Help for the Mathematics Learning Slump

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Abstract
As the achievement gap between different ethnic and economic groups continues to grow in both mathematics and science, new approaches to the problem must be investigated. Two groups of New York City (NYC) high school students attended summer school to remedy past failures on statewide examinations, some of which are required for high school graduation. One group attended a "traditional" session administered by the NYC Board of Education while a significantly smaller group attended a program designed by the staff of the Mathematics and Science Partnership (MSPinNYC), a City University of New York project located at Hunter College and funded by the National Science Foundation. The passing rates of those students enrolled in the MSPinNYC program are significantly higher than those enrolled in the traditional summer school program. This paper presents a brief description of the program and its students, as well as a look at the factor the authors think made the biggest difference, the presence of similar-age tutors. The audience is invited to engage in conversations about implications of this program for attacking the learning gap and areas of further research and evaluation.

Introduction
The crisis in mathematics learning among minority and economically deprived students that rose to the surface more than three decades ago continues virtually unabated today, particularly when viewed from the perspective of more advance mathematics and science. While members of the mathematics establishment quarrel and quibble about what constitutes the most important content for various age groups to master, and amidst public and popular media outcries about the importance of learning the same mathematics "they used to learn and learning it the way it used to be taught", test scores for African American and Hispanic students have begun to fall after a brief period of improvement.[i] The interest here is in investigating a practical strategy, the use of peer tutors in classrooms as well as in more informal settings, which might have the possibility of producing dramatic student improvement in real time for real students who are facing bleak, often hopeless futures.

The contention is that the involvement of peer tutors helped to bring about dramatically improved learning for high school students in grades nine through twelve who had previously failed statewide mathematics, biology, and/or chemistry tests (New York State Regents Examinations). For mathematics the stakes are particularly high since students are required to pass the first of the two mathematics tests as part of high school graduation requirements.

The surround: the MSPinNYC
The student tutors are part of the Mathematics and Science Partnership in New York City (MSPinNYC), a National Science Foundation funded project housed at Hunter College, a senior college in the City University of New York (CUNY) system. The tutor program

was inspired by and built upon two previously funded projects, Fellows for the Advancement of Mathematics Education (FAME), offered in the late 1980s and early 1990s at Long Island University in Brooklyn, New York and ASCEND, offered by the Fresno Unified Schools in California in the early 2000s. The MSPinNYC is a collaboration between CUNY campuses, the NYC Department of Education, and School Regions and high schools within NYC. It is, at once, a summer learning camp for high school students, a professional development school for high school and college teachers, a recruitment ground for future teachers, a particular way of confronting policy and practice in large urban centers, and a research laboratory for all its participants. It involves two major components: a micro that is focused on teaching and learning, and a macro, focused on research, policy, and scale-up, institutionalization and sustainability.

The project is experimental, and results in many groups working together to ensure success for all its students. Discovering what works, why it works, and for whom and in which environments particular approaches work best provoke the projects' actions and decisions. The experiments involve:

Employing indirect methods of addressing "all students"--efficacy issues.
Eliciting student voices within the instructional arena.
Partnering college and secondary school teachers.
Doing professional development in the process of teaching.
Learning mathematics and science content informally.
Doing research on practice, and altering practice in real time based on research through the development of a CUNY-wide research network.
Developing policy directly from practice supported by data and evidence as well as creating practice from policy.

Students before and after

The approximately 130 high school students who were part of the MSPinNYC in 2006 came from 11 high schools to study Math A (primarily elementary algebra) or Math B (primarily intermediate algebra, trigonometry and some probability and statistics), or chemistry, or living environment. Forty-six percent of the students were female, and 54% male, 46% African American, 45% Hispanic, 8% Asian, and less that 1% White or Native American. Their families spoke 15 different languages. The students had already failed the particular regents examination at least once, and many of the Math A students took up to five semesters to attempt passing what is traditionally a two-semester course.

Students were identified by teachers and guidance counselors in schools with whom the MSPinNYC had already developed partnerships, and teachers from those schools constituted a significant percentage of the summer staff. For the first two years of the program, CUNY college mathematics and science faculty have also been part of the teaching team. The student group who arrived on campus at the start of summer, 2006 lacked confidence and hope, displayed few study skills and showed little interest in the subject matter they were there to study. Their attention spans were extremely limited,

and their willingness to stay with problems was virtually non-existent. For example, the first time students attempted the practice regents exam, most gave up after 45 minutes. The fifth and last time students took the regents that summer, most spent over two hours working on it.

These same students, five weeks later, were confident and more able learners who willingly worked their way through problems they had not been successful with weeks earlier. Their scores were significantly higher when retaking the Regents examination than the scores of those who had attended the traditional NYC summer high school program offered to failing students. The results from the 2006 MSPinNYC program as compared with the traditional NYC program are shown below:

Math A: Fifty-seven percent of those enrolled in the NYC summer school program passed as compared with 88% enrolled in MSPinNYC. When the passing score was raised by 10 points, 27% of NYC summer school students passed as compared with 57% for MSPinNYC.
Math B: NYC showed a 31% pass rate as compared with MSPinNYC's 59%.
Living Environment (biology): NYC had a 59% pass rate as compared with 100% for MSP. Raising the bar by 10 points resulted in a 36% rate for NYC as compared with 91% for MSPinNYC students.
Chemistry: NYC showed a 27% pass rate as compared with 70% for MSPinNYC.

What made the difference?
The MSP summer program is uniquely designed to emphasize total immersion in one subject area. The students spend four days a week, six hours a day, for five weeks in an articulated program that includes classes, laboratories/workshops, tutoring, and weekly practice regents exams. Results from and analysis of the exams are employed for the purposes of formative assessment and as benchmarks to help measure student progress.

This program is admittedly very different in terms of physical sites, class time, staff, student-teacher ratios, and campus facilities from NYC's traditional summer school and academic year courses. The educated hunch, formative evaluations, and informal discussions point to involvement of tutors, use of practice regents examinations, and development of positive student and teacher beliefs as the program's most critical factors. The 2007 summer will provide a test for this theory as the project brings each of the three elements to traditional-type summer sessions offered at MSPinNYC high schools. For now we can only conjecture and invite mathematicians and scientists, mathematics and science educators, teachers and administrators, and evaluators and researchers to conjecture with us.

Who were the tutors, what were their roles, how were they prepared?
Of 123 tutors who completed pre-institute surveys, 54% were high school students and 46% were college students, the majority of whom were mathematics majors. All high school tutors had previously passed the regents they would be involved with and many

had taken more advanced high school mathematics courses. Females outnumbered males, 57 to 43 percent. Ethnically, 23% were African American, 23% Hispanic, 24% Asian, 15% White, and 15% other.[ii] The tutors were a decidedly more diverse group in terms of ethnicity than the teachers, a condition which appeared to enhance their ability to help the tutees succeed.

Each tutor was responsible for approximately two students during the five week period, albeit not each tutor worked every day. Tutors attended all student classes and laboratories/workshops, and tutored within the classroom setting as well as during specifically assigned tutoring periods. They maintained journals in which they noted and analyzed examples of student learning problems and successes, and met regularly with high school teachers to discuss their particular insights in regard to both teaching and learning and to raise questions about problematic content. In addition to a one day training session prior to the start of classes, weekly sessions for the continuing education of the tutors were conducted by MSPinNYC staff to address important aspects of teaching and tutoring that include content, pedagogy, language skills, and psychological and social factors. The passage that follows, written by an undergraduate tutor, illustrates the sensitivity and intelligence with which many tutors approached tutoring and reflected upon their work.

> Today's tutoring session went well. I felt like Dyana was cooperating fully and gave 100% in tutoring as opposed to today's class session. She told me herself that she was feeling more comfortable with the addition and subtraction of fractions now but still needed to use the number line which came to be a little difficult when dealing with big numbers. She was also able to get subtraction of negative numbers by the end of the tutoring session. She interacted and communicated well and was able to gather her ideas and explain her answers verbally but still had trouble when it came time to write them down. 'I don't know what to write,' would be her response even though her response verbally was correct. Overall, I felt like she wants to learn and understand the material but just has problems expressing them on paper. I liked that 15 minutes into the session she got comfortable enough with me to start communicating and expressing her thoughts aloud.

Tutors entered the program with very high expectations that they would be able to explain difficult material and confirmed those expectations for themselves during the course of the summer. A higher percentage of tutors (92%) indicated that they enjoyed the students they tutored at the end of the program than at the start (84%). However, at the start of the program more tutors (96%) believed they would learn content than they did at the end of the program (87%). Similarly, a higher percentage of tutors entered the program believing they would learn useful skills for the future (97.8%) as compared with the program's end (93.8%).

High school and college tutors appeared to struggle with keeping their students focused on the work and motivated and confident, especially early in the program. A number of them reflected upon the struggle to find the most effective ways to teach particular concepts. Individual comments indicate both the diversity of opinion among tutors and reveal individual learnings as well. Examples taken from tutor journals provide a "flavor" of their experiences as well as an indication of what was learned during the summer experience.

Tutor Comments

I have learned more of the (math.) concepts that I didn't quite recognize when I was in high school.
The constant repetition of material was like reinforcement for me (…) and information I was foggy about (in high school) became more clear.
Perhaps the greatest lesson I have learned was patience and how to guide the students to the answer rather than just giving it to them.
I learned the importance of incorporating hands-on activities.
I also learned how to use different teaching techniques with different students. (high school tutor--HST)
I learned to approach students in different ways so they can learn.
I've learned how to look at math problems in many different ways and ways that I have not heard of before.
I learned how hard it is to be a teacher. Teaching is not as easy as it looks. (HST)
I have learned how to communicate and how to work better with people.
…with the right support a student is willing to do whatever it takes to succeed. (HST)
All these students are capable of getting above 90 in their regents.
The best part of being a tutor was the interaction between my students and me, the way we worked together to accomplish teacher assignments.

Implications and research questions

Those involved in the MSPinNYC have developed new insights into and learned an enormous amount about how to help students who have previously failed. They believe that a good deal of what was learned can be transferred to schools and help ensure that in the future far fewer students will require summer school in order to pass regents exams. Some of the more significant and useful "findings":

Develop an environment of belief in the ability of all students to learn and all teachers to improve their crafts is indispensable---and can be developed.
Understanding that believing--and succeeding--are contagious!
The availability of benchmarks and indications of progressive improvement are as important for teachers as they are for evaluators and government agencies.
Tutoring, especially by those of ages similar to tutees, is extremely beneficial in terms of developing self-efficacy and confidence, learning content, and enhancing communication skills.

Role models are important, in terms of understanding culture and habits, as proof of success, and reason for hope.

Although more is almost always better in terms of knowing and experience, tutors can be educated for the job in relatively short periods of time.

A focus on examinations does not have to be bereft of developing conceptual thinking and mathematical skills.

Limiting the number of subjects studied simultaneously appears to increase chances for success.

Further research is required to determine more precisely: (1) just what is "happening" between tutor and tutee, (2) what it is most important for tutors to know and be able to do, (3) those environments in which, and subjects for which, tutoring works best, (4) the importance of similar ethnicity in a tutoring situation, (5) the appropriate role and training of teachers for work with tutors, (6) areas in which tutors themselves most benefit from tutoring, (7) tutor recruitment as a tool for attracting perspective teachers, (8) appropriate course sequences and course loads for high school students, (9) ways in which the tutor component of MSPinNYC might became part of teacher preparation programs, and (10) how best to address institutionalization and scale up.

[i] Based upon 2005 NAEP results for mathematics, percentages *of 12th graders scoring at or above proficient in terms of ethnicity are:* 29% of White students, 6% of African American students, 8% of Hispanic students, 36 percent of Asian/Pacific Islander students, and 6% of American Indian/Alaskan native. (Ordering reflects the size of each group.)

[ii] The 1.1 million NYC school children are 34.7% African American, 14.3% Asian, 36.7% Hispanic, and 14.2% White.