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The Development of Scientific Careers among Black and White Students: A Longitudinal Study

Willard B. Bowe Jr.
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THE DEVELOPMENT OF SCIENTIFIC CAREERS AMONG BLACK AND WHITE STUDENTS: A LONGITUDINAL STUDY

by

Willard B. Bowe, Jr.

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Master of Arts

Western Michigan University
Kalamazoo, Michigan
April 1977
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Willard B. Bowe, Jr.
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CHAPTER I

INTRODUCTION

Statement of the Problem

A relatively small proportion of black Americans become scientists. There are, of course, several reasons why black students have not tended to enter the natural, physical, or social sciences. Historically, a pattern of discrimination occurred in the formal training and hiring of blacks. However, black scientists who are well prepared today experience less overt discrimination than before; perhaps this is due to a need for more scientists along with the fact that--for political and social reasons--it is more difficult for various segments of the society to discriminate against minorities in today's society.

In addition, black students are no longer restricted by school policy from selecting subjects leading to careers in science. Given these changes, however, there is still only a small proportion of black students, as will be documented later, who are selecting science training in high school. In other words, while many of the overt racial discriminations of the past have ended, the outcomes today--as far as entering the science fields are concerned--are still much the same as when the more obvious racial discriminations occurred.
Perhaps this is due to certain residual conditions which are left over from prior racial discrimination and are equally effective in keeping many black people out of scientific careers.

There are, as this study assumes, residuals of prior ideologies which supported earlier discrimination patterns, which shape not only white Americans' responses toward blacks, but also black Americans' responses toward blacks. It is further reasoned that these responses have the unintended effect of keeping a disproportionately high number of black students from studying science when given a choice.

The conjecture at this point is that even if overt discrimination was drastically reduced, we would still have the residual consequences of discrimination remaining in the ideologies of black parents which have the same consequences, that is, fewer blacks than whites entering careers in science. Black children, like all children, come into the world and become the recipients of their parents' values and ideologies, over which they have little control.

Research Objectives

Thus, the general objective of this study is to determine if the sparsity of black adult scientists today is, as hypothesized, due to parental influences during adolescence, a period thought to be crucial in the development of careers in science.
One possible reason for there being few black scientists is that when black adults of today were in their adolescent period, they tended not to take those science courses which are prerequisites for science careers. An objective of this study will be to determine if 27- and 28-year-old black adults took fewer courses in science when they were in high school than was the case for their white counterparts, and to investigate what, if any, influence their parents had on this outcome.

The specific guiding questions of this study are as follows: (1) Is there a difference between the proportion of black and white ninth-grade students who take science? If so, what is the magnitude of this difference? (2) Will perceived parental evaluations of their children's science ability affect whether their children take science courses? If so, will these affects, as the literature suggests, be through their influence on their children's self-conceptions? (3) Will perceived parental evaluations have greater affects on whether their children take science than through their affects on self-conceptions? (4) What will be the influential nature of socioeconomic status, a condition commonly believed to determine parents' values and expectations for their children?

To elaborate further, this study will analyze the influences of parental evaluations of their children's ability to learn in science and to examine their entry into science
courses which tend to be prerequisites for careers in science. This analysis will include the determination of whether there are systematic differences in parental socialization to career entry into science as related to racial and socioeconomic status identities.

Theoretical Background and Review of Related Literature

Lepper (1968) has shown that there are some racial differences in the development of science-related concepts at the first-grade level. These differences are accounted for by differences in the subject's family background. However, in later elementary (fourth-grade) and middle-school (sixth-grade) levels, Koelsche and Newberry (1971) found no significant differences in science interest among black and white children.

Lisonbee's (1963) findings further confound the picture by the observation that the interests of black students are misunderstood by many middle-class teachers and that black students want to learn science but resist the usual methods of education, perhaps because many blacks do not read at a level to be sufficiently motivated under traditional school programs.

Deutsch (1960) concluded that many black children develop poor auditory discrimination, visual skills, and time concepts. Since in his study he found few physical defects of the eyes, ears, or brains of black children, he
attributed the deficiencies to inferior habits of hearing, seeing, and thinking, which may be altered.

Another reason, hypothesized to account for emergent differences in scientific abilities, is that black students, in the past, have tended to develop lower self-concepts of scientific or academic ability than white students after a certain age level, and this is usually after elementary school (Brookover, Erickson, & Joiner, 1967). This leads to one major implication: If (1) parental evaluations are a major source of student self-conceptions of science ability, (2) self-conceptions of science ability are related to entry into science, and (3) there is a difference in proportions of black and white students who are entering science courses, then one may hypothesize as a result that the evaluations of black parents will differ from white parents and/or they will differ in their impact on the child's self-concept of ability.

In other words, the black child's avoidance of science courses has not been just a case of past racial discrimination practices in training and hiring, but also, perhaps, a case of unconscious ideologies operating within his or her parents. These ideologies may have had their origin in past discrimination patterns and continue to exist after the discrimination has ended. If this is true, then basic to creating a more positive self-perception in black children is the elimination of negative ideological formations among
black parents.

On the other hand, Soares and Soares (1966) claim that parental pressures brought to bear on advantaged white children dispose them to lower self-perceptions if they feel that they are not measuring up to their parents' expectations. However, Soares and Soares have generated considerable controversy regarding the self-concept of disadvantaged children. The controversies arose from their findings that disadvantaged children have more positive self-perceptions than advantaged white children.

In contrast to the above study, Witty (1967) found lower self-conceptions among black children than among white children. Studies by Wylie (1963) appear to provide similar evidence. On the other hand, studies by Soares and Soares (1969, 1970) have shown that the self-concepts of black children may in certain situations exceed those of white children.

Epps (1969) has shown that the self-conceptions of ability of black children are positively correlated with their grade point averages. As may be expected, the perception of limited career opportunities in science is inversely related to grades, meaning that black children who received low grades are not likely to continue taking science courses in the future. Epps also indicated that self-concept of ability as measured by Brookover and his associates (1962, 1965, 1967) is the strongest of the personality correlates
of grades.

There is an obvious difficulty in interpreting the above results due to the inconsistency and the incompleteness of the research. Some results may be attributed to differences in definitions, instruments, age groups, research designs, regions, times, and the deficiencies of the black child. It is further emphasized that the evaluations of teachers, peers, and others also affect student self-conceptions of ability as well as student achievements.

Dyer (1963) has pointed out that making generalizations about studies and interpreting results about them, in the context of various self-theories, are difficult problems in research. However, considerable research supports the idea that self-conceptions of academic abilities, in spite of the methodological problems entailed, play important functions in shaping career choices. Given the accepted importance of self-concept in relation to race, social class, and other related variables to the existence of inconsistent and incomplete findings, it is evident that there is a need for a study of self-concept in relation to black and white children not only in school settings, but in the home environment as well.

An overview of the research literature suggests that there may be certain relevant differences in socialization between black and white families. Perhaps these differences have an influence on whether black and white students take
science courses in high school.

From the theoretical perspectives of Brookover and Erickson (1975), the following propositions and questions have been developed for this study:

(1) Both black and white children's self-concepts function to direct their behavior. However, it is a question as to whether particular types of self-conceptions such as self-concept of science ability function in the same way for both black and white students. It is possible that the self-concept of science ability of black students is more or less relevant in predicting entry into science than is the case with white students. This study will examine that question.

(2) The self-concepts of black and white children emerge from the social situation in which they are participants. Within both family and school settings, parents are important significant others. This particular study focuses on the influence of parents.

(3) As black and white children participate in family situations with different social expectations, their self-concepts are modified: (a) These children's self-concepts reflect their perceptions of the evaluations of ability their parents hold for them as students; and (b) without the support of parents' expectations, the self-concept is threatened and will, with high probability, be modified.

(4) While it is expected that parent evaluations will influence student self-conceptions, it still is a question
as to whether black and white students differ in the influence of their parents on particular self-conceptions, such as self-concepts of science ability. This study expects to find associational relations between parental evaluations and self-concepts of science ability among both black and white students. This study will then attempt to determine which group of parents is more relevant.

(5) Questions concerning parental influence commonly include consideration of possible impact of socioeconomic status. Parents are commonly believed to be agents of their culture. In accord with this perspective, it is expected that socioeconomic status will be related to parents' evaluations of their children. However, there is little research or theoretical base to assume that white and black children will differ in the relevance of socioeconomic status on parental evaluations or self-conceptions. This study is a pilot study, one purpose of which is to generate hypotheses about differences in parental evaluations and socioeconomic status influence between black students (who typically do not enter science courses in high school) and white students (who tend to enter science courses 3 to 1 over blacks).
CHAPTER II

RESEARCH METHODOLOGY

This chapter is divided into four major sections: the population and sample data used in this research, instrumentation and the major variables defined operationally, a description formulation of research hypotheses, and the analytical procedures used in this study.

Population and Sample

Description of population

The population for this study consists of those adult citizens of the United States, white and black, in the 27- to 28-year age category. It is common knowledge, supported by statistics, that there are relatively few black scientists as compared to white scientists. For older-age cohorts, these differences can be explained in terms of overt discrimination. Since the 1950's, however, with desegregation and changes in federal and local policies, many overt barriers no longer have the main explanatory force that they once had on younger black and white adults.

In the case of younger adults in their late twenties (typically, the earliest that one may become a scientist at the Ph.D. level), however, there still remains a vast
difference in the proportions of black and white scientists even though there are few social barriers.

It is the purpose of this study to examine a sample of the records of adults in this age category to assess whether a possible residual from early discrimination patterns remains in the ideology of black parents which now produces the same outcomes as earlier overt discriminations.

Sample

The sample data used in this study were from a longitudinal research conducted by Brookover and his associates (1962, 1965, 1967). The students in this study were originally in grade 8, during the 1961-62 academic year. In the fall of 1961, the first questionnaire was administered to the eighth-grade students in the four junior high schools of a city with a population of 100,000. During the fall of each succeeding year (1962, 1963, 1964, and 1965), the questionnaire was again administered to the same class until their scheduled graduation from high school.

In the beginning of this study, grades 8 and 12 were selected to measure certain variables, because these grades have advantages. Grade 12 was chosen for measuring the variable "taking science" because it was the last grade available to the student. However, because of the high dropout rates and the very small proportion of black students who took science courses in grades 10 (9 percent), 11
(12 percent), and 12 (15 percent), the ninth grade was selected for data-gathering on entry into science courses.

Grade 8 was selected to measure the predictor variable for the following reasons: This was the last grade in which science was a required course for all students, and the grade in which differences in science background would be minimal insofar as the number of years of science courses taken. Also, according to research discussed earlier concerning self-conceptions of science, it was believed that differences in science ability would begin to appear in the eighth grade. Whether students would continue to take science courses in the future would depend on their self-conceptions of science ability.

The eighth- and ninth-grade data of this pilot study consisted of 34 black and 34 white students on whom longitudinal data were available. Excluded were students who were not regularly promoted, were in special education programs, had moved out of the school system, or were school dropouts.

The data which were collected for grades 8 and 9 in the 1961-62 and the 1962-63 school years were valuable in many respects. The data may relevantly describe characteristics of the high-school experience of today's 27-year-olds, the young adult population for which generalizations are sought in this study. Furthermore, while differing historically from today's eighth-grade students, the theoretical relationship of the variables remains unchanged. The theoretical
perspective relating perceived evaluations, self-concept of academic ability, and academic behavior remains as applicable now as then. Through studying the high-school characteristics of today's young adults, further light may be shed on why there are fewer blacks than whites in the area of science.

In summary, this sample includes all black students who completed one or more science courses in the ninth grade of a midwestern city (N = 17). An additional equal number of 17 black students were randomly drawn from the black student population who had not taken science courses in high school. Two equal samples of white students who had taken and had not taken science were also randomly drawn from the same school class as follows:

<table>
<thead>
<tr>
<th></th>
<th>Black Students</th>
<th>White Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed science</td>
<td>17**</td>
<td>17*</td>
</tr>
<tr>
<td>courses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not complete</td>
<td>17*</td>
<td>17*</td>
</tr>
<tr>
<td>science</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Randomly drawn.

**Entire number of school population in this category.

Instrumentation

Major variables

(1) Socioeconomic status (SES).—The social class variable was obtained from student eighth-grade school
records and was based on the occupation of the student's father or whoever supported the family. The Duncan scale was used, where values range from 1 to 99, with 1 being the lowest and 99 being the highest.

(2) **Race.**—Race was determined from the school records data.

(3) **Perceived parental evaluation of science ability.**—This variable was measured by the student's response to the question, "What grade do you think your parents say you are capable of getting in science?" (See Appendix.) Scores ranged from 5 (among the best) to 1 (among the poorest). This variable was measured in grade 8.

(4) **Self-concept of science ability.**—This score was operationally defined as the sum of the scored response to the 8-item Michigan State University Self-Concept of Ability in Specific Subject Scale for science (see Appendix).* Each item was scored from 1 through 5, giving a total possible

---

*The specific subject self-concept scale was developed by Brookover, Paterson, and Thomas (1962) to parallel their Michigan State University General Self-Concept of Academic Ability Scale. Reliability tests on the general self-concept scale were done using Hoyt's analysis of variance. Reliability coefficients between .852 and .865 were found for the six grades tested. The Guttman scalogram analysis was also used to test the general self-concept scale and yielded reproducibility coefficients of .95 and .96 for blacks and whites, respectively. The specific self-concept scale items were tested and found to scale in a fashion parallel to the general self-concept scale items. The scientific self-concept scale was analyzed for reproducibility and was found to have a coefficient above the required .90 (see Brookover, Erickson, & Joiner, 1967, pp. 60, 157-61).
range from 8 to 80 (lowest to highest). This variable was also measured in grade 8.

(5) Whether taking science (TS).—This is the dependent variable which indicates whether the student completed a course in science in grade 9. Students who did take science were coded 1, those who did not were coded 0.*

Research Hypotheses and Questions

The major research hypotheses of this study are as follows:

\[ H_{R_1} \]: There will be a significant difference in proportions between black and white students taking science in the ninth grade.

\[ H_{R_2} \]: There will be an association between perceived parental evaluation and self-conceptions of science ability.

\[ H_{R_3} \]: There will be an association between self-conception of science ability among both black and white students.

\[ H_{R_4} \]: Social class will be associated with perceived parental evaluation among both black and white students.

The major research questions guiding this study are as follows:

* There is some question as to the statistical appropriateness of using a dichotomous dependent variable with regression. Goldberg (1964, pp. 248-51) cautions against this in his econometrics text. However, such usage is found in the literature as in Goldberg (1971), where voting (Democrat/Republican) was the dependent variable in his path analysis. Boyle (1971) further supports its use in his discussion of dummy variables in path analysis—the general effect of the violation of the rule is minor.
Q's₁: Is there a difference between the proportion of black and white ninth-grade students who take science? If so, what is the magnitude of this difference?

Q's₂: Will perceived parental evaluation of their children's science ability affect, as hypothesized, whether their children take science courses? If so, will these affects be through their influence on their children's self-conceptions?

Q₃: Will perceived parental evaluations have greater affects on whether their children take science than through their affects on self-conceptions?

Q₄: What will be the influential nature of socioeconomic status, a condition commonly believed to determine parents' values and expectations for their children?

Data Analysis

To answer these questions, the differences in proportions of black and white students who took science in the ninth grade will be analyzed. The t test will be used to report the proportions (percentages) of both black and white students who completed science courses in the ninth grade. To determine whether the differences between black and white science students are significant, the data will be tested for significance of the difference between proportions from independent samples. The findings will be presented in a contingency table.

Under the causal path analysis, separate path models of perceived parental evaluations of their child's ability
in science will be given. The purpose of these two models will be to compare and to show direct and indirect effects of SES, parental evaluations, and self-concept of science ability on the dependent variable, "taking science," for both black and white children.

A comparative table of both black and white students will be used to summarize the path weights from the separate path models.

Finally, the theoretical model makes known the following ordering of variables: socio-class as an independent variable, perceived evaluations and self-concept as intervening variables, and behavior (TS) as the dependent variable.
CHAPTER III

FINDINGS

In this chapter, three sections of findings are presented. The first section presents the proportion of black and white students in this study who have taken science courses. The second section presents findings in the form of a "causal" path analysis of four variables for black and white students separately. The third section compares the influence of black and white parents.

Race and Taking Science Courses

Table 1 presents the proportion of the number of students who were taking science courses in the ninth grade. As indicated in Table 1, there was a very small proportion

<table>
<thead>
<tr>
<th>Completed Science Courses</th>
<th>Black</th>
<th>White</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>17</td>
<td>47</td>
</tr>
<tr>
<td>No</td>
<td>85</td>
<td>94</td>
<td>53</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>111</td>
<td>100</td>
</tr>
</tbody>
</table>

$z = 6.40; .05$ level
of black students (15 percent) who completed science courses in the ninth grade as compared to white students (47 percent).

The findings reported in Table 1 are very similar to findings in other communities in the United States which were discussed in Chapter I. In other words, this study also found that relatively few black students enter science courses in high school, a common prerequisite for careers in science. Clearly, race is associated with career entry. The task is to determine why so few black students take science courses.

Causal Forces Affecting Course-Taking

The general purpose of this study is to determine if the reason so few black students take science in high school is because of their parents. Given the theoretical and empirical data of past work, it was generally hypothesized that parents would be relevant in affecting the course decisions of students by their influence on their children's self-concepts of science ability. It was questioned as to whether parents would also have additional influence on taking science that was not accounted for by their influence on their children's self-conceptions of science ability.

This study investigated, specifically, the indirect influence parents have through their influence on their children's self-conceptions of science ability which in turn
may affect course choices, and also their influence as parents which was not through their affect on their children's self-conceptions. In this latter case, the influence may take the form of providing norms, knowledge, attitudes, and resources. The statistical term for this type of influence in this path causal model is "direct influence," where no intervening variables are measured. As explained in the previous chapter, and because an association was found between race and science courses, separate path models were constructed to compare the indirect and direct effects of parents for both black and white students.

**Parental influence on black students**

As shown in Figure 1, six observations and conclusions are drawn: The evaluations of black parents of their children's science ability influenced their children's self-conceptions of science ability (.77), which in turn affected whether they took science (.37).

Black parents' evaluations of their children's science abilities also influenced whether their children took science courses (.78) over and above that which was the result of their influence on their children's self-conceptions.

The contribution of the self-conceptions of science ability (.37) of black students as to whether they took science was very dependent upon their parents' evaluations.
Figure 1
Parental Influence Among Black Students

Black Parents' Evaluations of Child's Science Ability\textsuperscript{a}

Socioeconomic Status\textsuperscript{a}

Taking Science Courses\textsuperscript{b}

Student's Self-Conceptions of Science Ability\textsuperscript{a}

\textsuperscript{a}Based on eighth-grade school records.

\textsuperscript{b}Based on ninth-grade school records.
and less directly dependent on their socioeconomic status (.12).

The direct and indirect effects of black parental evaluations were somewhat associated with their socioeconomic status (.29). Relatively, the direct path weights of socioeconomic status of black parents as to whether the black students took science (.18) was much less than for their parents' evaluations (.78). Even the direct (.18) and indirect (.29 and .12) effects of socioeconomic status of black families were not likely to account for as much effect on taking science as did parental evaluations directly (.78) and indirectly through effects on student self-conceptions (.77).

Clearly, these findings for black families are in accord with the view that most of the effects of social status (even though seemingly unusual) are through parents. More importantly, the above findings are in accord with the view that the parents of black children have a very important influence on whether their children take science courses.

**Parental influence on white students**

The findings for white students, shown in Figure 2, indicated patterns of influence somewhat similar to those of black students.

White parents' evaluations of their eighth-grade
Figure 2
Parental Influence Among White Students

White Parents' Evaluations of Child's Science Ability\textsuperscript{a}

Socioeconomic Status\textsuperscript{a}

Taking Science Courses\textsuperscript{b}

Student's Self-Conceptions of Science Ability\textsuperscript{a}

\textsuperscript{a}Based on eighth-grade school records.

\textsuperscript{b}Based on ninth-grade school records.
children's science abilities also influenced their children's self-conceptions of science ability (.48), which in turn influenced whether they took science one year later (.16).

White parents' evaluations of their children's science abilities also directly influenced whether their children took science courses (.44), not over and above, however, that which was the result of their influence on their children's self-conceptions.

The contribution of white students' self-conceptions of science ability as to whether they took science was somewhat directly dependent upon socioeconomic status (.23) and their parents' evaluations (.48). The evaluations of white parents were, in turn, strongly dependent on socioeconomic status (.42). The direct effect of socioeconomic status with whether white students took science (.12) was somewhat less than were the indirect effects (.42 and .23). In other words, socioeconomic status tended to have a direct effect on taking of science (.12) as well as indirectly, through its effects on parents' evaluations (.42) and students' self-conceptions (.23).

On the basis of the above findings, it is concluded that white parents play a significant role in whether their children take science; and that the major effects of social status are largely indirect, through their influence on parents.
Comparison of Influence of Black and White Parents

The summary of findings on both black and white students reported above in Figures 1 and 2 shows some important differences in patterns, which are illustrated in Table 2.

Table 2
Comparison of Black and White Students: A Summary of Path Model Weights

<table>
<thead>
<tr>
<th>Influence</th>
<th>Race</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black</td>
</tr>
<tr>
<td>1. Parental influence:</td>
<td></td>
</tr>
<tr>
<td>a) Direct on taking science</td>
<td>.78</td>
</tr>
<tr>
<td>b) On children's self-conceptions</td>
<td>.77</td>
</tr>
<tr>
<td>2. Self-concept influence on taking science</td>
<td>.37</td>
</tr>
<tr>
<td>3. SES influence:</td>
<td></td>
</tr>
<tr>
<td>a) Direct on taking science</td>
<td>.18</td>
</tr>
<tr>
<td>b) On parent evaluations of children</td>
<td>.29</td>
</tr>
<tr>
<td>c) Direct on students' self-conceptions</td>
<td>.12</td>
</tr>
</tbody>
</table>

While both white and black parents influenced whether their children took science courses, clearly the parents of black children were more influential than white parents in their direct effects on taking science (.78 and .44, respectively). Similarly, black parents seemed to have a greater influence on their children's self-conceptions of science ability (.77) than was the case for white parents (.48).
The greater relevance of black parents on whether their children take science seems to be further supported by the greater influence of black parents on their children's self-conceptions (.77) than was the case for white parents (.48). Furthermore, the index of influence was greater for black students (.37) than for white students (.16).

A reverse picture emerges, however, when the influence of social status is examined. The socioeconomic status of whites was more associated with direct effects on parental evaluations and student self-conceptions (.42 and .23, respectively) than was the case for black students (.29 and .12, respectively). Only in one case, direct effects of socioeconomic status on taking science, was there a greater observed association for blacks (.18) than for whites (.12), and both of these associations were relatively unusual.
CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary of Findings

The overall findings of this research may be briefly summarized as follows:

(1) It was found for adults, age 27, that a very small proportion of them who were black (15 percent) completed science courses in the ninth grade as compared with those who were white (47 percent). A comparison of the proportion of black and white students who took science showed a ratio of slightly over 3:1.

(2) It was found that the indirect effects of parental evaluations of their children's science ability influenced their children's self-conceptions of science courses. Also, eighth-grade white parents' evaluations of their children's science abilities influenced their children's self-conceptions of science ability, which in turn influenced whether they took science in the future.

(3) The effects of black parental evaluations of science ability also influenced whether their children took science courses. Furthermore, this was over and above the result of their influence on their children's self-conceptions. Also, white parents' evaluations of their children's science
abilities directly influenced whether their children took science courses.

(4) It was found that the contribution of black students' self-conceptions of science ability was highly dependent upon parental evaluations and less so on socioeconomic status.

(5) On the other hand, the contribution of white students' self-conceptions of science ability was directly dependent both upon socioeconomic status and their parents' evaluations, which in turn were also relatively strongly dependent on socioeconomic status.

(6) For black students, the direct and indirect effects of parental evaluations were somewhat associated with socioeconomic status. Socioeconomic status did not have as much direct impact on taking science as did parents' evaluations, and even the direct and indirect effects of socioeconomic status of black families were not likely to account for as much effect as parents alone directly.

For white students, socioeconomic status tended to have relatively strong direct effects on taking of science as well as indirectly through its effects on parents' and students' self-conceptions.

Conclusions

Our concerns for the influence of black and white parents on student self-assessment, which in turn affects
the student's entry into science courses, has led to several conclusions. This study has made known that perceived parental evaluations of students' scientific ability in science had a tremendous impact on whether their children took science courses. However, this impact on parental evaluation of a child's science ability was more meaningful for the black child than for the white child who took science.

These conclusions suggest that there is some indication that black children are able to compensate for their background deficiencies for taking science when they are encouraged by "significant others" not only to take science, but to do well while taking it. In other words, blacks who receive encouragement from their parents are more likely to take advanced science courses. On the other hand, when black parents accept unconscious ideologies, residuals of earlier discrimination patterns, they will probably fail to notice and encourage their black child who may have a promising scientific ability for science. Even in these supposedly "modern times," a gifted black student who attempts to accelerate his/her scientific education by taking science courses may be ridiculed or discouraged from taking science when his black parents are insensitive to his scientific academic abilities.

It was furthermore apparent that the black race is not proportionally represented in post-high-school areas in science education. Many black parents with young children
interested in science need to learn soluble skills in science courses, which many black children traditionally have avoided. When black parents influence their children to improve their ability in sciences, then their black children will be more likely to take science and become successful achievers in our technological society.

How important are self-concept and social class in influencing taking science courses in the ninth grade? For black parents, the evaluations of their children's self-conceptions of science ability on taking science courses have influenced the decision of their children to take science. Kinch (1963) indicated that when there are changes in evaluations of parents, there should also be changes in the child's self-conceptions of his scientific abilities. Parental evaluations of their black child's scientific abilities were demonstrated in the changes that they brought about in the black child's self-concept of ability, which in turn determined their child's decision to take science courses in the ninth grade. Therefore, creating changes in black parents' evaluations of their children are closely related to whether their children take science courses.

Historically, more blacks than whites enter traditional careers, careers requiring less advanced skills in science. This, no doubt, is a consequence of the inadequacies within our elementary and secondary schools to design programs which may help parents encourage their children in the area of
science. The science courses, for example, are often designed for the college-bound (gifted) students with high I.Q.'s, high reading and mathematics achievement scores, and high grade point averages. Thus, fewer blacks than whites receive the science instruction they need.

It is obvious that the black child's avoidance of science courses is but the other side of the effect of discrimination which has taken the form of unconscious ideologies within his parents, which creates the dilemma inherent in any attempt to build a more positive self-concept of science in the black child. Because basic to creating a more positive self-concept in black children is the elimination of unconscious ideologies of black parents in the home which may be preventing their children from taking science courses.

In this study, when black parents considered their child's career for the future, they were not able to avoid potentially dangerous ideologies or negative influences of the past. As a result, their children may have avoided science courses because of their socialization at home.

Recommendations

Given the findings of this study, the question of interest is how to break the unconscious ideologies among black parents. If society is truly committed to encouraging minorities to develop all their talents more fully, how can this be done? Removing external barriers, such as race
discrimination in hiring, will not automatically cause minorities to surge forth to fill the ranks of scientists.

If it is desirable to increase the participation of minorities in the world of science at a professional level, special efforts are needed to encourage minorities, especially blacks, to think seriously about these career areas. Since the decline in both scientific interest and achievement appears to occur at about the time blacks begin secondary school, programs aimed at increasing blacks' participation in scientific careers should probably begin early, even as early as the elementary school years. Efforts directed only at the young black child are likely to be less successful than programs which aim to change ideologies of parents and educators as well.

Some efforts have been made to develop career education programs to increase blacks' participation in science. However, most of these projects are too recent to evaluate their long-term effectiveness.

A number of research projects aimed at increasing the participation of minorities and women in careers in science were funded by the National Science Foundation in 1974. It is hoped that the results of these studies will be made available soon and will provide insight into how to plan and conduct scientific career education efforts.

The next question which tends to surface is: What can education do? On the basis of the current evidence, it
appears that in order for more minorities to become scientists and/or mathematicians, they must develop interest in these career areas at an early age, so that they do not self-select themselves out of mathematics and science courses in high school. Minorities will be more likely to develop these career interests if they are encouraged by parents and teachers to view these careers as realistic goals. Contact with appropriate minority role-models may promote this end.

Teachers of science at all levels should examine their own classroom behavior to see how they can foster greater interest in science among blacks and other minorities. Teachers should also examine their textbooks for subtle forms of institutional racism, as well as their own actions. On a more positive side, they might, for example, make an effort to include in their units projecting the history of science mention of the contributions of blacks as well as whites.

Many black students may also need special counseling to help them see how important science courses are as background for a wide variety of careers. Black scientists and other professionals might be encouraged to visit to talk with black students about their careers. And, of course, teachers and counselors should encourage black students and their parents to think about educational and career opportunities in fields requiring scientific skills.

Community resources may be used in scientific career education programs, and they are not costly. Many
communities have access to persons with varied skills and interests who might be willing to donate time for such a worthwhile course. Some large companies, labor unions, professional and educational organizations, and other community organizations might be quite willing to sponsor certain aspects of such a program. Furthermore, schools which devise truly innovative and promising programs might be eligible for federal funds for their efforts.

Science is an exciting career field. Many black students, however, need help in learning that jobs with intellectual and social challenges in science exist for them as well as for whites.
APPENDIX

MICHIGAN STATE UNIVERSITY SELF-CONCEPT OF ABILITY IN SPECIFIC SUBJECT SCALE

1. How do you rate your ability in science compared with your close friends?
   a. I am the best.
   b. I am above average.
   c. I am average.
   d. I am below average.
   e. I am the poorest.

2. How do you rate your ability in science compared with those in your class at school?
   a. I am among the best.
   b. I am above average.
   c. I am average.
   d. I am below average.
   e. I am among the poorest.

3. Where do you think you would rank in your school graduating class in science?
   a. Among the best
   b. Above average
   c. Average
   d. Below average
   e. Among the poorest

4. Do you think you have the ability to do college work in science?
   a. Yes, definitely.
   b. Yes, probably.
   c. Not sure either way.
   d. Probably not.
   e. No.

5. Where do you think you would rank in your college class in science?
   a. Among the best
   b. Above average
   c. Average
   d. Below average
   e. Among the poorest
6. How likely do you think it is that you could complete such advanced work?
   a. Very likely
   b. Somewhat likely
   c. Not sure either way
   d. Unlikely
   e. Most unlikely

7. Forget for a moment how others grade your work. In your own opinion, how good do you think your work is in science?
   a. My work is excellent.
   b. My work is good.
   c. My work is average.
   d. My work is below average.
   e. My work is much below average.

8. What kind of grades do you think you are capable of getting in science?
   a. Mostly A's
   b. Mostly B's
   c. Mostly C's
   d. Mostly D's
   e. Mostly E's
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