

**Achievement of Minority and English Language Learners in K-12 Math and Science**

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Report to the University of California Office of the President (March 2003)

Abstract

This article is a brief literature review of the research on academic achievement of minority and English Language Learners (ELL), especially Hispanics, in mathematics and science, particularly in middle and high school. This paper reviews statistical data about the performance of minority students in mathematics and science, including some exemplary efforts, programs, and projects successfully implemented in order to curb adverse student outcomes. A discussion about social status, equity, family support, and access to quality education is presented. These elements are considered as the primary factors influencing the performance of minority and ELL children in schools.

In April of 1983, the National Commission on Excellence in Education, which was created almost three years before by the U.S. Secretary of Education, began its *A Nation At Risk* report with the following introduction: "*All, regardless of race or class or economic status, are entitled to a fair chance and to the tools for developing their individual powers of mind and spirit to the utmost. This promise means that all children by virtue of their own efforts, competently guided, can hope to attain the mature and informed judgement needed to secure gainful employment, and to manage their own lives, thereby serving not only their own interests but also the progress of society itself.*" (p. 1). Today, twenty years later, an imaginary commission created for the same purpose would start with the very same statement and surely would propose the very same recommendations. Despite an overall modest increase in student achievement, large discrepancies still persist among minority and ELL students in comparison to White students especially in math and science.

The NAEP 1996 Mathematics Report Card for the Nation and the States found that White students recorded increases in their average mathematics scale scores for three grades--fourth, eighth, and twelfth--over the period 1990 to 1996. Although Hispanic students in the same grades also increased their average mathematics scale scores, the gap between Whites and Hispanics did not change during the same period of time. The National Education Longitudinal Study of 1988 (Second Follow-Up for 1994) found that at the end of the 12th grade Blacks are about 3-4 years of achievement growth behind Whites, and Hispanics are about 2-3 years behind Whites. This achievement growth discrepancy can be traced backwards to kindergarten. One important outcome of this longitudinal study established that "...the high school years do not contribute significantly to race/ethnicity differences in reading and mathematics achievement. Despite differences in the high schools attended by Black, Hispanic, and White students, the 12th-grade reading and mathematics achievement differences between these groups reflect differences in how much they knew when they entered high school, and not on their race or ethnicity per se."

(p.48). This conclusion tells us about the accumulative effect that discriminatory education plays during the first years of schooling.

*The Condition of Education 1995* reported the percentage of high school graduates taking remedial mathematics as follows: from 1982 to 1992 the percentage of White students taking remedial mathematics dropped from 27% to 14%. During the same period the percentage of Hispanics dropped from 48% to 24%. As can be seen, the gap between Whites and Hispanics remained unchanged.

ELL Hispanics, as the fastest growing ethnic group in the United States, populate the most disadvantaged central and metropolitan cities, and consequently they attend the most economically deprived public schools of the country. The USDE report (*The Condition of Education 1995*) also stated that while suburban schools maintained the percentage of Hispanic students around 4% from 1973 to 1993, in inner city schools this percentage increased from 10% in 1973 to 18% in 1983, and to 22% in 1993. Since those figures are average values, in some specific schools the percentage of Hispanic students is up to 100%.

The poor achievement and attainment of ELL Hispanic students start as early as preschool. Their greater likelihood of living in poverty limits the children's educational opportunities in two different ways. First, parents spend most of the time working out of home, and the companion adults when present (whether older relatives or parents) generally don't have the basic knowledge to help children with homework. According to data provided by the U.S. National Center for Education Statistics (1988), the percentage of eighth-grade students whose parents' highest level of education reach an associate or higher degree was 41% for Asians and 11% for Hispanics. Second, enrollment of children in private preschool, which could be an alternative to get quality education, is expensive for minority families. In spite of federal programs such as Head Start and others for disadvantaged preschoolers, fewer Hispanic children are enrolled in preschool than White children are. For example, *The Condition of Education 1995* reports that the enrollment rate for 3- to 4-year-olds in preschool increased from 18% in 1973 to

almost 40% in 1993 for White children, while for Hispanics the rate fluctuated around 15% during the same period of time.

This trend of lower achievement in Hispanic children that starts as early as preschool continues in subsequent years. In 1996 The National Assessment of Educational Progress (NAEP) measured the scores (*Indicators 13, 15, and 16*) for Hispanic 9-year-olds. Although these scores have increased in mathematics and science over the past 15 to 20 years, there has been no substantial change in the gap between Whites and Hispanics for that age group over the same period of time. This study established that at age 13 the average Hispanic children's level of mathematics skills might be as much as 2 years behind that of their White peers. This gap persists in high school too. At age 17, the score indicators showed gap levels comparable to 13-year-olds between Whites and Hispanics.

Another negative factor in the attainment of ELL Hispanic students is the rate of dropout from high school before graduating. Although the percentage of 10<sup>th</sup> to 12<sup>th</sup>-grade dropout rate among Hispanics was lower in 1992 (12%) than it was a decade earlier (19%), many educators consider this rate still unacceptable high. In contrast, for Whites the rate of dropout in 1992 was 5% for the same school grades. Among Hispanics there are subpopulations performing quite differently. For example, *The Condition of Education (1995)* study reported that in 1989 the average dropout rate for all 16- to 24-year-old Hispanics was 31% in total. However, a comparison between the Hispanic subgroups showed that Mexican-Americans accounted for 36%, Puerto Ricans for 32%, Cubans for 9% and "other Hispanics" for 19% from the grand total. Moreover, *The Center for Education Reform and Empower America Report* (Forgione, 1998) found that in relation to recent Hispanic immigrants "The dropout rate for Hispanic immigrants aged 16- to 24-years-old was 44 percent, compared to the dropout rate for first-generation Hispanics born in the United States, which was 17 percent." (p. 18).

In a related study, *The National Educational Longitudinal Study* (NELS) found in 1994 that the reason Hispanics and Whites reported for leaving school were more often connected to

schools than to job or family factors. NELS results are an indicator that the learning environment in schools plays a major role in the achievement and attainment of children especially for minority ELL students. Research and common sense also indicate that unsafe and untidy schools usually contribute to low students' performance and achievement. NELS (1994) also reported that 15% of Hispanics do not feel safe in schools in contrast to 9% of Whites. Hispanics were almost 3 times as likely as Whites to report concerns about the presence of gangs in schools. However, there were no difference when they agreed that "discipline is fair," "teaching is good," and "teachers are interested in students" in their respective schools.

Parental involvement also influences the performance of ELL Hispanics in schools. There is a generalized impression among US teachers that parents of Hispanic students tend to "leave to the professionals" the duty of education. This is a cultural behavior valid in other latitudes where schools also assume the responsibility of day care agencies, and parents are not often prepared to help their children with homework especially in higher grades. Research has shown (*Condition of Education, 1995*) that 8<sup>th</sup>-grade Hispanics were less likely than their Whites peers to talk with their parents about school activities, class studies, selecting courses, and homework. In a related behavior, this study also concluded that Hispanic parents were less likely to make voluntary visits to the school to inquire about the academic performance of their child or to offer themselves as volunteers at the school.

Course taking patterns, educational aspirations, future college enrollment rates, and college field of study is also different between Hispanics and Whites. Schiel, et al. (1996), using PLAN (ACT's 10th grade assessment) scores and ACT assessment scores in 1,174 high schools, found a relationship between students course taking patterns and their achievement. These scholars showed that in a typical high school, students with higher ACT scores have also taken upper-level mathematics and science courses. Schiel and colleagues found that their results are independent of students' gender, family income, and ethnic group. The authors of the study also concluded that the differential percentage of enrollment between Hispanics and Whites in upper-

level courses is remarkable due to the fact that Whites triplicate ELL enrollment. In 1992, according to *The Condition of Education 1995*, the percentage of Hispanics taking remedial mathematics was 24% compared to 14% of Whites. In the same year, this study reported that 10% of White students took calculus, against 4% of Hispanics. According to Schiel et al. (1996), appropriate counseling that focuses on getting more Hispanics into high-level high school courses is needed in order to improve their academic preparation. Leitman, R. et al (1995), using a nationally representative sample of 2,500 public school students, performed a survey of children and parents about mathematics and science. These authors found that only one third of the students who decided to take upper-level math courses said their math teachers or their parents participated in their decision. Among the students enrolled in advanced math courses, only 30% of Hispanics mentioned that teachers encouraged them to do so, compared to 60% of Whites.

In order to reverse the adverse data presented above, several exemplary efforts have been implemented successfully. From general programs like Head Start and Title I at the governmental level to individual teachers like Jaime Escalante in Los Angeles, all of these efforts have made an impact on the life of many minorities ELL children. *The Hope for Urban Education Report* (1999) provides examples of how federal resources combined with sound strategies of teachers and administrators can support comprehensive school improvement efforts. This report is a study of nine high-performing, high-poverty, urban elementary schools. Despite the differences among the nine schools, the authors found some remarkable similarities in their strategies to improve academic achievement. Such similarities can be enumerated as follows:

1. Schools defined a visible and attainable first goal, which should be completed before moving toward more ambitious goals;
2. School administrators requested the collaboration of teachers, staff, and parents to spend quality time among them looking for improvements and putting aside personal differences;

3. Schools addressed discipline problems, encouraging students to assume responsibility for their own behavior;
4. Schools nurtured a collective sense of responsibility for school improvements in all school members;
5. Schools permanently encourage teachers and students for high expectations;
6. School curriculum was aligned to the standards of the state and school districts;
7. Teachers received all the resources they requested for their teaching practice; and
8. Schools allocated additional time for instruction.

The authors considered that all eight strategies were instrumental in the success of the nine schools.

Among the individual efforts to improve minority ELL achievement, one example is worth to mention. Jaime Escalante was a teacher who chronicled his efforts to raise standards at predominantly Hispanic Garfield High School in East Los Angeles. He reached his goal by training his students to take the Advanced Placement (AP) Calculus test. Traditionally, expectations had been very low for Garfield students, but Escalante changed that trend. By 1987, Garfield was ranked fourth in the country in the number of students passing the AP Calculus test. After Escalante's success, the National Science Foundation (NSF) funded a project headed by the Los Angeles County Office of Education (Madrid, G. 1997) with the specific purpose of learning "whether or not the program could be replicated elsewhere." A team of teachers and administrators was selected to work in two high schools and three middle schools in Los Angeles, for a period of three years. The team, led by Mr. Escalante, prepared an instructional guide based on Escalante's successful teaching and motivating practice. This successful practice can be summarized into three main categories:

1. The teacher's personal characteristics: e.g., "is often funny or humorous," "captures and holds my attention."

2. Mathematical skill development: e.g., "calls attention to diagrams," "gives me a lot of math problems to do."
3. Cognitive restructuring including high teacher expectations: e.g., "has helped me see that education is important," "expect me to achieve and do well in math."

The program objectives are summarized in the following three areas:

1. Restructuring of the curriculum at the junior and senior high schools.
2. Improving students' performance especially in mathematics.
3. Replicating the program elsewhere.

The program was very intensive in terms of content and time, and it included the following nine component parts:

1. Summer programs;
2. Saturday school;
3. Afternoon tutoring;
4. Peer tutoring;
5. Parental involvement;
6. In-service professional development;
7. Curricular development;
8. Inter-school cooperation; and
9. Corporate partnerships.

The standardized test results in all five schools improved dramatically. In two of them the number of students that passed the achievement on advanced placement tests were above 80%.

Although the results were extraordinary, this kind of effort was also extraordinary. Garfield programs and alike are very difficult to implement, if not impossible, in a regular school setting without the additional personnel and economic resources that they demand, not to mention the great additional effort for part of the students.

In February, 1997, the National Council of Teachers of Mathematics (NCTM) created the Task Force on Mathematics Teaching and Learning in Poor Communities with a two-fold purpose: First, to investigate "what is known and not known" about mathematics teaching and learning in schools and districts serving poor communities; and second, to write a report to be presented in an invitational working conference. On June 7-10, 1998, about two-dozen of exemplary cases were presented in the working conference. This conference was organized around three major themes: a) student learning of mathematics; b) mathematics teachers and teaching; and c) school, district, and community context. Many of the conclusions and recommendations of the conference coincided with those already mentioned in this paper. However, the authors stressed some conclusions that are valuable to mention. They insisted on the necessity of retaining well-qualified teachers; making efforts to eliminate classroom disruptions; improving security in campus; more depth and clarity in curriculum; appropriate instructional materials; competitive salaries for teachers; more time for planning; class size reduction; multicultural sensitivity; appropriate assessment; consistent district support; and community involvement. All of these were considered as preconditions to improve students' achievement in poor schools.

In relation to mathematics learning, Beane (1988) suggested other influential factors that teachers should consider in order to improve the chance of success when working with disadvantaged students. These factors, some positive and some negative, might affect students' performance and sometimes intervention by the teachers is needed. Beane divided those factors into three main categories:

### **1. - Students Affective Factors**

#### Attitudes

Minority ELL students have positive attitudes toward mathematics and science in the early ages.

#### Persistence

Those students who are most successful in mathematics and science have developed the ability to persist

#### Stereotyping

Many teachers as well as many minority students, tend to stereotype mathematics and science as White male domains.

#### Utility

Minority ELL students are less likely to understand how the study of mathematics and science is applicable to everyday life.

#### Influence of Significant Others

Teachers, counselors, parents, and peers have a role in shaping students' attitudes toward mathematics and science.

### **2. - Student Cognitive Factors**

#### Previous Experience

Minority ELL students tend to perform best when the content is related to their previous experiences.

#### Academic Deficiencies

Achievement test performance by minority ELL students indicates growing competency in basic skills, but weakness in understanding and application of concepts.

#### Language

ELL students are handicapped in English-speaking mathematics and science classrooms and on achievement tests.

#### Misuse of Testing and Test Data

The use of standardized test data to predict achievement and to assess abilities is detrimental to minority students.

#### Learning Styles

Instructional strategies frequently do not complement the learning styles of many minority ELL students.

### **3. - Classroom Factors**

#### Teacher Expectations

Educators often perceive minorities as having inferior ability. This perception translates into an expectation of low achievement, which is communicated to and internalized by the minority child.

#### Teacher Anxiety: Mathematics

Teachers who do not have positive attitude about mathematics are likely to provide inadequate instruction.

These three groups of factors address important elements recognized in many studies as instrumental in helping minority ELL students. In her study, Beane (1988) suggested appropriate interventions in all aspects mentioned above in order to ameliorate the negative factors, especially when students are very young.

Clewell et al. (1988), studying 163 successful intervention programs in mathematics and science serving minority and female students, concluded that the intervention activities that developed confidence in mathematics performance and achievement were those interventions undertaken before the sixth grade. Clewell and colleagues found that successful programs also included activities involving role models, guest speakers, and counseling. The authors of *The Quality Education for Minorities Project* (1990) went even further in relation to the interventions at earlier age. They established, as the first goal of the project, the following ways of action: a) to increase access to quality pre- and post-natal health care; b) to increase participation in child nutrition programs; c) to ensure that every pre-schooler has access to quality day care and early childhood education; and d) to enable all parents to better assume their roles as first teachers of their children.

Another important element in the achievement and attainment of minority ELL students is parental support. Smith and Hausafus (1998) studied the relationship of the mother's support and participation to the score on standardized tests of eighth grade minority children in mathematics and science. Using a sample of 80 mothers and their children, the authors of the study found that parental involvement, parental style, and parental expectation as well as family environment was correlated with higher scores in standardized tests.

Finally, there is no achievement of minority ELL students without qualified teachers. The federally funded Dwight D. Eisenhower Professional Development Program and the State Higher Education Executive Officers, addressing the problem of minority students' underrepresentation in mathematics and science, have funded many successful programs in almost all states of the union. Many teacher credential programs across the nation now include preparation with emphasis in cross-cultural and bilingual studies. Austin & Fraser-Abder (1995) designed a pre-service teacher preparation program focused on the mentoring of beginning teachers working with populations of minority students. In this program, experienced teachers of mathematics and science served as mentors who played a crucial role in preparing pre-service teachers to instruct ELL minority students.

The achievement and attainment of minority students, especially Hispanics, has been studied from many angles and perspectives during the last two decades. This paper constitutes a short literature review and a starting point only. Under the title "Information Alert 44" in the references section of this paper, there is a selected collection of ERIC articles about programs in mathematics for urban and minority students, which could serve as further readings.

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References

Austin, T., Fraser-Abder, P. (1995). Mentoring Mathematics and Science Preservice Teachers for Urban Bilingual Classrooms. Education and Urban Society, 28(1), 67-89.

Beane, DeAnna B. (1988). *Mathematics and Science: Critical Filters for the Future of Minority Students*. Washington, DC. (ERIC Document Reproduction Service No. ED338758)

Clewell, B., Taylor, B., and Thorpe, M. (1992). The Prevalence and Nature of Mathematics, Science, and Computer Science Intervention Programs Serving Minority and Female Students in Grades Four through Eight. Equity and Excellence, 25(2), 209-15.

*Condition of Education* (1995, August). Progress in the achievement and attainment of Hispanic Students. Retrieved February 18, 2000 from the World Wide Web:

[http://www.ed.gov/pubs/CondOfEd\\_95/ovw2.html](http://www.ed.gov/pubs/CondOfEd_95/ovw2.html)

Forgione, P. D. (1998). Achievement in the United States: Progress since a Nation at Risk? Washington, DC: U.S. Department of Education, Center for Education Reform and Empower America.

*Hope for Urban Education: A Study of Nine High-Performing, High-Poverty, Urban Elementary Schools* (1999). The University of Texas at Austin. Washington, DC: U.S. Department of Education.

Information Alert 44. *Programs in Mathematics for Urban and Minority Students*. ERIC Clearinghouse on Urban Education. Retrieved February 29, 2000 from the World Wide Web:

<http://eric-web.tc.columbia.edu/alerts/ia44.html>

Ingels, S.J., Dowd, K. L., Baldridge, J.D., Stipe, J.L., Bartot, V.H., Frankel, M. R., Owings, J., & Quinn, P. (1994). *National Education Longitudinal Study of 1988*. Second Follow-Up: Student Component Data File User's Manual. Washington: DC: U.S. Department of Education, Office of Educational Research and Improvement, National Center for Education Statistics.

Leitman, R. et al (1995) Uninformed Decisions: A Survey of Children and Parents about Math and Science. NACME Research Letter, 5(1).

Madrid, G., Powers, P., Galvin, K., Kester, D., Santos, W., Yamarone, S. (1997). *Jaime Escalante Mathematics and Science Program, Final Project Report*. National Science Foundation. Los Angeles: CA. (ERIC Document Reproduction Service No. ED424311)

National Assessment of Educational Progress (NAEP) (1996). *NAEP 1996 Mathematics Report Card for the Nation and the States*. Washington, DC: U.S. Department of Education. Retrieved February 29, 2000 from the World Wide Web:  
<http://nces.ed.gov/nationsreportcard/96report/97488.shtml>

National Council of Teachers of Mathematics (1998). *Task Force on Mathematics Teaching and Learning in Poor Communities*. Retrieved February 29, 2000 from the World Wide Web: <http://www.nctm.org/committees/rac/TFPC/overview.htm>

National Commission on Excellence in Education (1983). *A Nation At Risk*. Washington, DC: U.S. Department of Education. Retrieved February 28, 2000 from the World Wide Web:  
<http://www.ed.gov/pubs/NatAtRisk/risk.html>

Quality Education for Minority Project (1990). *Education That Works: An Action Plan for the Education of Minorities. Report Summary*. Cambridge: MA. (ERIC Document Reproduction Service No. ED316627)

Schiel, J., et al (1996). *Factors Associated with Longitudinal Educational Achievement, as Measured by PLAN and ACT Assessment Scores*. ACT Research Report Series. Iowa: IA. (ERIC Document Reproduction Service No. ED403298)

Smith, F. M., Hausafus, C. O. (1998). Relationship of Family Support and Ethnic Minority Students' Achievement in Science and Mathematics. Science Education, 82(1), 111-25.

State Higher Education Executive Officer (1997, February). Increasing the success of minority students in mathematics and science through teacher professional development. Teacher

Success. Retrieved February 18, 2000 from the World Wide Web:

<http://www.sheeo.org/teacher/tsfeb97.htm>