DOCUMENT RESUME

ED 201 692 UD 021 389

AUTHOR Holmes, Barbara J.
TITLE Black Students' Performance in the National Assessments of Science and Mathematics.
INSTITUTION Education Commission of the States, Denver, Colo. National Assessment of Educational Progress.
SPONS AGENCY National Center for Education Statistics (DHEW), Washington, D.C.; National Inst. of Education (ED), Washington, D.C.
REPORT NO NAEP-SY-SM-50
PUB DATE Dec 80
CONTRACT OEC-0-74-0506
GRANT NIE-G-80-0003
NOTE 47p.; Some tables may be marginally legible due to reproduction quality of original document.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; *Black Students; *Classification; Course Content; Elementary Secondary Education; Mathematical Concepts; *Mathematics; Performance Tests; *Sciences; Scientific Concepts

ABSTRACT

This study was conducted in order to identify some of the broad characteristics of achievement in science and mathematics by black students. A nationwide sample of nine, thirteen, and seventeen year old students was tested with a series of exercises that were developed to assess science and mathematics performance. The exercises were designed to probe both content and processes across several taxonomic levels. Findings indicated that, compared to the national average, black students as a group experienced problems in mathematics at all age levels, but these were accentuated by age seventeen. In science, a smaller overall gap in performance was found at age nine. This gap narrowed by age thirteen, but widened noticeably at age seventeen. The many tables of data included in this report indicate particular content areas and specific taxonomic levels at which black students experience difficulty. (MK)

BLACK STUDENTS' PERFORMANCE IN THE NATIONAL ASSESSMENTS OF SCIENCE AND MATHEMATICS

No. SY-SM-50

by
Barbara J. Holmes, Ph. D.

National Assessment of Educational Progress

Education Commission of the States
Suite 700, 1860 Lincoln Street
Denver, Colorado 80295

December 1980

The National Assessment of Educational Progress is funded by the National Institute of Education. It is under contract with the Education Commission of the States. It is the policy of the Education Commission of the States to take affirmative action to prevent discrimination in its policies, programs and employment practices.

The National Assessment of Educational Progress is an education research project mandated by Congress to collect and report data, over time, on the performance of young Americans in various learning areas. National Assessment makes available information on assessment procedures and materials to state and local education agencies and others.

The work upon which this publication is based was performed pursuant to Contract No. OEC-0-74-0506 of the National Center for Education Statistics and the National Institute of Education; also, Grant No. NIE-G-80-0003 of the National Institute of Education. It does not, however, necessarily reflect the views of those agencies.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

For the past decade, various reports of student achievement have indicated that black students in American schools generally perform below the level obtained by their white contemporaries in science and mathematics (Helgeson et al., 1978; The Condition of Education, 1978, pp. 94-97). Reports also have indicated that achievement has declined among all American students during the past decade in science and in mathematics. (See various National Assessment reports: Changes in Mathematical Achievement, 1973-78, 1979; Science Achievement: Racial and Regional Trends, 1969-73, 1976; Three National Assessments of Science, 1969-77: Technical Summary, 1979.) Given this information, one might conclude that American students -- especially those who are black -- are ill-prepared to seek careers and occupations requiring knowledge of science and mathematics.

This conclusion should not be accepted, however, without more detailed examination of students' performance. For example, in cases where there have been differences in achievement between groups over time, it would seem fair to ask, "Are there any areas where either group's performance is consistently above, below or equivalent to some national level of performance?" Ability and achievement are not synonymous terms. Numerous factors, such as student exposure to subject materials (Medley and Quirk, 1974; Thorndike, 1971), student motivation (Epps et al., 1971; Banks et al., 1978), interaction between the tested and the testers (Katz et al., 1963, 1964, 1972), socioeconomic variables (Davis, 1952; Cameron, 1968) and others are well documented as affecting performance on tests, regardless of a student's ability.

Too often researchers have searched for answers to questions about differential achievement in the "characteristics of the performers" rather than in the "characteristics of the performance." The implications of each of these approaches are quite different. The first implies some pathological deviation among those in the test sample, and the second implies the availability of more information in the data. As Sylvia Johnson (1979, p. 21) recently remarked, "Focusing on race as a 'cause' of performance differences,...is bound to be counterproductive." Moreover, race is not a causative or independent variable although, like a person's sex, it may be associated with and found in conjunction with certain putative social factors.

A more useful approach seeks additional information in achievement data by identifying areas and ages where intervention might likely be most beneficial.

The purpose of this report is to present the results of an exploratory look at achievement data for black students gathered in large-scale, national assessments of science and mathematics. The outcome is a description of some of the characteristics of black students' performance at ages 9, 13 and 17.

SCIENCE AND MATHEMATICS ASSESSMENTS

Achievement of American students in science has been assessed on three occasions by the National Assessment. The first assessment was conducted during the 1969-70 school year, the second in 1972-73 and the third in 1976-77. In addition, NAEP has completed two assessments of mathematics achievement -- the first conducted during 1972-73, and the second five years later, in 1977-78. Each of these assessments was administered to students at ages 9, 13 and 17. In each survey, approximately 2,500 students nationally responded to each exercise. Of the 2,500 students, approximately 400, or 16%, were black; 125, or 5%, were Hispanos; 50, or 2%, were Oriental and Native American; and 1,925, or 77%, were white.

The availability of data and several unique features of the National Assessment program make it an excellent source for identifying characteristics of performance among student groups. NAEP assessments are designed to describe how defined groups of students -- as opposed to individual students -- respond to a broad range of exercises in a subject area (see Appendix A for group definitions). In addition, NAEP exercises result from several techniques designed to ensure objectivity:

- Data gathered with NAEP exercises are not designed to be predictive.
- Exercises measure objectives developed to reflect taxonomic levels and a broad spectrum of subject-area content.
- Exercises are written through a team approach involving a cross-section of educators, professional and lay persons in a consensus process; therefore, exercises do not represent any single curriculum.
- Exercises are reviewed extensively for bias and content validity and are tried out in the field before inclusion in a nationwide assessment.

- Exercises range in complexity from "easy" to "difficult."
- Exercises are administered with a paced audio tape to compensate for variations in reading and comprehension skills.

Taxonomy and Content for Science and Mathematics Assessments

For assessment purposes, the domain of science was described in two broad dimensions. One dimension involved classification of the cognitive abilities required to respond to specific types of science questions, based on a condensed and simplified version of Bloom's Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain (1956). The second dimension divided the domain of science into three major areas: (1) content, the body of knowledge of science; (2) the process by which that body of knowledge comes about; and (3) science and society -- the implications for that body of knowledge for mankind. In the 1976-77 assessment of science, 209 exercises were administered to 9-year-olds, 284 to 13-year-olds and 313 to 17-year-olds.

The taxonomic and content areas for science are:

SCIENCE

Taxonomic Levels
- Knowledge
- Comprehension
- Application
- Analysis, Synthesis and Evaluation (ASE)

Science Content (the body of knowledge of science)
- Biology
- Physical Science
- Earth Science
- Integrated Topics

Science Process (the process by which that body of knowledge comes about)
- Process Methods
- Decision Making

Science and Society (the implications of that body of knowledge for humankind)
- Persistent Societal Problems
- Science and Self
- Applied Science and Technology

The 1977-78 mathematics assessment was designed to measure students' performance at four different cognitive process levels crossing a variety of traditional mathematics content areas. In the mathematics assessment, 386 exercises[1] were administered to 9-year-olds, 533 to 13-year-olds and 654 to 17-year-olds.

The following list describes the taxonomic and content areas for mathematics.

MATHEMATICS

Taxonomic Levels
- Knowledge
- Skill
- Understanding
- Application

Content Areas
- Numbers and Numeration
- Variables and Relationships
- Shape, Size and Position
- Measurement
- Other Topics

The remainder of this report will describe the data source, give an overview of changes in science and mathematics achievement, describe the method of identifying some of the characteristics of black students' performance by taxonomy and content areas and discuss some of the implications of this exploratory analysis.

Description of the Data Source

Students in the National Assessment sample are chosen through a multistage probability sampling design so they represent the national population. Therefore, on the basis of the performance of about 2,500 9-year-olds on a given exercise, we can generalize (or infer) about the probable achievement of all 9-year-olds in the nation. Performance is thus reported in terms of the percentages of young persons correctly answering a given exercise.

---

[1] In the 1977-78 mathematics assessment, there was one booklet of items per age that was designed to be administered with an electronic hand-held calculator. Those exercises are not included in this analysis.

Changes in national performance are the differences between the percentages of young persons correctly answering a given exercise or set of exercises from one point in time to another. Changes in performance of certain groups of students are indicated by changes in the percentage correct for a group and by changes in the group's position compared with the national percentage correct. By observing these two changes, we can determine, first, whether a larger or smaller proportion of students answered an exercise correctly in one assessment than in another, and, second, whether or not there was a change between assessments in the group's standing compared with the nation as a whole. Both types of information contribute to our understanding of whether the achievement level of a given group has changed. In reporting mean changes, only those changes greater than twice their standard error are considered statistically significant. In reporting changes greater than two standard errors, NAEP is confident that changes of this magnitude would occur by chance in fewer than 5% of all possible replications of its sampling and data collection procedures.

An Overview of Changes[2] in Performance in Science and Mathematics

National trends in performance were quite similar for both science and mathematics. Declines in achievement were noted at all ages, with 9-year-olds declining least and 17-year-olds declining the most. Nine-year-olds' declines were not always statistically significant and, in science, the declines appeared to have decreased between the second and third assessments (see Three National Assessments of Science: Changes in Achievement, 1969-77, 1978).

---

[2]In order to report changes in achievement over time, a portion of the exercises are not released so that they may be readministered to the same age students during subsequent assessments of the subject area. In addition, all administrative and scoring techniques are duplicated from assessment to assessment to assure the accuracy of the change measures.

When performance of black students is compared with the nation, the trends are less clear. In the science assessments, the average percentages of correct responses for blacks were 10 to 15 points below the nation at all ages with no significant or consistent changes over time. In mathematics, blacks' average performance was 10 to 20 percentages points below the nation, but blacks' relative standing improved between 1972-73 and 1977-78 (the age-17 change was not statistically significant).

Method for Comparing National and Blacks' Performance

The exploratory analysis in this report is based on the response data gathered on the collections of exercises administered to 9-, 13- and 17-year-olds during the 1976-77 science assessment and the 1977-78 mathematics assessment.

Tables 1 and 2 display the overall national results compared with black students' performance in science and mathematics by taxonomic level and content categories for each age group. These mean percentages reflect performance on all cognitive exercises included in the science and mathematics assessments, respectively.

Table 1 indicates that the mean difference between black students' performance and national performance is 13 percentage points at age 9, 12 percentage points at age 13 and 17 percentage points at age 17 on all cognitive exercises included in the science assessment. This pattern suggests that some of the problems in science that occur at age 9 may be abated by age 13. However, by age 17, problems noted in science at age 9 seem to reappear and to become more vivid. Notice that this general pattern is reflected also in the content breakdown, but with some exceptions. For example, on science Application exercises at ages 9 and 13, the mean difference between black students and the nation remained the same, but increased at age 17. On the other hand, on Analysis, Synthesis and Evaluation exercises, the deficit was large at age 9 (17 percentage points), but decreased by age 13 to 13 percentage points. The deficit by age 17, however, increased to 20 percentage points.

Among the science content areas, Process Methods appears to be the site of problems for black students: at age 9, the deficit was 17 percentage points; at age 13, the deficit was 13 percentage points; and at age 17, the deficit was 19 percentage points. Nevertheless, the general pattern observed in the taxonomic level persists.

TABLE 1. Mean National Percentages of Correct Responses and Blacks' Mean Differences From the Nation in the 1976-77 Science Assessment by Taxonomic Levels and Content Areas, Ages 9, 13 and 17

	No. of Exercises			Mean National Percent Correct			Mean Black Difference From the Nation		
	9	13	17	9	13	17	9	13	17
All exercises	209	284	313	51	49	53	-13	-12	-16
Taxonomy									
Knowledge	26	29	32	58	49	53	-13	-11	-13
Comprehension	119	139	140	49	50	52	-13	-11	-14
Application	51	88	110	48	48	55	-13	-13	-17
Analysis, synthesis and evaluation	10	28	31	49	49	54	-17	-13	-20
Content									
Biology	66	77	74	53	51	56	-13	-11	-15
Physical science	71	66	82	45	49	46	-11	-11	-14
Earth science	27	43	43	46	42	49	-11	-12	-16
Integrated topics	2	14	19	--	42	51	---	-10	-17
Process-methods	41	58	62	54	54	57	-17	-13	-19
Persistent societal problems	12	48	56	48	41	55	-11	-11	-17
Science and self	14	22	25	56	59	68	-13	-12	-13
Applied science and technology	1	15	21	--	42	51	---	-11	-16
Decision making	1	11	16	--	56	67	---	-14	-17

TABLE 2. Mean National Percentages of Correct Responses and Blacks' Mean Differences From the Nation in the 1977-78 Mathematics Assessment by Taxonomic Levels and Content Within Taxonomy, Ages 9, 13 and 17

	No. of Exercises			Mean National Percent Correct			Mean Black Difference From the Nation		
	9	13	17	9	13	17	9	13	17
All exercises	386	633	654	52	54	58	-11	-15	-17
Taxonomy									
Knowledge	161	147	140	66	67	72	-11	-14	-15
Skill	137	272	273	43	52	59	-11	-17	-18
Understanding	44	108	105	40	52	58	-10	-15	-17
Application	44	106	136	38	43	43	-11	-14	-18
Content within taxonomy*									
Knowledge:									
Number and numeration	120	86	68	67	71	78	-12	-14	-15
Geometry	25	44	46	59	57	68	- 9	-12	-17
Measurement	16	17	17	66	70	79	- 7	-16	-16
Skill:									
Computation	48	129	127	35	52	67	- 9	-16	-18
Measurement	30	32	21	53	55	57	-11	-21	-23
Graphs and tables	16	27	29	59	69	73	-15	-17	-17
Geometry	15	19	15	44	46	55	-11	-12	-19
Algebra	19	43	59	39	52	40	-12	-19	-15
Application:									
Routine problems	33	85	114	37	41	42	-13	-15	-19
Nonroutine problems	---	---	10	--	--	40	---	---	-17

Not all mathematics exercises are included in these means. In addition, not all the categories are strictly content within taxonomy, such as, routine and nonroutine problems within application.

Table 2 displays the overall national mathematics results compared with black students' performance by taxonomy and content areas within taxonomic levels for each age group. Generally, the pattern of mean differences between black students' performance and national performance in mathematics is not the same as in science: deficits increase at each successive age. Although the performance difference between black students and the nation at age 9 may not be cause for great alarm, the increase in the differences by age 17 is suggestive of some grave problems.

The performance differences between black youngsters and the nation may reflect differences of exposure. Deficits at age 17 may be due to low black enrollments in science and mathematics after grade 10. Science courses are electives in many schools after completion of minimal science requirements for graduation. Another exposure factor that may account for the deficits is time-on-task versus quality of instruction in disadvantaged-urban and rural schools, for instance.

Although this exploratory analysis is based on a comparison between the total national and black samples, an analysis of performance among black students would yield more refined results. For example, the overall results of the 1976-77 science assessment indicated that black youngsters at ages 9 and 13 who attended schools in advantaged-urban areas performed near or above the overall national percentages (see Science Achievement in the Schools: A Summary of Results From the 1976-77 National Assessment of Science, 1978, pp. 20-21).

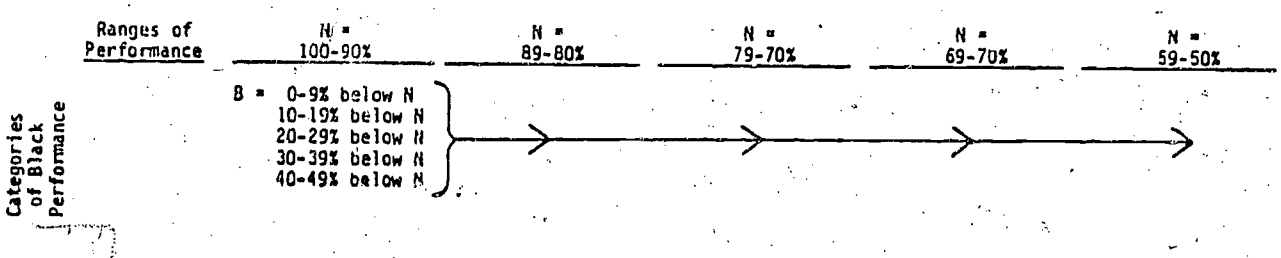
In order to identify the characteristics of performance among black students, a comparison between national performance and blacks' performance was made. National performance (N) thus was used as a standard against which black students' performance (B) could be examined. All national percentages for exercise-level data were categorized into ranges of performance. Specifically, national percentages were grouped on the basis of the following ranges:

All exercises where N % = 100-90
All exercises where N % = 89-80
All exercises where N % = 79-70
All exercises where N % = 69-60
All exercises where N % = 59-50

Exercises on which the percentages of correct responses met this criterion became a pool of selected exercises for this analysis. All exercises on which the percentages of correct responses were 49% or less were excluded from this analysis. A different cut-off point could yield different results. Obviously, there is some point at which level of difficulty of the exercises and minimal exposure of students to material influence

performance. A cut-off point is determined with reference to the goals of the analysis. The goal of this exploratory analysis was to test the efficacy of the method in order to see if broad characteristics of performance could be identified.

Next, blacks' performance was compared with national performance within the context of the ranges of performance listed above. Thus, the comparative method was:



This procedure resulted in placement of the selected exercises into the categories of blacks' performance. Next, exercises were placed in taxonomic levels by topical or content areas. Because of the large amount of data examined through these successive steps, Tables 3-8 will summarize some of the detail by collapsing the ranges of national performance into a single category comprised of all exercises where national performance was more than 50%.

One further examination was made of all exercise-level data. This examination located all exercises on which the percentages of correct responses by black students were <u>above</u> national percentages of correct responses.

In science at age 9, black students performed above the nation on 18 exercises with national percentages ranging from 3-66%; at age 13, on 15 exercises with national percentages ranging from 6-63%; and at age 17, on 17 exercises with national percentages ranging from 10-99%.

In mathematics at age 9, black students performed above the nation on 21 exercises with national percentages ranging from 6-75%; at age 13, on 28 exercises with national percentages ranging from 6-79%; and at age 17, on 8 exercises with national percentages ranging from 5-50%. Because the number of exercises on which blacks' performance was higher than the nation was so small and the national percentages ranged so widely, no further detailed analysis was undertaken to identify characteristics of blacks' performance on these exercises.

SCIENCE ACHIEVEMENT

Two cautions apply when interpreting the data: (1) the categories of blacks' performance and ranges of national performance refer to the percentages of students who responded correctly to an exercise, not to the number of exercises that a single student answered correctly; (2) the ranges of national performance encompass all science and mathematics exercises where national percentages of correct responses are greater than 50%. An example from the detail (not included in the summaries presented in this report) of this analysis will illustrate the significance of these points for interpreting the data. For nine exercises, the national performance of 9-year-olds fell in the 100-90% range. Of these nine exercises, black students' performance fell 0-9% below the nation on only three exercises and 10-19% below the nation on the remaining six exercises. This means that while some 90 to 100% of the national sample responded correctly to the nine exercises, 81-99% of the black sample responded correctly to three of the exercises, and 71-80% of the black sample responded correctly to the remaining six exercises. So although black students performed below the nation on the exercises mentioned here, the national level of performance is quite high and blacks' performance is only slightly less high. These exercises, then, do not indicate taxonomic levels or content areas where black students necessarily require remediation. Therefore, blacks' performance is to be interpreted relative to the nation in this report simply because a comparison is made between these two data points.

Table 3 presents the distribution of selected science exercises across the categories of blacks' performance. Shown in the first column is the total number of exercises administered at each age level. The second pair of columns shows the number and percentage of exercises for which national performance was greater than 50%. The categories of blacks' performance have been retained as described in the previous section, and both the number and percentages of selected exercises that fit each category of blacks' performance is shown.

Of 209 exercises administered at age 9, 96 (or 46%) meet the selection criterion described in the previous section -- that is, their percentages of success were above 50%. Of these 96 selected exercises, black students' performance was 0-9% below the nation on 20% of those selected, 10-19% below the nation on 43% of the exercises selected; and 20-29% below the nation on 37% of those selected. Black students' performance did not fall 30% below the nation on any of the selected exercises.

TABLE 3. Comparison Between National and Black Students' Performance on Selected 1976-77 Science Exercises

	Total Exercises Administered	Total Selected Exercises: National Performance >50%		Black Performance on Selected Exercises by Categories of Performance							
				0-9% Below N		10-19% Below N		20-29% Below N		30% or More Below N	
		No.	%	No.	%†	No.	%	No.	%	No.	%
Age 9	209	96	46	19	20	41	43	36	37	0	--
Age 13	284	120	42	33	28	58	48	28	23	1	1
Age 17	313	170	54	24	14	59	35	71	42	16	9

N = national

**Percentage of total exercises administered.*
†Percentage of total exercises selected.

In Table 3 and the others, one would hope to see that more exercises are in the 0-9% category of blacks' performance than in the 20% or below categories. This would indicate that black students' performance is relatively near the national performance level, and if national performance itself is low, one could conclude that at least black students are not performing much differently than the nation. When the number of exercises in the 20-29% category is large, however, this suggests that black students may be having problems not experienced by students nationally. Conclusions or interpretations about the middle category of blacks' performance, 10-19%, are less clear and must be made on the basis of the taxonomic and content nature of the actual exercises.

In Table 3, note that there are more science exercises on which blacks' performance is 10-19% and 20-29% below the nation than there are on which blacks' performance is only 0-9% below the nation. This is the case at all three age levels.

Next examine the exercises within each category of black students' performance by taxonomic classification. Table 4 presents the distribution of the selected exercises across the science taxonomy by the categories of black students' performance. The four taxonomic levels have been combined into two levels so that the patterns are clearer. Earlier, it was suggested that the possible site of problems are those exercises on which blacks performed from 10-19% or 20-29% below the nation. Note that at all ages, the largest percentages of exercises on which blacks' performance is 20-29% below the nation are those classified as Application and ASE: at age 9, 54%; at age 13, 31%; and at age 17, 60%. Conversely, black students' performance is relatively close to the nation on those exercises classified as Knowledge and Comprehension at all three ages. Looking at the 20-29% category for age 13, some problems observed in the Knowledge and Comprehension levels at age 9 seem to decrease (age 9 -- 32%; age 13 -- only 19%). Moreover, there appears to be some reduction of the problem in Application and ASE by age 13 (age 9 -- 54%; age 13 -- 31%). Note also that at age 13, only 24% of the total selected exercises for this age group are those where blacks' performance is 20-29% below the nation. On the other hand, at age 17, 51% of the total selected exercises are those where blacks' performance is 20-29% below the nation. In addition, the earlier problem in Knowledge and Comprehension, suggested by the data for 9-year-olds, reappears at age 17. These patterns suggest that the duration of time between ages 13 and 17 can have critical consequences for the black student's performance in science.

TABLE 4. Distribution of the Selected Exercises Across Science Taxonomy by Categories of Blacks' Performance, Ages 9, 13 and 17

	Knowledge and Comprehension	Application and ASE	Total
Age 9 total exercises	72	24	96
0-9%	22%	13%	20%
10-19%	46	33	43
20% or more	32	54	37
TOTAL	100%	100%	100%
Age 13 total exercises	69	51	120
0-9%	32	22	28
10-19%	49	47	48
20% or more	19	31	24
TOTAL	100%	100%	100%
Age 17 total exercises	84	86	170
0-9%	19	9	14
10-19%	39	30	35
20% or more	42	60	51
TOTAL	100%	100%*	100%

Percentages may not total 100% due to rounding.

Table 5 displays the selected science exe: distributed across the content areas by ranges of black stu en ' performance for each age group. At age 9, the total number of selected exercises is small in certain areas such as Integrated Topics, Persistent Societal Problems, and Science and Self. There are no selected exercises in Decision Making and Applied Science. The number of selected exercises is a function of two things: First, at age 9, for instance, fewer exercises are developed for administration in certain more complex content areas. Second, even though more exercises are developed in the complex content areas, national performance was below the cut-point (50% or better) selected for this exploratory analysis. Therefore, at ages 13 and 17, the "zeros" under a content area mean that national performance was below the cut-point even though more exercises were developed and administered in the content areas than at age 9.

Next, consider the column, "Total." At age 9, black students' performance fell into the 0-9% category on 20% of the total selected exercises, into the 10-19% category on 43% of the total selected exercises and into the 20-29% category on 37% of the total selected exercises. It has been suggested earlier in this report that performance gaps of 0-9% below the nation may not suggest serious difficulties. This pattern also persists at age 13. However, at age 17, black students' performance fell into the 0-9% category on only 14% of the total selected exercises and the percentages increase for each subsequent range of black students' performance. This trend was observed in Table 1, where it was noted that performance difficulties among black students might lessen somewhat at age 13, but reappear and become more evident at age 17.

To determine the content areas where black students' performance appears weakest, observe the distribution of selected exercises within the content areas at each range of performance. For example, at age 9, there appear to be problems in Biology, Earth Science, Process Methods and in Science and Self, as evidenced by the large percentages of exercises occurring in the 10-19% and 20-29% categories. However, at age 13, fewer exercises are in the 20-29% category than at age 9, except in Earth Science and Applied Science. Also note at age 13 that percentages of exercises where black students' performance is only 0-9% below the nation are larger than at age 9.

At age 17, the converse is the case: fewer of the selected exercises appear in the the category of 0-9% below the nation and more of the selected exercises appear in the category of 20-29% below the nation. Process Methods (64%), Physical Science (62%), Integrated Topics (57%) and Earth Science (53%) are examples of content areas where black students appear to experience particular difficulty.

TABLE 5. Distribution of Selected Science Exercises Across Categories of Blacks' Performance by Science Content, Ages 9, 13 and 17.

	Biology	Physical Science	Earth Science	Integrated Topics	Process/ Methods	Decision Making	Persistent Societal Problems	Science and Self	Applied Science	Total
Age 9 total exercises	32	27	11	1	16	0	5	4	0	96
0-9%	19%	30%	9%	0%	12%	0%	20%	25%	0%	20%
10-19%	41	37	64	0	44	0	40	50	0	43
20% or more	41	33	27	100	44	0	40	25	0	37
TOTAL	100%*	100%	100%	100%	100%	0%	100%	100%	0%	100%
Age 13 total exercises	35	26	10	4	22	0	13	6	4	120
0-9%	34	31	20	25	18	0	30	33	0	28
10-19%	55	38	20	50	55	0	62	50	50	48
20% or more	11	31	60	25	27	0	8	17	50	24
TOTAL	100%	100%	100%	100%	100%	0%	100%	100%	100%	100%
Age 17 total exercises	39	31	15	7	36	2	25	8	7	170
0-9%	26	6	20	29	3	0	4	38	29	14
10-19%	38	32	27	14	33	50	48	25	29	35
20% or more	36	62	53	57	64	50	48	38	42	51
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

*Percentages may not total 100% due to rounding.

MATHEMATICS ACHIEVEMENT

Tables 6 through 8 present the results of the analysis of the mathematics data. Table 6 shows the comparison between national and black students' performance on selected 1977-78 mathematics exercises. We find that of the 386 exercises administered at age 9, only 50%, or 193 exercises, meet the selection criterion. Of this number, black students were 0-9% below the nation on 47 exercises, 10-19% below the nation on 113 exercises, 20-29% below the nation on 32 exercises, 30-39% below the nation on only 1 exercise and 40-49% below on none of the exercises. Notice that the numbers of exercises on which blacks performed below the nation are large in the 10-19% and 20-29% categories.

Table 7 presents the distribution of the selected exercises across the mathematics taxonomy by categories of blacks' performance. Again, for clarity the four levels have been combined into two. Notice that at age 9, black students were 0-9% below the nation on 27% of the Knowledge and Skills exercises and on only 16% of the Understanding and Application exercises. However, the percentages of Knowledge and Skills (17%) and Understanding and Applications (18%) exercises occurring in the 20%-or-more range of blacks' performance represent fewer than one-fifth of the total selected exercises. At age 13, the percentages of exercises in the 20%-or-more-below category has increased, with 46% of these exercises occurring at the Knowledge and Skills level and 39% occurring at the Understanding and Application level. At age 17, we note that 49% of the Knowledge and Skills exercises are those where blacks' performance was 20% or more below the nation, and that 55% of the Understanding and Application exercises also fit this category of blacks' performance. More problem exercises appear in the higher taxonomic level.

Table 8 displays the distribution of the selected exercises across the mathematics content areas by categories of blacks' performance. The mathematics content areas are defined in Appendix B. First notice the "Total" column in Table 8. The percentages of selected exercises occurring in the 0-9% range of blacks' performance decrease as age increases. At age 9, 24% of exercises appear in the 0-9% range; at age 13, 18% of the exercises appear in this range; and at age 17, only 14% of the exercises appear in the 0-9% range of blacks' performance. This pattern is an indication of increasing problems in mathematics at each successive age and was first noted in Table 2.

TABLE 6. Comparison Between National and Black Students' Performance on Selected 1977-78 Mathematics Exercises, Ages 9, 13 and 17

	Total Exercises Administered	Total Selected Exercises: National Performance >50%		Black Performance on Selected Exercises by Categories of Performance									
				0-9% Below N		10-19% Below N		20-29% Below N		30-39% Below N		40-49% Below N	
		No.	%*	No.	%†	No.	%	No.	%	No.	%	No.	%
Age 9	386	193	50	47	24	113	59	32	16	1	5	0	--
Age 13	633	337	53	59	18	132	39	115	34	31	9	0	--
Age 17	654	402	61	58	14	139	35	136	34	63	16	6	1

N = national

**Percentage of total exercises administered.*
†Percentage of total exercises selected.

TABLE 7. Distribution of the Selected Exercises Across Mathematics Taxonomy by Categories of Blacks' Performance, Ages 9, 13 and 17

	Knowledge and Skills	Understanding and Application	Total
Age 9 total exercises	148	45	193
0-9%	27%	16%	24%
10-19%	56	67	59
20% or more	17	18	17
TOTAL	100%	100%*	100%
Age 13 total exercises	223	114	337
0-9%	17	18	18
10-19%	37	44	39
20% or more	46	39	43
TOTAL	100%	100%	100%
Age 17 total exercises	265	137	402
0-9%	14	15	14
10-19%	37	30	35
20% or more	49	55	51
TOTAL	100%	100%	100%

**Percentages may not total 100% due to rounding.*

TABLE 8. Distribution of Selected Exercises Across Mathematics Content Areas by Taxonomy and Categories of Blacks' Performance, Ages 9, 13 and 17

	Numbers & Numeration	Variables & Relationships	Geometry (Shape, Size, Portion)	Measurement	Other Topics	Total
Age 9 total exercises	94	5	21	29	44	193
0-9%	22%	0%	33%	45%	14%	24%
10-19%	58	80	57	45	68	59
20% or more	20	20	10	10	18	17
TOTAL	100%	100%	100%	100%	100%	100%
Age 13 total exercises	152	25	43	32	85	337
0-9%	20	8	19	9	18	18
10-19%	38	32	51	25	42	39
20% or more	42	60	30	66	40	43
TOTAL	100%	100%	100%	100%	100%	100%
Age 17 total exercises	181	19	61	30	111	402
0-9%	17	5	18	13	11	14
10-19%	33	32	41	23	37	35
20% or more	50	63	41	64	52	51
TOTAL	100%	100%	100%	100%	100%	100%

Next observe the 20%-or-more category of blacks' performance for each content area at each age. At age 9, for instance, the percentages of selected exercises in this range of performance are less than the percentages of selected exercises in the 10-19% range. However, at age 13, this pattern is reversed in all content areas except Geometry and Other Topics where the larger percentages occurred in the 10-19% range. At age 17, the percentages of selected exercises in all content areas are greater in the 20%-or-more-below-the-nation category than in the 10-19% range. This pattern is an indication of problems in all of the mathematics content areas. Moreover, the pattern becomes accentuated by age 17.

Table 8 also allows us to see that Variables and Relationships and Measurement are major sources of content problems at ages 13 and 17. Among 17 black students, however, problems are suggested in all the content areas.

Appendix C shows the distribution of selected exercises across science and mathematics content areas by taxonomy and categories of blacks' performance for ages 9, 13 and 17.

CONCLUSION

The purpose of this analysis has been to identify some of the broad characteristics of performance by black students at ages 9, 13 and 17 in science and mathematics. As the findings are reviewed, one must keep in mind that all statements reflect the analysis of data based on group performance rather than on individual performance. These data in no way imply that individual black students did not or could not respond correctly to any exercise or sets of exercises.

On the basis of this exploration of exercises used in the 1976-77 science assessment and the 1977-78 mathematics assessment, clearer patterns of black students' performance have been identified. The difference between the pattern of performance in science and mathematics is that the mathematics problems appear to exist at <u>all</u> age levels and become <u>accentuated</u> by age 17. In science, there appears to be a smaller, overall gap in performance between blacks and the nation at age 9; moreover, the gap tends to narrow at age 13, but widens noticeably at age 17.

These patterns of black students' performance were suggested in Tables 1 and 2. The results presented in Tables 3, 4 and 5 clarify which areas present specific problems. For example, Table 3 indicates that there were 16 science exercises at age 17 where black students' performance fell into the 30-39%-below-the-nation category. Table 4 indicates that the Application and ASE taxonomic levels appear to be sites of major problems at age 9 and again at

age 17. Table 5 pinpoints particular content-area problems suggested first in Table 1. For example, although the data in Table 1 suggested the problems in Process Methods, now mirrored in Table 5, Table 1 did not present as clear a picture of problems now seen in the Earth Science, Physical Science and Applied Science content areas at ages 13 and 17.

Tables 6, 7 and 8 also provide a slightly different view of the mathematics data than that presented in Table 2. For example, Table 6 indicates that there are exercises on which black students' performance fell into the 30-39%-and 40-49%-below-the-nation categories at ages 13 and 17, although national performance was 50% or better. Black students' performance did not fall into the 40-49%-below-the-nation category in science at any age.

Table 7 suggests that problems at all ages may be more grave in the Understanding and Application levels than in the Knowledge and Skills levels of the taxonomy. However, at age 17, problems may be of equal strength across the taxonomy.

Table 8 indicates specific mathematical content areas where black students apparently experienced the greatest problems: Variables and Relationships and Measurement at ages 13 and 17 in particular; at age 17, across all content areas. Table 2, however, is perhaps the better display for discerning that at age 13, black youngsters experienced more problems in Skills/Measurement exercises than in Knowledge/Measurement exercises. Table 2 reflects a somewhat different primary analysis of the mathematics data than that employed for the science data.

This analysis does not provide any final answers about black students' performance in science or mathematics. Instead, the application of the exploratory method has resulted in the identification of several broad characteristics of performance patterns among black students at ages 9, 13 and 17. One of the most notable outcomes of this exploration has been the discovery that black students' performance in science does not reflect the same pattern as black students' performance in mathematics. This result has some implications for those interested in designing and implementing intervention strategies. In addition, the results have also revealed several content areas in both science and mathematics where black youngsters appear to experience consistent difficulty. This result may have educational significance for those engaged in curriculum development. Finally, the results of this exploratory analysis seem to argue for early intervention in science and mathematics for black students. This does not mean, however, that on-going remediation at the more advanced ages (13 and 17) should be curtailed. It simply suggests that early intervention should accompany later remediation activities.

Several additional aspects of black students' performance should be investigated. For example, variations in performance among black students could pinpoint more precisely those students most likely to benefit from intervention measures. Other categories, such as level of parental education, region of the country and community size, should be explored for their potential effect on student performance.

APPENDIX A

DEFINITIONS OF REPORTING GROUPS

National Assessment examines results for various groups of people within the national population. These groups are defined as follows:

Group Definitions

Sex

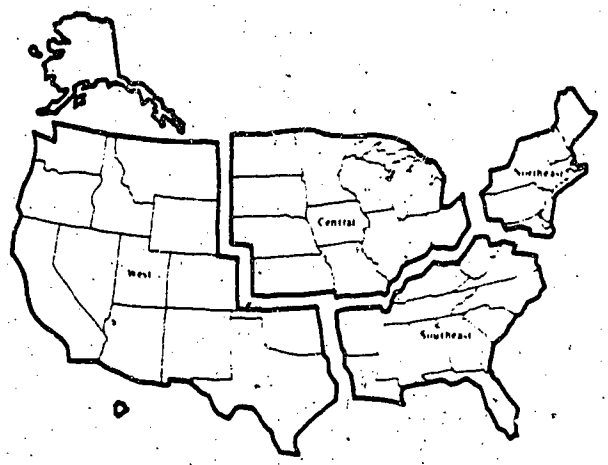
Results are reported for males and females.

Race

Results are presented for blacks, whites and Hispanos.

Region

The country has been divided into four regions: Northeast, Southeast, Central and West. States included in each region are shown on the following map.



Level of Parental Education

Three categories of parental-education levels are defined by National Assessment, based on students' reports. These categories comprise those whose parents did not graduate from high school, those who have at least one parent who graduated from high school and those who have at least one parent who has had some post-high-school education.

Type of Community

Communities in this category are defined by an occupational profile of the area served by a school as well as by the size of the community in which the school is located.

Advantaged urban. Students in this group attend schools in or around cities with a population greater than 200,000 where a high proportion of the residents are in professional or managerial positions.

Disadvantaged urban. Students in this group attend schools in or around cities with a population greater than 200,000 where a high proportion of the residents are on welfare or are not regularly employed.

Extreme rural. Students in this group attend schools in areas with a population under 10,000 where most of the residents are farmers or farm workers.

Size of Community

Big cities. Students in this group attend schools within the city limits of cities having a 1970 census population over 200,000.

Fringes around big cities. Students in this group attend schools within metropolitan areas (1970 U.S. Bureau of the Census urbanized areas) served by cities having a population greater than 200,000 but outside the city limits.

Medium cities. Students in this group attend schools in cities having a population between 25,000 and 200,000, not classified in the fringes-around-big-cities category.

Smaller places. Students in this group attend schools in communities having a population less than 25,000, not classified in the fringes-around-big-cities category.

Grade Level

Results are categorized for 9-year-olds in the 3rd or 4th grade; 13-year-olds in the 7th or 8th grade; and 17-year-olds in the 10th, 11th or 12th grade.

APPENDIX B

MATHEMATICS CONTENT AREAS

Numbers and numeration. These exercises deal with the ways numbers are used, processed or written. Knowledge and understanding of numeration and number concepts are assessed as whole numbers, fractions, decimals, integers, percents and order relationships. Problem solving, including both routine and nonroutine number problems, is also included. Some exercises are consumer problems that deal primarily with the uses of mathematics in commercial situations. This latter group is emphasized more at the 17-year-old level than at the two younger ages.

Variables and relationships. These exercises deal with facts, definitions and symbols of algebra; the use of variables in equations and inequalities; the use of variables to represent elements of a number system; functions and formulas; coordinate systems; and exponential and trigonometric functions. There are very few exercises in this category appropriate for 9-year-olds and only a few topics are appropriate for 13-year-olds. Many more are appropriate at the 17-year-old level.

Shape, size and position. These exercises measure objectives related to school geometry. They concern plane and solid shapes, congruence, similarity, properties of triangles, properties of quadrilaterals, constructions, sections of solids, other basic theorems and relationships, rotations and symmetry.

Measurement. These exercises cover appropriate units; equivalence relations; instrument reading; length, weight, capacity, time and temperature; perimeter, area and volume; nonstandard units; and precision and interpolation. Some of the measurement exercises require the use of metric units.

Other topics. The topics included at all age levels are probability and statistics; graphs, tables and charts; and logic (Mathematics Objectives, Second Assessment, 1978, pp. 18-19).

APPENDIX C

DISTRIBUTION OF SELECTED EXERCISES ACROSS SCIENCE AND MATHEMATICS CONTENT AREAS BY TAXONOMY AND CATEGORIES OF BLACKS' PERFORMANCE, AGES 9, 13 and 17

Table C-1. Distribution of the Selected Exercises Across Science Taxonomy by Categories of Blacks' Performance, Ages 9, 13 and 17

Categories of Black Performance		Science Taxonomy: Knowledge	Comprehension	Application	Analysis, Synthesis and Evaluation
ge 9 - 96 selected exercises					
-9%	19				
0-19%	41	9 or 22%	24 or 59%	8 or 19%	-0-
0-29%	36	5 or 14%	18 or 50%	10 or 28%	3 or 08%
ge 13 - 120 selected exercises					
-9%	33	4 or 12%	18 or 55%	8 or 24%	3 or 09%
0-19%	58	7 or 12%	27 or 47%	20 or 34%	4 or 07%
0-29%	28	2 or 07%	11 or 39%	11 or 39%	4 or 44%
30% +	1			1 or 100%	
ge 17 - 170 selected exercises					
-9%	24	3 or 13%	13 or 54%	7 or 29%	1 or 04%
0-19%	59	6 or 10%	27 or 46%	22 or 37%	4 or 07%
0-29%	71	5 or 07%	28 or 39%	26 or 37%	12 or 17%
30% +	16	1 or 06%	1 or 06%	12 or 75%	2 or 13%

Table C-2. Distribution of 96 Selected Exercises Across Science Content Areas by Taxonomy and Categories of Blacks' Performance, Age 9

	Biology	Phys. Sci.	Earth Science	Integ. Topics	Process. Methods	Persistent Societal Problems	Science and Self	Applied Science	Decision Making
Knowledge									
0-9% - 4	3	1	-	-	-	-	-	-	-
10-19% - 9	4	1	4	-	-	-	-	-	-
20-29% - 5	2	1	2	-	-	-	-	-	-
Comprehension									
0-9% - 12	3	4	1	-	2	1	1	-	-
10-19% - 24	6	8	3	-	3	2	2	-	-
20-29% - 18	7	4	1	-	4	1	1	-	-
Application									
0-9% - 3	-	3	-	-	-	-	-	-	-
10-19% - 8	3	1	-	-	4	-	-	-	-
20-29% - 10	4	3	-	1	1	1	-	-	-
Analysis, Synthesis and Evaluation									
0-9% - 0	-	-	-	-	-	-	-	-	-
10-19% - 0	-	-	-	-	-	-	-	-	-
20-29% - 3	-	1	-	-	2	-	-	-	-
Totals	32 or 33%	27 or 28%	11 or 12%	1 or 01%	16 or 17%	5 or 5%	4 or 4%	0	0

Table C-3. Distribution of 120 Selected Exercises Across Science Content Areas by Taxonomy and Categories of Blacks' Performance, Age 13

	Biology	Physical Science	Earth Science	Integ. Topics	Process-Methods	Persistent Societal Problems	Science and Self	Applied Science	Decision Making
Knowledge									
0-9%-4	3	-		-	-	-	1	-	-
10-19%-7	5	-	1	1	-	-	-	-	-
20-29%-2	1	-	1	-	-	-	-	-	-
Comprehension									
0-9%-18	5	5	1	1	3	2	1	-	-
10-19%-27	9	5	1	-	4	4	2	2	-
20-29%-11	3	2	4	-	-	1	-	1	-
Application									
0-9%-8	3	2	-	-	1	2	-	-	-
10-19%-20	5	5	-	1	4	4	1	-	-
20-29%-11	-	6	1	-	3	-	1	-	-
30%+-1	-	-	-	-	1	-	-	-	-
Analysis, Synthesis and Evaluation									
0-9%-3	1	1	1	-	-	-	-	-	-
10-19%-4	-	-	-	-	4	-	-	-	-
20-29%-4	-	-	-	1	2	-	-	1	-
Totals	35 or 30%	26 or 22%	10 or 08%	4 or 03%	22 or 18%	13 or 11%	6 or 05%	4 or 03%	-0-

Table C-4. Distribution of 170 Selected Exercises Across Science Content Areas by Taxonomy and Categories of Blacks' Performance, Age 17

	Biology	Physical Science	Earth Science	Integ. Topics	Process-Methods	Persistent Societal Problems	Science and Self	Applied Science	Decision Making
Knowledge									
0-9%-3	2	-	1	-	-	-	-	-	-
10-19%-6	3	-	-	-	1	1	-	1	-
20-29%-5	2	2	-	1	-	-	-	-	-
30%+ -1	1	-	-	-	-	-	-	-	-
Comprehension									
0-9%-13	5	1	2	1	1	-	2	1	-
10-19%-27	8	5	2	1	2	7	1	1	-
20-29%-28	5	3	6	2	4	6	-	2	-
30%+ -1	-	-	-	-	-	1	-	-	-
Applications									
0-9%-7	2	1	-	1	-	1	1	1	-
10-19%-22	4	5	1	-	7	4	-	-	1
20-29%-26	3	10	-	1	8	2	1	1	-
30%+ -12	2	4	1	-	3	1	1	-	-
Analysis, Synthesis and Evaluation									
0-9%-1	1	-	-	-	-	-	-	-	-
10-19%-4	-	-	1	-	2	-	1	-	-
20-29%-12	-	-	1	-	7	2	1	-	1
30%+ -2	1	-	-	-	1	-	-	-	-
Totals	39 or 23%	31 or 18%	15 or 09%	7 or 04%	36 or 21%	25 or 15%	8 or 05%	7 or 04%	2 or 01%

Table C-5. Distribution of the Selected Exercises Across Mathematics Taxonomy by Categories of Blacks' Performance, Ages 9, 13 and 17

Categories of Black Performance	Mathematics Taxonomy			
	Knowledge	Skills	Understanding	Application
Age 9, 193 Selected Exercises				
0-9% - 47	28 or 60%	12 or 26%	4 or 08%	3 or 06%
10-19% - 113	46 or 41%	37 or 33%	10 or 09%	20 or 17%
20-29% - 32	15 or 47%	9 or 28%	2 or 06%	6 or 19%
30-39% - 1	0	1 or 100%	0	0
Age 13, 337 Selected Exercises				
0-9% - 59	19 or 32%	20 or 34%	9 or 15%	11 or 19%
10-19% - 132	37 or 28%	45 or 34%	24 or 18%	26 or 20%
20-29% - 115	31 or 27%	47 or 41%	23 or 20%	14 or 12%
30-39% - 31	7 or 23%	17 or 55%	1 or 03%	6 or 19%
Age 17, 402 Selected Exercises				
0-9% - 58	17 or 29%	21 or 36%	9 or 16%	11 or 19%
10-19% - 139	35 or 25%	63 or 45%	22 or 16%	19 or 14%
20-29% - 136	30 or 22%	59 or 44%	21 or 15%	26 or 19%
30-39% - 63	15 or 24%	20 or 32%	12 or 19%	16 or 25%
40-49% - 6	0	5 or 83%	1 or 17%	0

Table C-6. Distribution of 193 Selected Exercises Across Mathematics Content Areas by Taxonomy and Categories of Blacks' Performance, Age 9

	Numbers & Numeration	Variables & Relationships	Geometry (Shape, Size, Position)	Measurement	Other Topics
Knowledge					
0-9% - 28	17	-	5	6	-
10-19% - 46	36	-	6	4	-
20-29% - 15	15	-	-	-	-
30-39% - 0					
Skills					
0-9% - 12	3	-	1	7	1
10-19% - 37	12	4	4	9	8
20-29% - 9	1	1	1	3	3
30-39% - 1	-	-	-	-	1
Understanding					
0-9% - 4	1	-	1	-	2
10-19% - 10	-	-	2	-	8
20-29% - 2	1	-	1	-	-
30-39% - 0	-	-	-	-	-
Application					
0-9% - 3	-	-	-	-	3
10-19% - 20	6	-	-	-	14
20-29% - 6	2	-	-	-	4
30-39% - 0	-	-	-	-	-
Totals	94 or 49%	5 or 02%	21 or 11%	29 or 15%	44 or 23%

Table C-7. Distribution of 337 Selected Exercises Across Mathematics Content Areas by Taxonomy and Categories of Blacks' Performance, Age 13

	Numbers & Numeration	Variables & Relationships	Geometry (Shape, Size, Position)	Measurement	Other Topics
Knowledge					
0-9% - 19	11	-	7	1	-
10-19% - 37	23	-	10	4	-
20-29% - 31	18	-	7	6	-
30-39% - 7	2	-	4	1	-
Skills					
0-9% - 20	10	2	1	2	5
10-19% - 45	21	8	5	4	7
20-29% - 47	21	10	2	7	7
30-39% - 17	4	5	-	6	2
Understanding					
0-9% - 9	7	-	-	-	2
10-19% - 24	6	-	6	-	12
20-29% - 23	10	-	-	-	13
30-39% - 1	-	-	-	-	1
Application					
0-9% - 11	3	-	-	-	8
10-19% - 26	8	-	1	-	17
20-29% - 14	5	-	-	-	9
30-39% - 6	3	-	-	1	2
Totals	152 or 45%	25 or 07%	43 or 13%	32 or 10%	85 or 25%

Table C-8. Distribution of 402 Selected Exercises Across Mathematics Content Areas by Taxonomy and Categories of Blacks' Performance, Age 17

	Numbers & Numeration	Variables & Relationships	Geometry (Shape, Size, Position)	Measurement	Other Topics
Knowledge					
0-9% - 17	9	-	5	3	-
10-19% - 35	18	-	12	4	1
20-29% - 30	10	-	15	5	-
30-39% - 15	8	-	5	2	-
Skills					
0-9% - 21	16	1	-	1	3
10-19% - 63	33	6	6	3	15
20-29% - 59	36	8	3	4	8
30-39% - 20	10	2	-	3	5
40-49% - 5	-	2	-	2	1
Understanding					
0-9% - 9	3	-	6	-	-
10-19% - 22	7	-	5	-	10
20-29% - 21	11	-	--	-	10
30-39% - 12	3	-	--	-	9
40-49% - 1	--	-	--	-	1
Application					
0-9% - 11	2	-	-	-	9
10-19% - 19	2	-	2	-	15
20-29% - 26	7	-	2	1	16
30-39% - 16	6	-	-	2	8
TOTALS	181 or 45%	19 or 05%	61 or 15%	30 or 07%	111 or 28%

BIBLIOGRAPHY

Banks, W.C. et al. "Toward a Reconceptualization of the Social Cognitive Bases of Achievement Orientations in Blacks," Review of Educational Research, vol. 48, 1978, pp. 381-398.

Bloom B. et al. Taxonomy of Educational Objectives, Handbook I: Cognitive Domain. New York: David McKay, 1956.

Cameron, H. "Nonintellectual Correlates of Academic Achievement," Journal of Negro Education, vol. 37, 1968, pp. 252-257.

Changes in Mathematical Achievement, 1973-78, Report no. 09-MA-01, 1972-73 and 1977-78 Assessments. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1979. ERIC no. ED 177 011. ISBN 0-89398-134-6.

Davis, A. Social Class and Learning. Cambridge, Mass.: Harvard University Press, 1952.

Epps, E. et al. "Effects of Race on Comparison and Motives on Negro Cognitive Performance," Journal of Educational Psychology, vol. 62, 1971, pp. 208-208.

Fornoff, F.J. A Survey of the Teaching of Chemistry in Secondary Schools. Princeton, N.J.: Educational Testing Service, 1969.

Hechinger, Fred M. "SAT SCORES: What Happened to the Test and the Brightest?" Saturday Review/World, vol. 1, 1974.

Helgeson, S.L. et al., eds. The Status of Pre-College Science, Mathematics and Social Science Education: 1955-75. Columbus, Ohio: The Ohio State Literature Review, 1978.

Johnson, S.T. The Measurement Mystique: Issues in Selection for Professional Schools and Employment. Washington, D.C.: Institute for the Study of Educational Policy, Howard University, vol. 2, 1979.

Katz, I. et al. "Race of Evaluator, Race of Norm, and Expectancy as Determiners of Black Performance," Journal of Experimental Psychology, vol. 8, 1972, pp. 1-15.

Katz, I. et al. "Effects of Difficulty, Race of Administrator, and Instructions on Negro Digit-Symbol Performance." ONR Technical Report. Washington D.C.: Office of Naval Research, 1963.

Katz, I. et al. "The Influence of Race of the Experimenter and Instructions Upon the Expression of Hostility by Negro Boys," Journal of Social Issues, vol. 20, 1964, pp. 54-59.

Mathematical Applications, Report no. 09-MA-03, 1977-78 Assessment. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1979. ERIC no. ED 176 965. ISBN 0-89398-136-2.

Mathematical Knowledge and Skills, Report no. 09-MA-02, 1977-78 Assessment. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1979. ERIC no. ED 176 964. ISBN 0-89398-135-4.

Mathematics Objectives, Second Assessment, 1977-78 Assessment. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1978. ERIC no. ED 156 439. ISBN 0-89398-133-8.

Medley, D.M. and T.J. Quirk. "The Application of a Factorial Design to the Study of Cultural Bias in General Culture Items on the National Teachers Examination," Journal of Educational Measurement, vol. 11, 1974, pp. 235-245.

National Assessments of Science, 1969-73, Report no. 04-S-00, 1969-70 and 1972-73 Assessments. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1975. ERIC no. ED 104 723. ISBN 0-89398-285-7.

Science Achievement: Racial and Regional Trends, 1969-73, Report no. BRS-1, 1969-70 and 1972-73 Assessments. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1976. ERIC no. ED 127 143. ISBN 0-89398-291-1.

Science Achievement in the Schools: A Summary of Results From the 1976-77 National Assessment of Science, Report no. 08-S-01. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1978. ERIC no. ED 164 337. ISBN 0-89398-294-6.

Science Objectives for the Third Assessment, 1976-77 Assessment. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1979. ERIC no. ED 179 402. ISBN 0-89398-293-8.

The Condition of Education: Statistical Report. Washington, D.C.: National Center for Education Statistics, 1978.

The Influence of High School Racial Composition on Black College Attendance and Test Performance. Washington, D.C.: National Center for Education Statistics, 1978.

Thorndike, R. "Concepts of Culture Fairness," Journal of Educational Measurement, vol. 8, 1971, pp. 63-70.

Three National Assessments of Science, 1969-77: Technical Summary, Report no. 08-S-21, 1969-70, 1972-73 and 1976-77 Assessments. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1979. ERIC no. ED 168 901. ISBN 0-89398-297-0.

Three National Assessments of Science: Changes in Achievement, 1969-77, Report no. 08-S-00, 1969-70, 1972-73 and 1976-77 Assessments. Denver, Colo.: National Assessment of Educational Progress, Education Commission of the States, 1978. ERIC no. ED 159 026. ISBN 0-89398-296-2.