experienced project leaders, and were assessed on research-based observational measures. By 2001, a "model of excellence" was developed, and over 50 teachers and several university faculty were certified.

•In 1994, Weldon, North Carolina, was the lowest performing district in the state. Algebra Project organizers began holding community-wide discussions. Some teachers and the principal became involved, and middle school students attended a summer leadership academy. The students began organizing themselves and their community. In 1998-99, 22 of the 58 Weldon 8th graders determined to take Algebra I as well as their regular Grade 8 Mathematics, even though there was no Algebra teacher. Principal Lydia Harding Elder, and Algebra Project Trainers Laura Smith (from NCCU) and Freddie David (a high school teacher from Bennettsville, SC) volunteered to teach Algebra I after school and every other Saturday. Result: **82% scored "proficient" or above on the state Algebra test. Scores for regular Grade 8 Mathematics also rose sharply, from 48% proficient in 1998 to 74% in 1999.** As a result of students' and parents' advocacy, a new middle school was constructed, a community center created, and a place for tutoring. In Fall 2003, 15 of the students were located: 12 were enrolled in colleges (many won scholarships), 2 were in the armed services, and 1 had no current plans. One of them, Ernest Brooks Jr., has graduated from Morehouse College, is in graduate school and serving on the Algebra Project Board.

• From 1997 to 2001, under an NSF grant for work in Cambridge, MA, Brooklyn, NY; Plainfield, NJ, and several areas of the south, the Algebra Project attracted **over 700 teachers into professional development institutes and workshops. 31% participated more than the 100 hours expected, and 17% participated from 150-400 hours**, because they volunteered to attend additional workshops, to lead workshops for other teachers, or to organize and lead supplementary sessions for students. This participation profile compared favorably with teachers a similar NSF project serving eastern Massachusetts.

•At St. Helena Elementary School near Beaufort, SC, where nearly all students are African American and qualify for free or reduced-cost lunch, under the leadership of the principal and several Algebra Project teachers, Grade 5 state math **test scores rose from 20 percentile points below state average in 1999 to 25 points above in 2004. 80% of 5th graders performed at or above proficiency,** higher than nearby, affluent Hilton Head.

•Lanier High School in Jackson, MS, is the Algebra Project's first high school for R&D. All students are African American and 85% qualify for free or reduced cost lunch. In 2003, 56% of 9th grade students of Algebra Project teachers passed the state Algebra I test on the first attempt, compared with 38% of nonAlgebra Project students (ns=106, 87). (Students were placed by counselors according to scheduling needs.) All Algebra Project students who failed the test continued into Grade 10 math and passed the test later. By Grade 12, 33% were still at Lanier taking college-prep math, compared to 7% of the nonAlgebra Project students.

• Two recent micro-ethnographic studies of the classrooms of master Algebra Project teachers found that students are positioned effectively to become math learners, that mathematics is conveyed as a transparent rather than opaque subject, and that teaching incorporates four important epistemologies of learning.

• Lanier High School in Jackson, MS, was the site of the project's first experiment with a cohort model for math instruction. Moses' team worked with a cohort of students for all four years of high school in daily double periods. These students outperformed the nonAlgebra Project students at the same high school on many indicators. For example, **69% of the students who remained in the project for two years graduated in four years, compared with 27% who participated for one year or not at all.** This high school was historically the lowest performing of eight high schools in Jackson (a low performing district in a low performing state). In two other low performing high schools piloting the new Grade 9-10 instructional modules (Petersburg, VA; San Francisco), **Algebra Project students outperformed their nonparticipating peers on the end of course Algebra I test, especially on the functions strand** (West, 2010).

• In a study of students' mathematical thinking in three high schools, **Algebra Project students showed understanding and problem solving abilities for basic function concepts on a level that compared favorably with incoming college students**, and even pre-service teachers (Dubinsky and Wilson, 2013).

• In 2014, the Policy Evaluation & Research Group of the Education Testing Service produced a **Logic Model and Theory of Action for the Algebra Project's High School Cohort Model,** under a supplement to the NSF award work described below.

• Under NSF/DRL award 0822175 (2008-2014), the Algebra Project studied a cohort model designed to "harness the peer culture" and accelerate mathematics learning for students who enter high school performing in the lowest quartile on the math portion of state tests.

At six high schools, cohorts of ~20 students took math together with the same teacher for Grades 9-12. They used rigorous materials designed by mathematicians and teachers to engage low performing students through a unique pedagogy, and enable them to graduate on time ready to take college math courses for credit. The project's classroom materials are designed to engage students who have experienced academic failure, who enter Grade 9 with conceptual foundations different from those of average- to high-performing students. Its materials and pedagogy build cognitive *and* noncognitive skills together.

Research included (a) preliminary studies at Edison High School, "little Haiti", Miami; and (b) a multi-site study of cohorts implemented "from scratch" in five demographically different high schools in Ypsilanti, MI; Mansfield OH; Eldorado, rural Illinois; and Los Angeles. Nearly all students performed BELOW "proficient" in math on the Grade 8 state test.

Results

Graduation: In 4 of 5 schools in the multi-site study, Cohort students had 4-year graduation rates (federal formula) above 70% (from 71-80%). In 3, their graduation rates were 11-32% higher than the non-project students, matched for race, gender, math proficiency and language status. At the 4th school, rates were similar (~75%). But this Cohort comprised the lowest performing students in a class of 97, so they appear to have "caught up" with their peers. At the 5th school, graduation rates were similar and low: 43% (Algebra Project) versus 41%. But here the Cohort kept changing -- only 7 students were present for 3-4 years. Five graduated, approximating the <70% rates of the other Cohorts.

Growth in Mathematics Proficiency: (a) Concept of Function: Mathematicians Ed Dubinsky (FIU) and Robin Wilson (CSU/Pomona) studied Algebra Project Cohort students' development of the function concept at three schools. Cohort students acquired the concept at a level similar to college students, and even as well as some teachers in training (Dubinsky & Wilson, 2013). (b) Proficiency on State Tests in Ohio: At Mansfield High, the Algebra Project and nonAlgebra Project students entered Grade 9 averaging the same math proficiency: in both groups only 17% were ≤ "proficient". Cohort student's proficiency rose from 17% in Grade 8 to 82% in Grade 10, and averaged 30.2 points (± 2) compared with only 19.3 (± 2) points for *all* noncohort students, and 20.6 (± 2) points for a noncohort sample matched on race, gender and Gr 8 top score.

Development of Student Attitudes: Student progress was *best* in the 3 sites where most Cohort students also participated in the afterschool program of the Young People's Project (YPP). In YPP they were mentored by College Math Literacy Workers to design, conduct, and debrief after school workshops 1-2x/week for Grade 4-7 students in the community. YPP assisted students to gain positive attitudes toward mathematics and mathematics achievement.

Broader Impact of Research under NSF/DRL

The Algebra Project's broad goal is to demonstrate to the nation how students in low income communities can achieve in mathematics to the level needed today for citizenship and family-supporting jobs. This project had an impact both locally and nationally, and in universities as well as schools. For example, a model materials development site was created at FL Hamer Freedom High School in Bronx, NY, where internationally-known Cornell Geometer David Henderson collaborated with two teachers to implement an innovative sequence in algebra-geometry. Mathematician colleagues at both Ohio State U/Mansfield and Southern Illinois Univ. are starting STEM institutes. At U. Michigan SOE, Mark Thames implemented an NSF study of the explicit and implicit teaching strategies used by Bob Moses, teaching low performing rising 9th graders in a lab setting for 2 weeks each of 3 summers. Educators and mathematicians attended from around the country. The Algebra Project collaborated with the Educational Testing Service to host national meetings to discuss project research and expansion, attended by researchers and

national leaders (Math for America, 100k STEM Teachers in 10 Years; NACME, Children's Defense Fund), as well as teachers, administrators and community activists. Math for America Fellows interned in a Cohort classroom in Los Angeles, and videos of teaching there were beamed to hundreds of students in other countries as part of Univ. of Southern California's digital teacher education course. At OSU/Mansfield, Algebra Project national teacher development specialists co-taught a teacher preparation course with OSU faculty. The district also asked them to conduct teacher professional development district-wide K-6 for 2010-13.

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Selected Research & Evaluation Reports 1995-2015

(middle school and high school implementations)

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Note on Evaluation Design:

The Algebra Project offers materials, professional development and community development support to sites, but implementation is designed by site members and differs significantly from site to site. Therefore evaluations need to document the implementation and consider the impact on teachers, students and sites in the context of community support and implementation features.

Measures of implementation:

1. *interest and participation of site members in designing and implementing;*
2. *development of a local board to guide project implementation;*
3. *requests for professional development services for teachers;*
4. *change in teachers' beliefs about students, mathematics, and educational outcomes;*
5. *change in teaching practices;*
6. *adoption and spread of Algebra Project pedagogy within a school;*
7. *use of Algebra Project instructional materials in the classroom;*
8. *increasing integration of the Algebra Project with other classroom materials;*

Measures of impact on students:

9. *increased interest of students in algebra, math, and learning in general;*
10. *increased enrollment (and passing rates) in higher level mathematics courses in high school;*
11. *student performance on math tests (Algebra Project classroom tests, state mandated tests, college admission tests, college math placement tests)*
12. *students' deep understanding of mathematics concepts as indicated by in-depth performance assessments and interviews on mathematics problems.*