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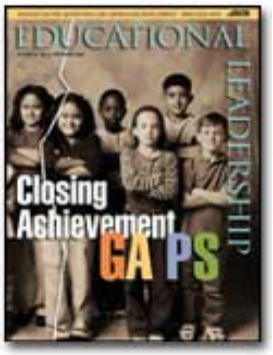

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Why Do Students Drop Advanced Mathematics?

A look at two high schoolers shows that high expectations and teacher collaboration encourage students to persist through a challenging curriculum.

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Concerns about the achievement gap have led to cries for change in high school mathematics. In an effort to increase the number of students who take advanced math classes, policymakers have urged raising graduation requirements, eliminating remedial courses, and implementing high-stakes assessments. As a result, schools feel pressured to support *all* students' success in the college preparatory math curriculum. Yet historically high attrition from mathematics—especially among black, Latino, and Native American youth and students of low socioeconomic status—exacerbates this challenge. How can schools stem the flow of math dropouts and encourage students to persevere through a challenging math curriculum?

High attrition from mathematics is frequently attributed to either the individual characteristics of students or the low expectations of teachers. Many teachers believe that such personal characteristics as innate math ability or drive to succeed determine who persists in advanced math classes and who drops out (Horn, in press; Ruthven, 1987). Although this explanation has some validity, it places the onus of achievement solely on the student, leaving no role for adult intervention.

The “teacher expectation effect” has been well documented in education research (Weinstein, 2002). In the United States, we place a lot of faith in the power of teachers' expectations, from President Bush's indictment of “the soft bigotry of low expectations” to Hollywood's teacher heroes who buck the system by expecting more of students whom others have written off. It is part of our folklore of teaching.

Yet high expectations without the teaching tools to back them up only lead to disappointment.

Expectations do not simply reside in math teachers' heads and hearts; they come to life in the experiences students have in mathematics classrooms—and in their cumulative math-related experiences in school. Imagine, for example, a math-hating student who feels motivated and successful working with a caring, “high expectations” teacher. What happens to that student's

motivation once the student moves on to a new teacher? Can “math turnarounds” stay turned around?

What “Turnarounds” Can Teach Us

As part of a Stanford University research study, I have been looking at “turn-around” students in two California high school math departments (Boaler, n.d.). I am currently following two groups of students who entered their first college preparatory math class seemingly unprepared because of prior low achievement or low test scores in math, yet who managed to succeed in these classes. I have found that high expectations, strong classroom practice, and intensive collaboration among math teachers in the high school play a key role in supporting these students' long-term success.

The students I am tracking attend either Greendale High School,[1] a suburban school with mostly white, middle-class students, or Railside High School, which is urban and has an ethnically diverse student body. During the last four years, I have used classroom observation, student and teacher interviews, assessments, and other kinds of measurements to follow approximately 400 students as they progress through their school's math curriculum. The two students I describe here are representative of the math turnarounds at each school. Closely examining the experiences of these girls—one of whom persisted in college preparatory mathematics despite obstacles and one of whom returned to remedial math—sheds light on conditions that help students persist in advanced math.

A Tale of Two Turnarounds

Gabrielle, a white, middle-class student, attended Greendale High and took Integrated Mathematics—her first college preparatory math class—in her sophomore year, taught by Ms. Nelson. As a freshman, Gabrielle had taken a remedial math course in which, she claimed, “we didn't do any real math.”

Railside High freshman Tamika came to Ms. Larimer's algebra class with low scores on a prior test of math achievement. Tamika, a middle-class African American, remembers that “in 7th grade, I was, like ‘Aw, I hate math! I'm never taking this class!’”

Both Gabrielle and Tamika succeeded in their first year of college preparatory math, turning around their achievement in the subject. That success was connected to their teachers' high expectations and demanding classroom practices.

Ms. Nelson, a National Board-certified teacher who had won a national teaching award, taught her students through complex problems that combined algebra and geometry. She emphasized student thinking. Students had to explain their answers, were praised for asking questions, and were gently but firmly admonished when they did not push themselves. Ms. Nelson adjusted her teaching to support student understanding, yet pressed for rigor.

Ms. Larimer at Railside had similar high expectations. An answer was not an end point in her class: Students had to justify their reasoning by explaining *why* their answers made sense. As in Ms. Nelson's class, students debated and deliberated mathematical ideas and made presentations to their peers.

Both teachers used instructional methods advocated by the National Council of Teachers of Mathematics (2000), emphasizing mathematical thinking and problem solving. Both sustained a mathematically demanding environment while reaching students with weak mathematical preparation.

Gabrielle earned a *B* in Ms. Nelson's class and became optimistic about her ability to succeed in challenging math classes. She planned to take the next two courses in the college preparatory sequence. Tamika, who had started out "hating math," also earned a *B*. She described the satisfaction she felt as she learned to work difficult math problems with Ms. Larimer: "It makes you feel like you're smart, like you're good at it."

Year Two: A Steeper Climb

To qualify for college, a goal both girls aspired to, Gabrielle and Tamika each needed to succeed in the next college preparatory math course they took. As I followed their progress through the next school year, I witnessed the challenges both girls faced.

Gabrielle

In her second college prep math course, Gabrielle found herself uncomfortable being a junior in a class filled with freshmen and sophomores. She reported her reluctance to ask questions in class, not wanting to look "dumb." Gabrielle's teacher for this class, Ms. Gillett, was committed to student learning and had received the same training that Ms. Nelson had in the school's innovative math curriculum. But subtle differences in Ms. Gillett's teaching practices hindered Gabrielle's progress.

In a class early on in the academic year, for example, Gabrielle tried presenting a partial solution to a problem, along with questions about the content. Instead of exploring her questions, as Ms. Nelson would have done, Ms. Gillett moved the lesson forward when another student offered the correct answer. Subsequently, Gabrielle's participation and forthrightness with questions diminished. Gabrielle and some of her classmates reported feeling that Ms. Gillett taught "to the smart kids."

Gabrielle did not have a good rapport with Ms. Gillett. It didn't help that Ms. Gillett contacted Gabrielle's mother about her daughter's "inappropriate clothing" without talking to Gabrielle first. Gabrielle eventually stopped doing her homework and ultimately earned a *D* in the course. To finish her math requirements, she retreated to the remedial track for her senior year.

Tamika

Tamika also encountered obstacles in her progress through the advanced math curriculum. As she noted,

> My freshman year, I loved algebra. It was so easy. It was one of my favorite classes. I was like, "Yes! I can't believe I'm doing this good in math!" And then I got to geometry, and I was like, "Ahhh!"

In Railside's geometry classes, as in its algebra classes, students worked in groups and were asked to explain their thinking—but two important differences caught Tamika off guard. First, the curriculum moved at a faster pace. Ms. Larimer's algebra classes met 90 minutes daily for two semesters, but Tamika's geometry class met 90 minutes daily for only *one* semester, requiring the teacher to cover material more quickly. Second, students were expected to be more responsible for their learning in the geometry class. In the algebra classes, teachers kept students inside during lunch or after school to complete any unfinished homework, whereas Railside's geometry teachers did not take such strong measures. Tamika explained,

> Geometry was one of those classes that was like, if you don't get it, come get help. That was when I was lazy. I didn't want to come get help.

After receiving a *B*- for the first half of geometry, Tamika ended the course with a *D,* earning credit but not a promotion to the next math class. She retook the second half of the class and had varying test scores and homework grades. During Tamika's struggle through geometry, her teachers (Ms. Watson and Ms. Murphy) regularly discussed the best way to support her, frequently planning together and observing in each other's classrooms. Her geometry teachers also communicated with Tamika's parents and Ms. Larimer about her. Ms. Watson and Ms. Murphy both held high expectations of their students and were committed to helping each student achieve excellence.

Despite a more concerted effort on her part, however, Tamika did poorly on a major test at the end, again earning a *D*. After Tamika's two inconsistent performances, her geometry teachers evaluated her work and decided to allow her to attempt advanced algebra, the next class in the curriculum. She earned a *B* in the first semester and a *C* in the second semester of advanced algebra. In her senior year, Tamika earned a *B*+ in precalculus, a course that exceeds college entry requirements.

What Helped Tamika Persist?

Why did Tamika stay turned around as a math student whereas Gabrielle eventually gave up? The girls started with similar aptitudes and attitudes toward math, and both worked with teachers who had high expectations. I believe that four factors—three of which point beyond classroom practice to aspects of the way each school's math department was organized—supported Tamika's success.

High expectations built into the curriculum. Greendale separates its students into a college preparatory and a non-college preparatory track, whereas Railside places all students into a college preparatory track. In a sense, high expectations are built into Railside's mathematics curriculum: *All* students must succeed in advanced classes. Unlike Gabrielle, Tamika had no remedial track to fall back on when she encountered challenges.

Scheduling that facilitates a second chance. Greendale's block scheduling meant that classes met for double periods every other day, year-round. In contrast, Railside uses a block schedule that requires most classes to meet for 90 minutes a day for half of the academic year. This schedule enables Railside students to take more courses per year. If they encounter failure, as Tamika did, they can quickly retake a course without getting off their grade level. Gabrielle did

not have this option.

Teacher collaboration. Greendale's Ms. Nelson described herself as a "lone wolf," teaching with inconsistent support from her departmental colleagues. If Ms. Gillett and Ms. Nelson had had opportunities to discuss in depth their observations of students and their teaching methods, perhaps Gabrielle would not have felt so unwelcome in Ms. Gillett's class. In contrast, math teachers at Railside prided themselves on working collectively to teach rigorous mathematics. The teachers observed one another's classes and met weekly to plan lessons, design assessments, and consult about classroom challenges. They remained aware of one another's expectations for students, which minimized jolting variations as students moved from teacher to teacher.

Awareness of status issues. Gabrielle felt stigmatized in Ms. Gillett's college preparatory math class as an off-grade-level student who was not seen as one of "the smart kids." Ms. Gillett did not address Gabrielle's insecurity. Railside math teachers, on the other hand, worked consciously to change students' sense of mathematical incompetence to one of competence. Teachers often contacted parents to tell them of students' positive performances; Ms. Larimer did so with Tamika in the year she taught her. These teachers adopted the use of *Complex Instruction* (Cohen & Lotan, 1997), an approach that deliberately addresses differences in academic status. They often "assigned competence," or publicly acknowledged the intellectual contributions of low-status students, as demonstrated in this exchange:

> *Mr. R.:* I heard several people say that it equals negative *y*.
>
> *Donna:* No, because *y*'s not a number.
>
> *Mr. R.:* Very good. Did you all hear what Donna said?

This strategy helps students reimagine not only their own but also their peers' potential.

I consider the teachers' improvement-oriented collaboration at Railside to be the most important factor leading to Tamika's success—and one that all math teachers should strive to emulate in their own schools. Some teachers relish the independence they feel once classroom doors are closed. But if we are to stop struggling students from dropping out of advanced math classes when the path becomes steep, teachers must coordinate their expectations, their knowledge of students, and—to some extent—their teaching practices. Just as it takes a whole village to raise a child, it takes a whole mathematics department to raise the achievement of students like Gabrielle and Tamika.

Endnote

[1] All names of schools and individuals are pseudonyms.

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