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ABSTRACT

A number of recent studies have yielded data on the factors affecting the science achievement of disadvantaged students. For example, it was found that students' socioeconomic status (SES) increased as a predictor of their science achievement as the students moved through school. Furthermore, the effect of being Black (or, to a lesser degree, Hispanic) was similar to the effect of SES. Black students were shown in one study to perform best on science exercises most dependent on daily experience and common knowledge, and poorest on those that involve a detached research attitude toward the object and phenomena of science. Other studies found that poor and minority students are most affected by classroom factors such as too little time spent on science instruction and too much time spent on discipline, that Black students' science career plans are generally less related to their abilities than are Whites' plans, and that minority interest in science apparently does not lead to choosing the appropriate high school subjects for entering a science major in college. The research suggests a complex pool of attitudes and motivations that indirectly affect minority science preparation and the choice of a science career. These include attitudes and aspirations, stereotyping, role models, general academic success, cultural values, and parental influence and support. Research also suggests that the school counselor for whom ethnicity or sex make no difference can play a most important role in increasing enrollment of the disadvantaged in nonrequired science and mathematics courses.
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INCREASING SCIENCE ACHIEVEMENT FOR
DISADVANTAGED STUDENTS

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Increasing Science Achievement for Disadvantaged Students*

The reform commission reports of the 1980's have focused national concern on the teaching and learning of science. Achievement in science is seen as stagnant or declining; shortages of qualified teachers, low enrollments, inadequate budgets, outdated texts and teaching materials, and a decline in science emphasis have all been cited as possible causes.

A comparison of results from the National Assessment of Educational Progress in 1981-82 with those from 1977 yields a slight decline in science scores among 17-year-olds, and no significant change among 9- and 13-year-olds. Mathematics performance, which is important among other reasons as a predictor of science achievement, declined for the two groups of older students and remained about the same for 9-year-olds (14).

On the other hand, in contrast to the general trend, the science and mathematics scores of all age groups in the lowest quartile by achievement went up between 1977 and 1981-82. This may be because the science and mathematics curricula are better for low-achievers than for moderate or high achieving students. Perhaps the emphasis on basic skills during the 1970s may not have enabled the high achievers to acquire and use the higher order cognitive skills, such as problem-solving, analyzing, and synthesizing. Performance increases among the lowest student quartile may also be the positive result of special federal programs aimed at disadvantaged students.

Race, Class, and Science Achievement

Although the National Assessment scores of black students are generally lower than those of white students, they present a similar picture: declines for top students and gains for students at the lower end in both science and mathematics (6).

Analyzing the 1977 National Assessment by problem difficulties shows that "black students performed best on those science exercises most dependent on daily experience and common knowledge and poorest on those that involve a detached research attitude toward the object and phenomena of science" (13, p.16). In mathematics, the most difficult problems for black students were those that are theoretical and for which there is no experiential base.

According to a meta-analysis of 305 studies of student characteristics and K-12 science achievement conducted between 1960 and 1981 (4), students' socio-economic status (as measured by father's income, income of school district, average income of area where students live, or a combination thereof) increased as a predictor of their science achievement as the students moved through school. The effect of being black on science achievement was similar to the effect of SES: about 20% smaller in the elementary grades than at the higher grade levels. Unfortunately, SES levels were not controlled for in the analysis by race. Being Hispanic was also related to lower science achievement, though the effect was not so pronounced.

Classroom Factors Affecting Science Achievement

From the early school years on, poor and minority students tend to have less classroom exposure to science and mathematics (2). Black 17-year-olds average only a year of high school mathematics instruction, compared with two years for the majority of the nation's 17-year-olds (1). In addition, the vagueries of ability groupings (often based on insensitive or biased tests) may result in low personal standards

*The generic term "disadvantaged" is used here to refer to students who generally receive fewer opportunities for science instruction and science achievement because of race, poverty, and/or poor academic performance. It should be noted, however, that there are a number of science education programs aimed at "gifted disadvantaged." These programs are not separately discussed within this digest.

for achievement, in psychological scars associated with de facto segregation, and in less, rather than more, opportunity for disadvantaged students to acquire higher order mathematics and verbal skills.

Discipline and behavior problems, which have a variety of sources and are common among disadvantaged students, may also interfere with teachers' perceptions of science achievement, and consequently with the kind of instruction offered and the possibility of future placement (11).

Minority Preparation and Science Career Choice

According to Berryman (2), by contrast with white students, black students' science career plans are generally less related to their abilities. In a small study of black, inner city eighth graders, Jacobowitz (7) found that a preference for a science career was unrelated to science achievement, though it was related to having a "science self-concept." Black boys in the study were more likely than black girls to have a preference for scientific careers and to have a "science self-concept," even though their science achievement test scores did not differ significantly from girls'. Fleming and Malone (4) note that black elementary students begin by being less interested in science than whites, but the difference dissipates by middle school, and blacks actually have more favorable attitudes toward science than white students by high school.

However, minority interest in science apparently does not lead to choosing the appropriate high school subjects for entering a science major in college. Marrett (10) found that black female science majors at Wayne State University had taken less math than all other science majors, including black males. They had even taken less math than white males who weren't science majors. According to Erlick and Lebold (3, p.35), "Minorities who have considered science are less likely to have taken or plan to take the high school mathematics and science courses or to have a home science hobby than the majority of white students."

The research points to a complex pool of attitudes and motivations which indirectly affect minority science preparation and the choice of a science career (2, 13, 16):

- *Attitudes and Aspirations* toward schooling in general carry over into science. Students who enter and do well in science subjects generally have high all-around academic motivation and aspirations.
- *Stereotyping* can make students believe a particular skill or area is inappropriate or lead them to fear the teachers or professionals in a particular field.
- *Role models* help students with—and the lack of them hinder students from—identifying with potential success in an area. The most powerful role is a parent, relative or friend of the same sex working in the preferred profession.
- *General Academic Success*, which is consistently lower among blacks and other minorities than among whites, affects initiative in choosing science courses as well as achieving in them. In addition, as general academic success increases, expectations of college and post college go up.
- *Cultural Values*, such as a reluctance to control nature, or an ethic against competition, may easily hinder science achievement, given the way the subject is currently taught.
- *Parental Influence and Support*, including parents' own college attendance, affects both science and mathematics achievement and the choice of a science major in college. (In fact, being a second generation college student tends to equalize the choice of a science or mathematics major among white, black, American Indian, Chicano and Puerto Rican students.)

Counseling and Minority Enrollment in Nonrequired Science and Mathematics Courses

Nearly ten years ago, an analysis of counseling practices showed that both black and white secondary school counselors tended to steer black students away from science related areas (15). A more recent study (5) indicates that special efforts and programs of the counseling staff are a significant factor in increasing black female enrollment in nonrequired science and mathematics courses. According to this study, while the age, sex or ethnicity of the counselor made no difference, black female enrollment in more advanced mathematics and science courses was increased by:

The structural autonomy of the counselor to institute programs for special students, including developing procedures for reporting student progress to parents; establishing criteria for students taking nonrequired mathematics and science courses; and creating student conduct rules; and

Special efforts by the counselor to encourage black females to enroll in nonrequired mathematics and science courses.

The number of college credits a counselor had taken in counseling minority students also approached significance in its effect on black female mathematics and science enrollment—although 71% of the counselors had taken 0-3 credits. There is also some evidence that in-service programs for K-12 teachers, counselors and administrators that focus on methods and materials to attract minorities in science may improve student attitudes toward studying and interest in learning about science occupations (8).

"Science for All Students"

In its commission report, *Educating Americans for the 21st Century*, the National Science Foundation (12) recommended that all K-6 students receive 60 minutes of mathematics and 30 minutes of science instruction daily. All 7th and 8th graders should take a year each of mathematics and science. At the secondary level, all students should receive three years of mathematics, three years of science and technology, and a semester of computer science. The NSF isolates four sources of science achievement for all students:

- early hands-on experience
- disciplined and rigorous study
- substantial time on task and homework at all levels
- strong motivation and commitment by students, teachers, administrators and parents

Strategies to Increase Science Participation Among Disadvantaged Students

Strategies to increase the participation of disadvantaged students in science must both increase the total number of mathematics/science students before and during high school and decrease the attrition of black and other minority students from mathematics and science in public school as well as in higher education. Toward this end, an effort must be made to:

- help minority students toward early college tracking;
- insist on pre-collegiate training, especially in mathematics and science;
- acquaint disadvantaged students with the science careers available and the preparation needed for them (2).

A number of specific features have also been identified in elementary and secondary science programs successful with minorities and other disadvantaged students (9, 13):

- immediate student involvement "doing" science in a laboratory in order to convey its utility
- early recognition of deficiencies, careful groupings, and curriculum planning to create early success
- clear, well defined goals
- sensitivity to student differences in selecting cues, processing information and analyzing data
- sensitivity to student differences in reactions to criticism and praise

When special programs for minorities and other disadvantaged students are institutionalized, continual monitoring must be conducted to ensure that all elements are maintained.

— Carol Ascher

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Availability of Documents Cited

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