

# Middle School: Getting on the Road to Challenging Mathematics and Science Courses

"Mathematics is the language of science, and algebra is the minimum vocabulary that scientists of every discipline use to describe their work."

--Dr. George Castro, Associate Dean of the College of Science at San Jose State University

## Laying the Foundation

*Algebra is the "gateway" to rigorous mathematics courses.*

Rigorous mathematics courses build upon the skills and concepts that students learn in earlier mathematics courses. Traditionally, students cannot take a rigorous mathematics course in high school until they have successfully completed one or more prerequisite courses. Algebra I, or another course that covers basic algebraic concepts, is the prerequisite for more rigorous mathematics in high school.

*Students who plan to take advanced mathematics and science courses during high school and begin to study algebra during middle school are at a clear advantage.* A rigorous sequence of mathematics spans several years. The traditional sequence of mathematics courses involves one year courses in algebra I, geometry, and algebra II, followed by a half-year course in trigonometry, a full- or half-year course in pre-calculus, and then calculus or an Advanced Placement course. Increasingly, schools are covering these rigorous content areas in courses that integrate algebra, geometry and other areas of mathematics such as statistics and probability, rather than teaching each separately. According to NELS, approximately 60 percent of the students who took calculus in high school had taken algebra in the 8th grade. The typical high school sequence of rigorous science courses (biology, chemistry, and physics) also necessitates an early background in algebra and geometry.

*Students who do not take courses covering algebraic concepts early in their educational career risk closing the door on many important opportunities, including opportunities to take courses outside of mathematics and science.* Some high schools require students to complete a specific package of courses, including mathematics and science, in order to graduate. By the junior and senior years, students who have not planned ahead have fewer options in choosing which courses they take. Students who do not complete prerequisite and required courses early enough not only risk being unable to take more rigorous courses in those disciplines later, but also may not have time in their schedules to take other courses that can help prepare them for college or a career, including foreign language, art, Advanced Placement, and "tech prep" courses.

## Course-Taking Patterns in Middle School

*Despite recent increases in the proportion of students taking algebra I in the 8th grade, in 1996, most students were not enrolled in this course.* The proportion of 8th-graders taking the National Assessment of Educational Progress (NAEP) mathematics assessment who reported taking algebra has increased. In 1992, only 20 percent of students reported taking algebra. In 1996, the next year the NAEP mathematics assessment was administered, 25 percent reported taking algebra. This increase may be due to a number of factors, including the National Council of Teachers of Mathematics' (NCTM) call for including algebraic topics in the middle school curriculum.

*Minority and low-income students continue to be less likely to take challenging mathematics courses in middle school than other students.* The 1996 NAEP data reveal that minority students are less likely to report being enrolled in algebra in the 8th-grade. The data also indicate that students from disadvantaged backgrounds are less likely to be enrolled in algebra during the 8th grade: While 29 percent of students who were not eligible for the national school lunch program reported being enrolled in algebra during the 8th grade, only 15 percent of students who were eligible for the national school lunch program were enrolled in algebra.

*While the number of students taking algebra courses has increased, recent evidence suggests that the content of these courses has remained rigorous.* Many states have recently increased mathematics requirements for

high school graduation, often requiring that students take more years of mathematics than were required in the past, or mandating that students complete certain courses. A recent study supported by the National Science Foundation (NSF) examined the content of mathematics courses in schools in several of the states making the most substantial changes in mathematics requirements. The study focused on basic courses, such as algebra I, which had experienced large enrollment increases because of more stringent graduation requirements. Despite the larger numbers of students enrolling in the courses, the study found that the content of these courses was essentially unchanged, indicating that more students were, in fact, being exposed to rigorous mathematics.

## **Parent and Student Attitudes about Mathematics and Science**

***Large proportions of middle school students indicate that they do not plan to take mathematics and science courses beyond what their schools require.*** A nationally representative survey of public school students and parents conducted by Louis Harris Associates for the National Action Council for Minorities in Engineering (NACME), Inc.<sup>(3)</sup> found that large proportions of students would like to **stop** taking mathematics and science courses as soon as they can. Fifty-one percent of the 5th through 11th grade students surveyed indicated that they would take mathematics classes only as long as required, while 47 percent reported they would study science only as long as it is required. Distressingly, young minority students--5th through 8th graders who will soon be facing major decisions about which courses to take--were more likely to indicate that they planned to drop mathematics and science as soon as they were able to (61 percent planned to drop mathematics, and 58 percent planned to drop science). Minority students of all ages were more likely than other students to say that they would like to stop taking mathematics and science as soon as they could.

***However, the same students indicate that they would be interested in going to college, and taking college-level mathematics courses.*** Eighty-six percent of all students surveyed said that they would like to go to college. Although less than half of the 9th- to 11th-grade students said that they planned to take trigonometry or algebra II in high school, nearly two-thirds said that they were interested in taking Advanced Placement courses. These contrasts signal that many students do not understand the importance of, and requirements for, taking rigorous mathematics and science courses in high school, including the need to take algebra by the 8th grade. In fact, only 25 percent of minority and 42 percent of non-minority 5th- through 8th-grade students recognized that if they did not take algebra they would not be able to take other mathematics classes in the future.

***Parent and teacher involvement may make a large difference in students' decisions about mathematics and science.*** According to the NACME survey, ninety-four percent of students indicated that their parents' or guardians' advice was important to them in deciding what they would study in school, and 88 percent indicated their teachers' advice was important. Ninety-one percent of parents want their children to continue their education beyond high school. However, when 9th- through eleventh-graders were asked who decided which mathematics classes they would take, 79 percent indicated that they had made the decision by themselves.

***Analysis of the NELS data indicates that students with greater levels of parental involvement are more likely to take advanced mathematics courses.*** Analysis of the course-taking patterns of the NELS students who were in 8th-grade in 1988 reveals that regardless of whether the level of parent involvement was reported by the student, the parent, or the teacher, higher levels of parental involvement were consistently associated with higher likelihoods of taking rigorous mathematics courses. While only 8 percent of those students who said that they did not discuss programs at school with their parents took algebra I by the 8th grade, 17 percent of those who said that they discussed school programs three or more times during the previous semester took algebra I by the 8th grade. Students whose parents or teachers indicated greater levels of parental involvement were also more likely to take advanced courses. Thirty-seven percent of students whose parents said that they rarely talked to their child about high school plans took geometry by the 10th grade, while 48 percent of those students whose parents said they regularly spoke to the child about high school plans took geometry by the 10th grade. While 27 percent of students whose teachers said their parents were not involved took geometry by the 10th grade, a full 63 percent of the students whose teachers said that their parents were very involved took geometry by the 10th grade.