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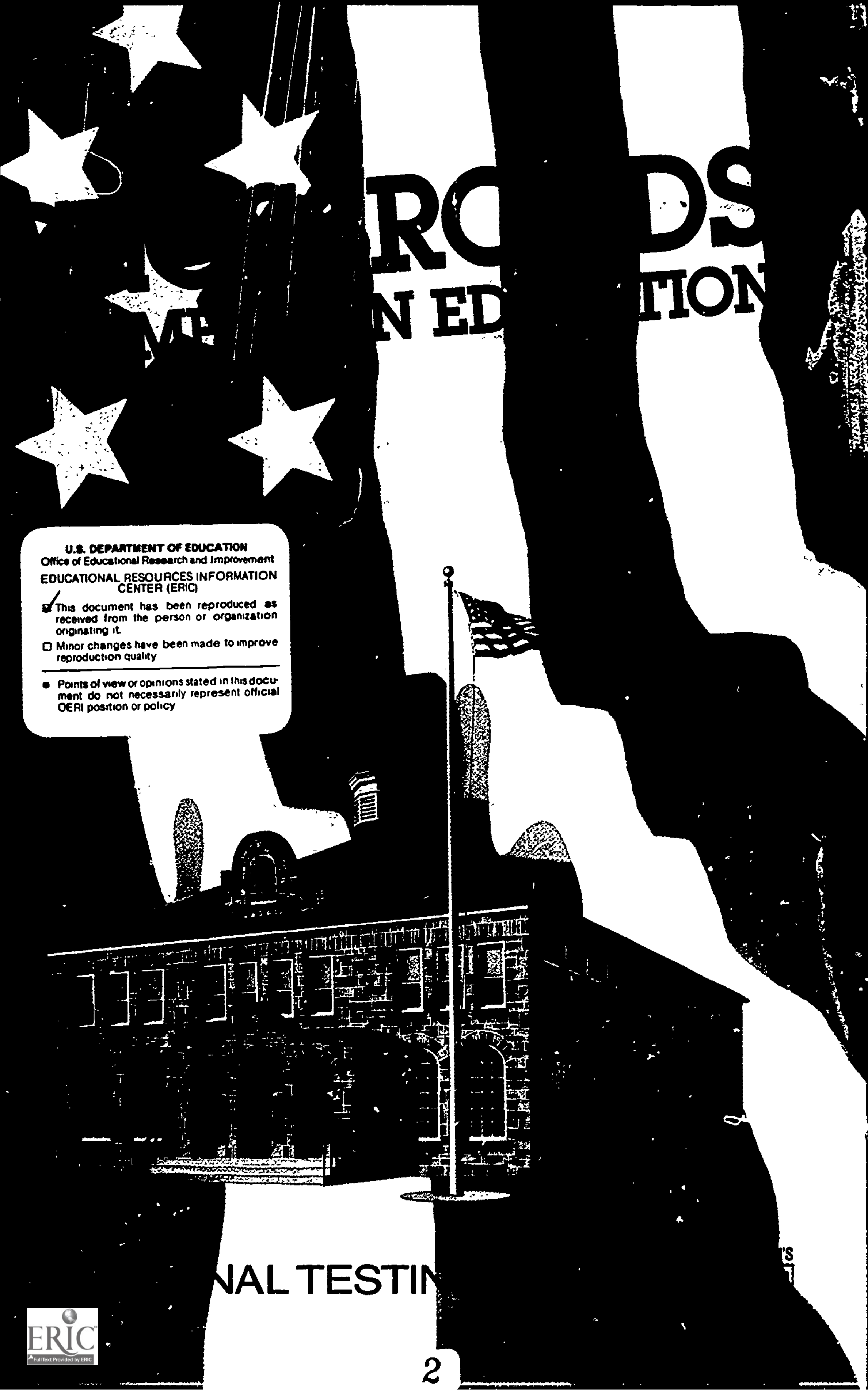
ABSTRACT

This summary report from The Nation's Report Card offers a synthesis of findings from recent national assessments of American education for 9-, 13-, and 17-year-old students in a variety of subject areas. Areas covered include reading, writing, mathematics, science, American history, literature, and computer competence. Trends in academic achievement, levels of learning, and factors related to achievement are discussed. Since 1969, the National Assessment of Educational Progress (NAEP) has conducted regular surveys of student proficiency in a range of subjects, each involving a national sample of students; about 1.4 million students from a cross-section of grade levels have participated in the assessments to date. Findings from recent NAEP assessments provide evidence of progress in students' academic achievement. Results from the 1984 and 1986 assessments indicate that, on the average, students' proficiency in reading has improved; proficiency in writing, mathematics, and science has improved in recent assessments following earlier declines. Equity is being approached between minority students and their white peers. Student achievement gains are associated with time spent on homework, course rigor, participatory teaching, and supportive home environments. The findings also indicate a lack of significant advancement in the area of innovative and thoughtful application of knowledge. Descriptions of proficiency levels (levels 150, 200, 250, 300, and 350) for reading, mathematics, and science are appended in the form of sample test items. (TJH)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CROSSROADS
IN AMERICAN EDUCATION

A Summary of Findings

THE NATION'S REPORT CARD naep

Arthur N. Applebee   Judith A. Langer   Ina V.S. Mullis

ETS

Educational Testing Service
Princeton, New Jersey

February 1989

Report No 17 OV-01

This report is based primarily on the following NAEP reports:

The Reading Report Card, Progress Toward Excellence in Our Schools. Trends in Reading Over Four National Assessments, 1971-1984 (Princeton, NJ: National Assessment of Educational Progress, 1985).

Arthur N. Applebee, Judith A. Langer, and Ina V.S. Mullis, *The Writing Report Card. Writing Achievement in American Schools* (Princeton, NJ: National Assessment of Educational Progress, 1986).

John A. Dossey, Ina V.S. Mullis, Mary M. Lindquist, and Donald L. Chambers, *The Mathematics Report Card: Are We Measuring Up? Trends and Achievement Based on the 1986 National Assessment* (Princeton, NJ: National Assessment of Educational Progress, 1988).

Ina V.S. Mullis and Lynn B. Jenkins, *The Science Report Card: Elements of Risk and Recovery* (Princeton, NJ: National Assessment of Educational Progress, 1988).

The following reports are also referenced:

Arthur N. Applebee, Judith A. Langer, and Ina V.S. Mullis, *Writing Trends Across the Decade* (Princeton, NJ: National Assessment of Educational Progress, 1986)

Arthur N. Applebee, Judith A. Langer, and Ina V.S. Mullis, *Literature and U.S. History: The Instructional Experience and Factual Knowledge of High-School Juniors* (Princeton, NJ. National Assessment of Educational Progress, 1987).

Michael E. Martinez and Nancy A. Mead, *Computer Competence. The First National Assessment* (Princeton, NJ: National Assessment of Educational Progress, 1988).

Acknowledgments

Many individuals generously contributed their ideas, time and energy to implementing the 1984 and 1986 assessments and generating the reports listed above. Their diligent work is gratefully acknowledged as laying the foundation for this report.

For this summary report, the authors express their gratitude to Lynn Jenkins, whose thoughtful reviews and skillful editing helped bring the report to its current form. Bev Cisney is acknowledged for her exceptional dedication and word-processing skills. Kent Ashworth, Jan Askew, Paul Barton, Eugene Johnson, Janet Johnson, and Archie Lapointe are also thanked for their helpful comments on successive drafts.

Foreword

Each biennial assessment for the Nation's Report Card gives us cause to reflect on the educational progress our country has made and the directions that the results suggest will lead to sustained and even more substantive improvements. *Crossroads in American Education* tells us we have brought the nation's young people to a minimum standard of literacy — they generally have mastered rudimentary reading and writing skills and some fundamental knowledge in mathematics and science. But very few of our young people can use their knowledge and skills for thoughtful or problem-solving purposes, and not many can reason at higher levels.

How can students be better prepared to apply their skills and knowledge in thoughtful ways, as will be required throughout their lives?

Aristotle made the point that "People become house builders through building houses, harp players through playing the harp." We might add that students can become thinkers and problem solvers through learning experiences that challenge them and stretch their minds. *Crossroads in American Education* indicates that the typical school experience can be strengthened with more learning opportunities that actively involve the student — a time-honored pedagogical fact with new meaning today.

Recent improvements are evident and represent significant national accomplishment. But progress falls short of what the times require. Much more progress is needed for the economic development of our nation and the intellectual well-being of the next generation.

Recent findings of the National Assessment of Educational Progress (NAEP) indicate that:

- An estimated 61 percent of 17-year-olds do not demonstrate the reading ability necessary to find, understand, and explain relatively complicated information, including material about topics they study in school;
- More than one-quarter of 13-year-olds fail to demonstrate an adequate understanding of the content and procedures emphasized in elementary school mathematics;
- In science classes, 41 percent of the 11th graders and 60 percent of the 7th graders report never being asked to write up a science experiment independently.

Our nation is at an educational crossroads. Education must prove that it is equal to the challenges of technology and the information age. The success of our economy and, indeed, the survival of our democracy have become more dependent than ever before on each individual's ability to master increasingly complex knowledge and skills.

The NAEP data presented in this report place the future of educational opportunities in the hands of the American people: Can we be satisfied with gradual improvements in basic skills, or should we also work to ensure schooling prepares all American children for the challenges that lie ahead of them? I believe the answer is clear.

Gregory R. Anrig
President
Educational Testing Service

CONTENTS

OVERVIEW

THIS SUMMARY report from The Nation's Report Card offers a synthesis of findings from recent national assessments in a variety of subject areas, including reading, writing, mathematics, and science, as well as U.S. history, literature, and computer competence. Since 1969, the National Assessment of Educational Progress (NAEP) has conducted regular surveys of student proficiency in a range of subjects, each involving a national sample of students; some 1.4 million students from across the grades have participated in the assessments to date.[1]

Findings from recent NAEP assessments provide evidence of progress in students' academic achievement. Results from the 1984 and 1986 assessments indicate that, on the average, students' proficiency in reading has improved across time, and proficiency in writing, mathematics, and science has improved in recent assessments after earlier declines. In addition, there is evidence that some strides have been made toward equity: Gaps in average academic performance that have historically existed between Black students and their White peers and between Hispanic students and their White peers have been reduced by a considerable margin in some subjects.

Despite these positive signs, the remaining challenges are many. Not all ground lost during the 1970s and early 1980s has been regained, and there was considerable concern even at the time of the first assessments about the quality of student learning. In addition, a closer examination of the NAEP data indicates that recent gains in student performance have occurred primarily at the lower levels of achievement. For example, students have improved in their ability to do simple computation, comprehend simple text, and exhibit knowledge of everyday science facts. However, too few students develop the capacity to use the knowledge and skills they acquire in school for thoughtful or innovative purposes. And too few students learn to reason effectively about information from the subjects they study.

[1] Detailed information on sampling, number and types of items, and derivation of scales is presented in each subject area report (see page 2).

The NAEP assessments have pinpointed a number of variables that appear to be positively related to academic proficiency. Corroborating common wisdom, NAEP has found that students who spend more time on homework, take more rigorous courses, have teachers who use more participatory instructional activities, and who have a home environment supportive of learning generally have higher proficiency in various subject areas than their peers who lack these characteristics. It should be noted, however, that chicken-and-egg questions cannot be answered by the NAEP data; for example, one cannot know whether students with higher proficiency are more likely to seek out rigorous courses or whether the courses themselves strengthen proficiency.

Overall, the NAEP data suggest that American education is at a crossroads. While academic achievement appears to be improving after years of decline, the continuing lack of growth in higher-level skills suggests that more fundamental changes in curriculum and instruction may be needed in order to produce more substantive improvements. The educational system in this country needs to extend its focus from the teaching and learning of skills and content to include an emphasis on the purposeful use of skills and knowledge. Fortunately, instructional research and pedagogy point to some promising new directions for developing qualitatively different approaches to teaching and learning.

TRENDS IN ACADEMIC ACHIEVEMENT

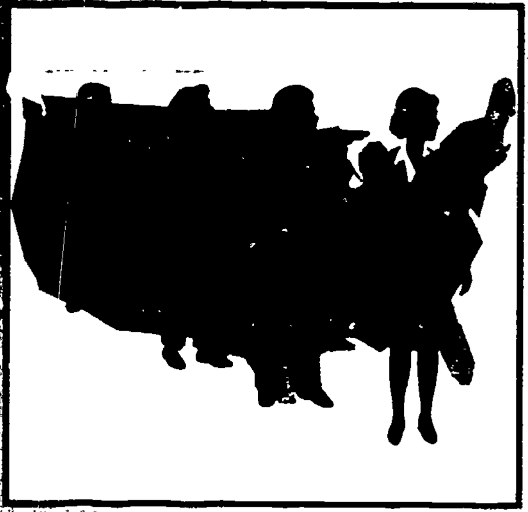
Signs of Progress

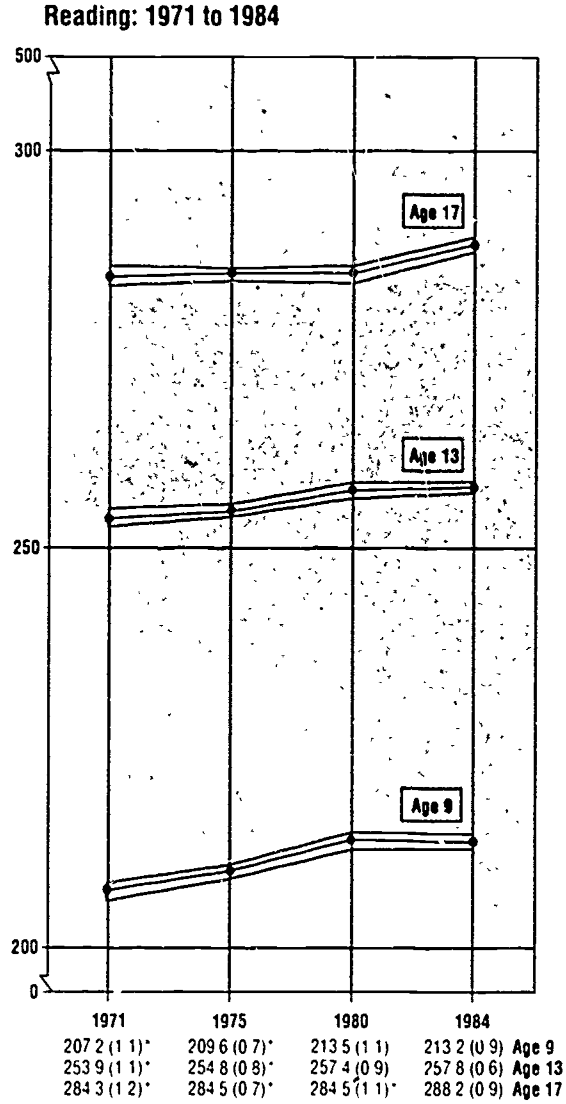
IN EACH subject area it assesses, The Nation's Report Card summarizes trends in average proficiency for 9-, 13-, and 17-year-olds on a subject-area proficiency scale. Using these scales, it is possible to talk about subject-matter proficiency for particular subpopulations, report trends in performance, trace the growth of students' proficiency across age or grade levels, and estimate the relationship between proficiency and background variables.[2]

Trends in the overall academic proficiency of the nation's 9-, 13-, and 17-year olds in reading (from 1971 to 1984), mathematics (from 1973 to 1986), and science (from 1969-70 to 1986) are summarized in Figure 1. Trends in writing proficiency, which are based on performance on individual items rather than composite scales, are discussed later in this section. In general, students' proficiency in reading, mathematics, science, and writing appears to have improved in recent assessments, with gains for certain age groups in various subjects being greater than others. Given this common theme, however, a closer study of trends in achievement reveals variations in the timing of declines and recoveries.

[2] While the scales for different subject areas are expressed in the same numerical units, they are not comparable. Like all other scales developed using Item Response Theory (IRT) technology, the NAEP scales cannot be described in absolute terms; thus, for example, one cannot say how much learning in mathematics equals how much learning in science and reading. It should also be noted that the terms proficiency and achievement refer specifically to performance on the items on the NAEP assessment.

Figure 1: National Trends in Average Proficiency: Ages 9, 13, and 17



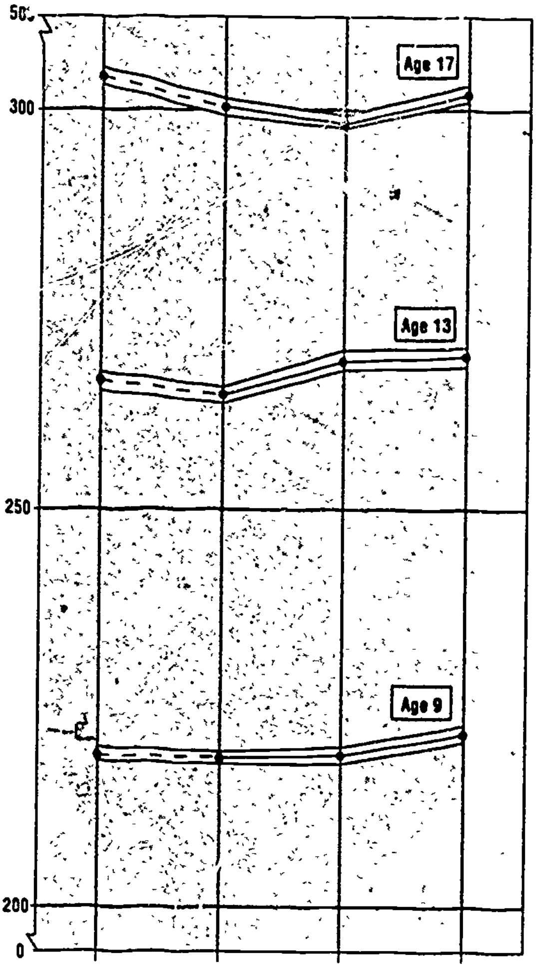


[--] Extrapolated from previous NAEP analyses

* Statistically significant difference from the most recent assessment at the 05 level Standard errors are presented in parentheses

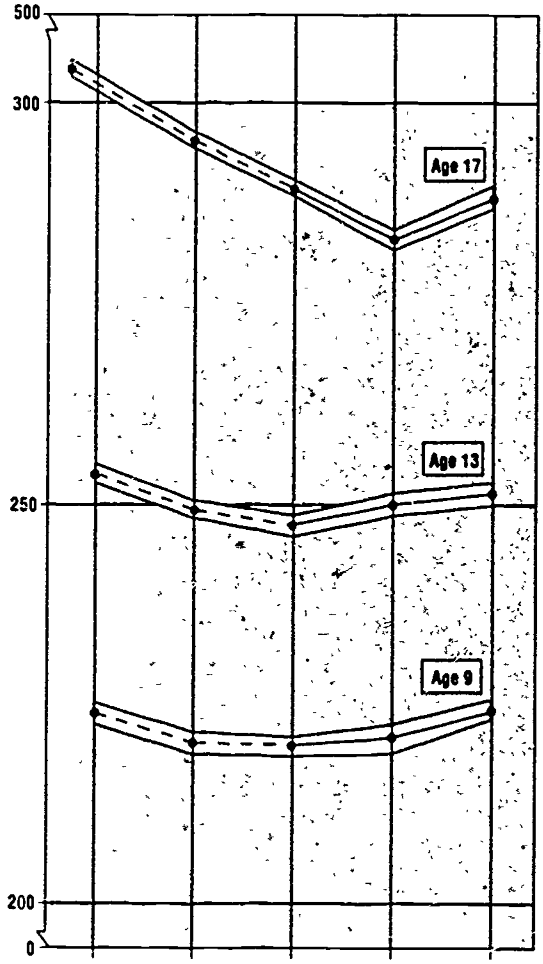
Reading. Students at all three ages were reading significantly better in 1984 than in 1971. The reading proficiency of 9- and 13-year-olds improved steadily through the 1970s, then was stable from 1980 to 1984. In contrast, 17-year-olds' reading proficiency remained relatively constant across the 1970s, then improved between 1980 and 1984.

Mathematics: 1973 to 1986



	1973	1978	1982	1986
Age 9	[219 1] (0 8)	218 6 (0 8)*	219 0 (1 1)	221 7 (1 0)
Age 13	[266 0] (1 1)	264 1 (1 1)*	268 6 (1 1)	269 0 (1 2)
Age 17	[304 4] (0 9)	300 4 (0 9)	298 5 (0 9)*	302 0 (0 9)

Science: 1969-70 to 1986†



	1970	1973	1977	1982	1986
Age 9	[224 9 (1 2)]	[220 3 (1 2)]	219 9 (1 2)*	220 9 (1 8)	224 3 (1 2)
Age 13	[254 9 (1 1)]	[249 5 (1 1)]	247 4 (1 1)	250 2 (1 3)	251 4 (1 4)
Age 17	[304 8 (1 0)]	[295 8 (1 0)]	289 6 (1 0)	283 3 (1 1)*	288 5 (1 4)

Estimated population mean proficiency and 95% confidence interval It can be said with 95 percent certainty that the mean proficiency of the population of interest is within this interval

† Note While 9- and 13 year-olds were assessed in the spring of 1970 17-year olds were assessed in the spring of 1969

Mathematics. The mathematics proficiency of 9- and 13-year-olds was higher in 1986 than in the first NAEP mathematics assessment in 1973. The performance of 9-year-olds remained quite stable across the 1970s, then improved significantly from 1982 to 1986. In contrast, 13-year-olds' proficiency declined slightly in the mid-1970s, improved significantly from 1978 to 1982, then changed little from 1982 to 1986. Seventeen-year-olds' proficiency declined steadily from 1973 to 1982, then showed signs of initial recovery by improving significantly between 1982 and 1986.

Science. After declining in the early 1970s and changing little from 1973 to 1982, 9-year-olds' science proficiency improved between 1982 and 1986, regaining the levels of the 1970 assessment. Trends were similar for 13-year-olds, although their average proficiency declined more and recovered less. For students at age 17, science proficiency dropped steadily from 1969 to 1982 before increasing significantly from 1982 to 1986. Despite recent gains, 17-year-olds' average proficiency in 1986 remained well below that of 1970, when science proficiency was first measured.

Writing. An examination of trends in writing achievement between 1974 and 1984 also reveals some recent improvements, although writing proficiency across the ages generally appeared to be no better in 1984 than it was 10 years earlier. The writing proficiency of 13- and 17-year-olds climbed between 1979 and 1984, after declining from 1974 to 1979. Across the same decade, 9-year-olds' writing performance was somewhat more uneven, declining on some writing tasks while improving on others.

A study of the timing of declines and recoveries for each age group across subject areas reveals some interesting patterns. The NAEP mathematics results indicate that students born in 1965 declined in performance at ages 13 and 17 compared to students born earlier. Further, those students born four years later (in 1969) showed gains at ages 13 and 17 compared to students born in 1965. Thus, it appears that the recent declines and improvements at age 17 may reflect declines and improvements made by this group of students when they were 13, suggesting that the recent improvements at age 17 are not simply the result of changes currently being made to strengthen high-school graduation requirements. Similar patterns of performance by birth-year cohorts were evident in the science and reading assessments.

The improvements in achievement reflected in the assessment data also may reflect the positive impact of a variety of recent efforts to reform education. Cumulatively, these efforts seem to have halted earlier declines in each subject and begun to bring proficiency levels back to where they were in the early 1970s.

Signs of Equity

In the last 20 years, one of the major goals of educational reform has been to improve the performance of minority populations historically at risk of school failure. A variety of programs have been introduced to accomplish this goal, from preschool and day-care programs to targeted classes providing additional instruction as part of the regular school day. Given that achievement levels have begun to improve somewhat for the nation as a whole, how well have members of these minority groups done during this period?

Figures 2A and 2B summarize trends in the performance gap between Black and Hispanic schoolchildren and their White peers at ages 9, 13, and 17. In general, it appears that the performance gaps, as measured by differences in average proficiency, have narrowed across time, particularly for Black students. Decreases in the disparities in reading and mathematics performance are the most consistent among the subject areas across time, with the gap decreasing gradually, while the gaps in science performance are the least stable. For Hispanic and Black students alike, the gap in science achievement relative to White students increased until 1982, before narrowing between 1982 and 1986.

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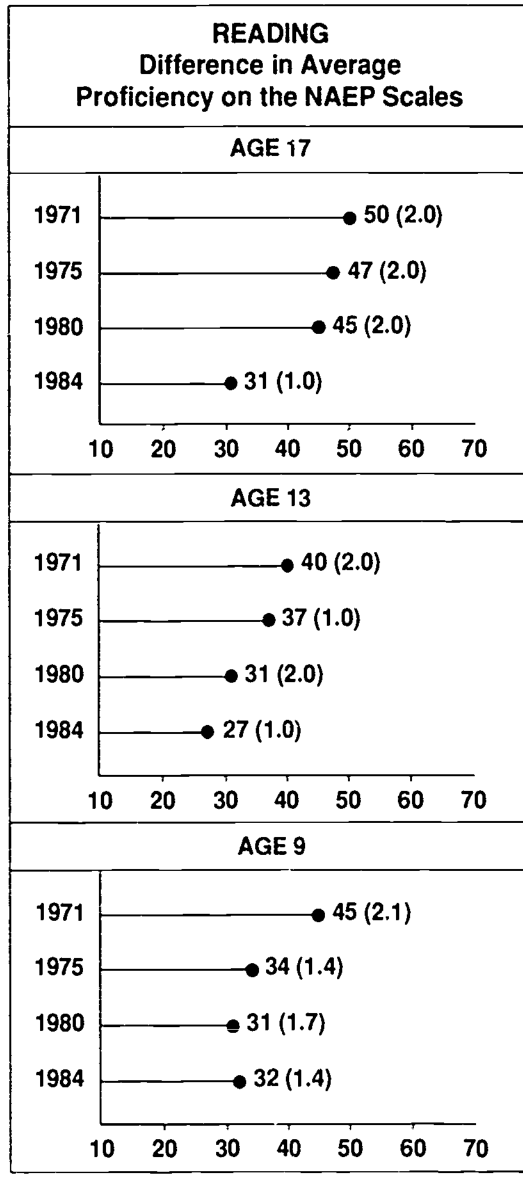
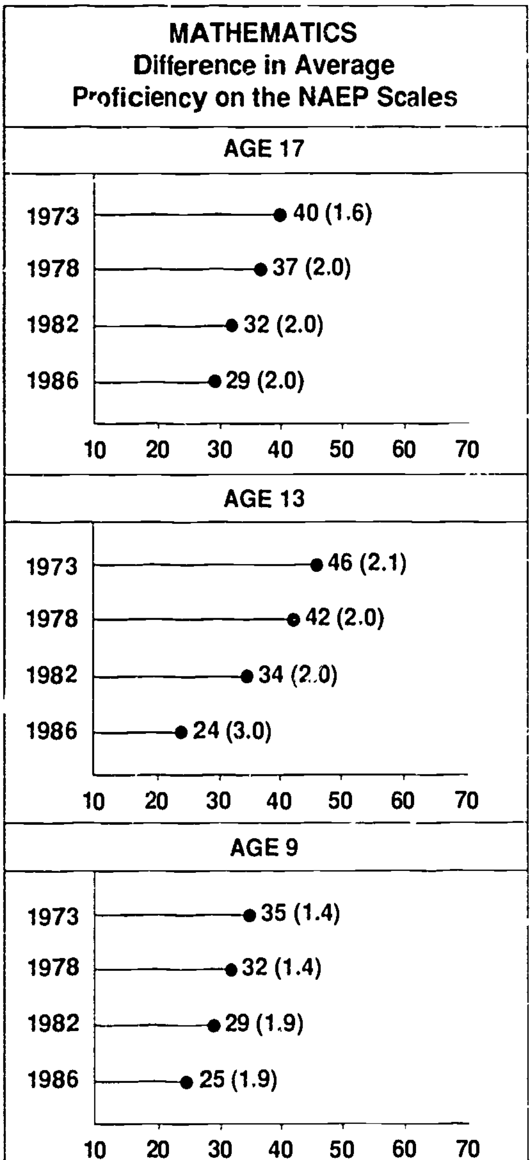
Gap Between the Average Proficiency of White and Black Students Across Subject Areas, 1969 to 1986: Ages 9, 13, and 17*

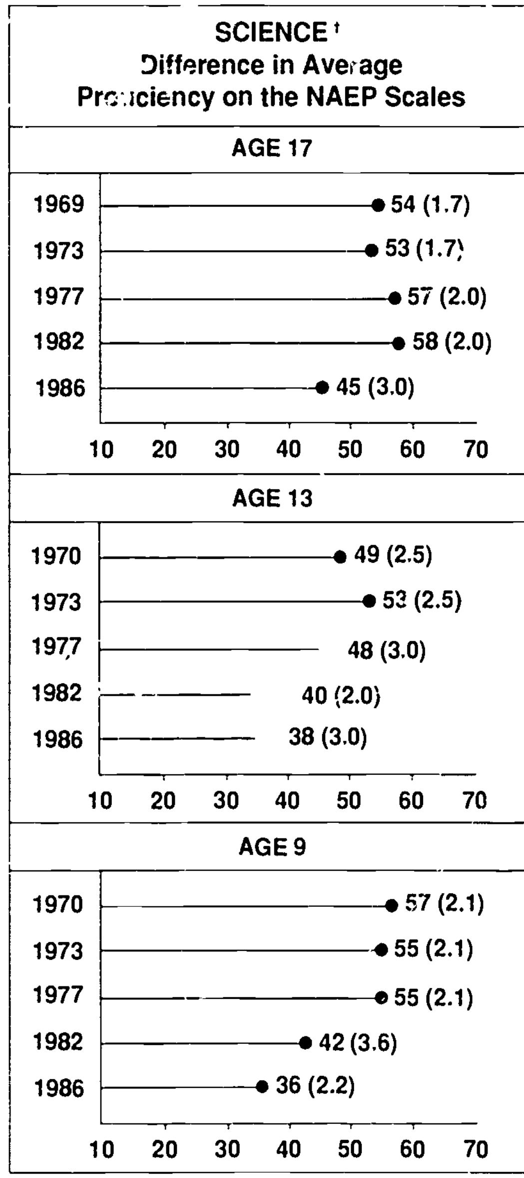
FIGURE 2A



* Average proficiency for White students minus average proficiency of Black students Standard errors are presented in parentheses It can be said with 95 percent certainty that the difference in mean proficiency between the populations of interest is within ± 2 standard errors.

† Note While 9- and 13-year-olds were assessed in the spring of 1970, 17-year-olds were assessed in the spring of 1969.

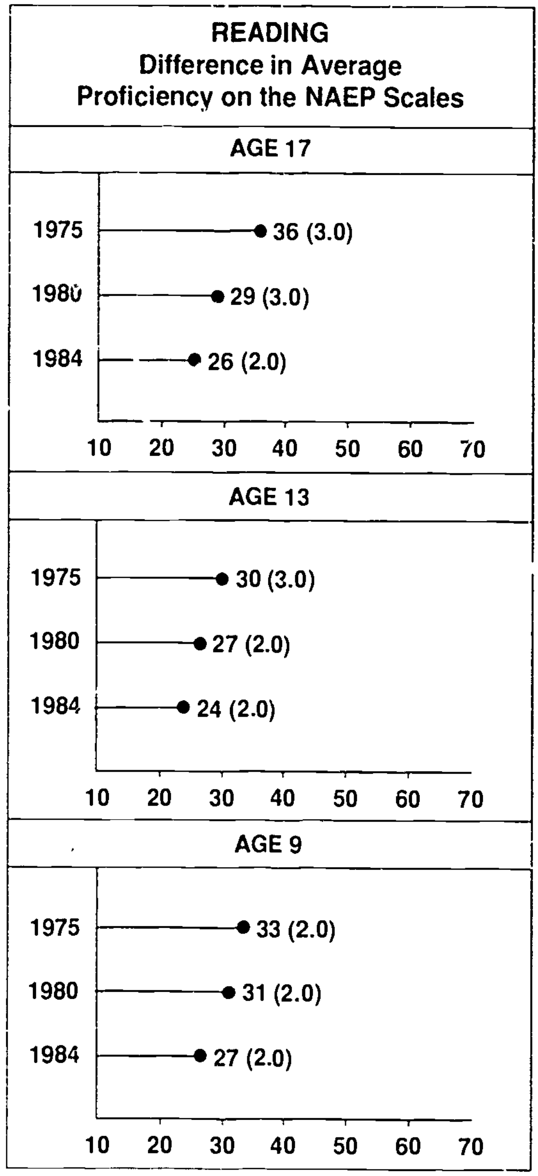

MATHEMATICS
Difference in Average
Proficiency on the NAEP Scales
AGE 17
1973 40 (1.6)
1978 37 (2.0)
1982 32 (2.0)
1986 29 (2.0)
10 20 30 40 50 60 70
AGE 13
1973 46 (2.1)
1978 42 (2.0)
1982 34 (2.0)
1986 24 (3.0)
10 20 30 40 50 60 70
AGE 9
1973 35 (1.4)
1978 32 (1.4)
1982 29 (1.9)
1986 25 (1.9)
10 20 30 40 50 60 70


SCIENCE †
Difference in Average
Proficiency on the NAEP Scales
AGE 17
1969 54 (1.7)
1973 53 (1.7)
1977 57 (2.0)
1982 58 (2.0)
1986 45 (3.0)
10 20 30 40 50 60 70
AGE 13
1970 49 (2.5)
1973 53 (2.5)
1977 48 (3.0)
1982 40 (2.0)
1986 38 (3.0)
10 20 30 40 50 60 70
AGE 9
1970 57 (2.1)
1973 55 (2.1)
1977 55 (2.1)
1982 42 (3.6)
1986 36 (2.2)
10 20 30 40 50 60 70

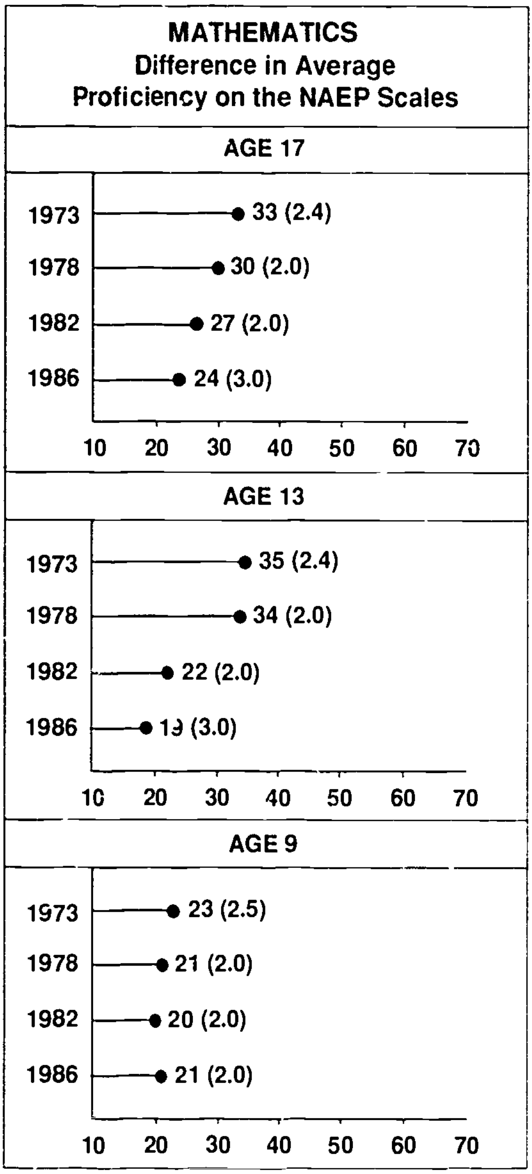
THE NATION'S REPORT CARD NAEP

Gap Between the Average Proficiency of White and Hispanic Students Across Subject Areas, 1973 to 1986: Ages 9, 13, and 17*

FIGURE 2B



* Average proficiency for White students minus average proficiency of Hispanic students Standard errors are presented in parentheses It can be said with 95 percent certainty that the difference in mean proficiency between the populations of interest is within ± 2 standard errors


MATHEMATICS
Difference in Average
Proficiency on the NAEP Scales
AGE 17
1973
33 (2.4)
1978
30 (2.0)
1982
27 (2.0)
1986
24 (3.0)
10 20 30 40 50 60 70
AGE 13
1973
35 (2.4)
1978
34 (2.0)
1982
22 (2.0)
1986
19 (3.0)
10 20 30 40 50 60 70
AGE 9
1973
23 (2.5)
1978
21 (2.0)
1982
20 (2.0)
1986
21 (2.0)
10 20 30 40 50 60 70

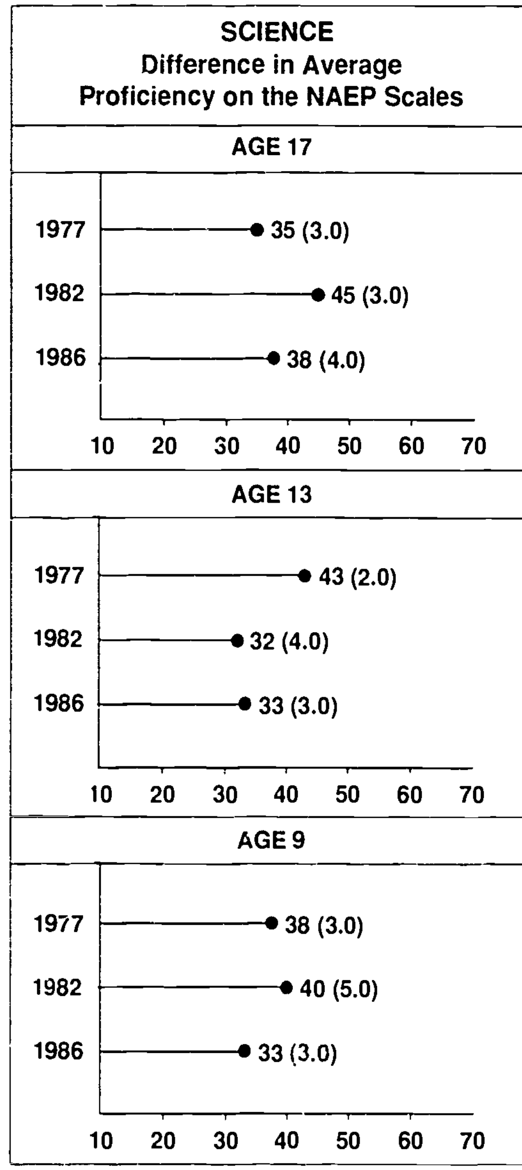
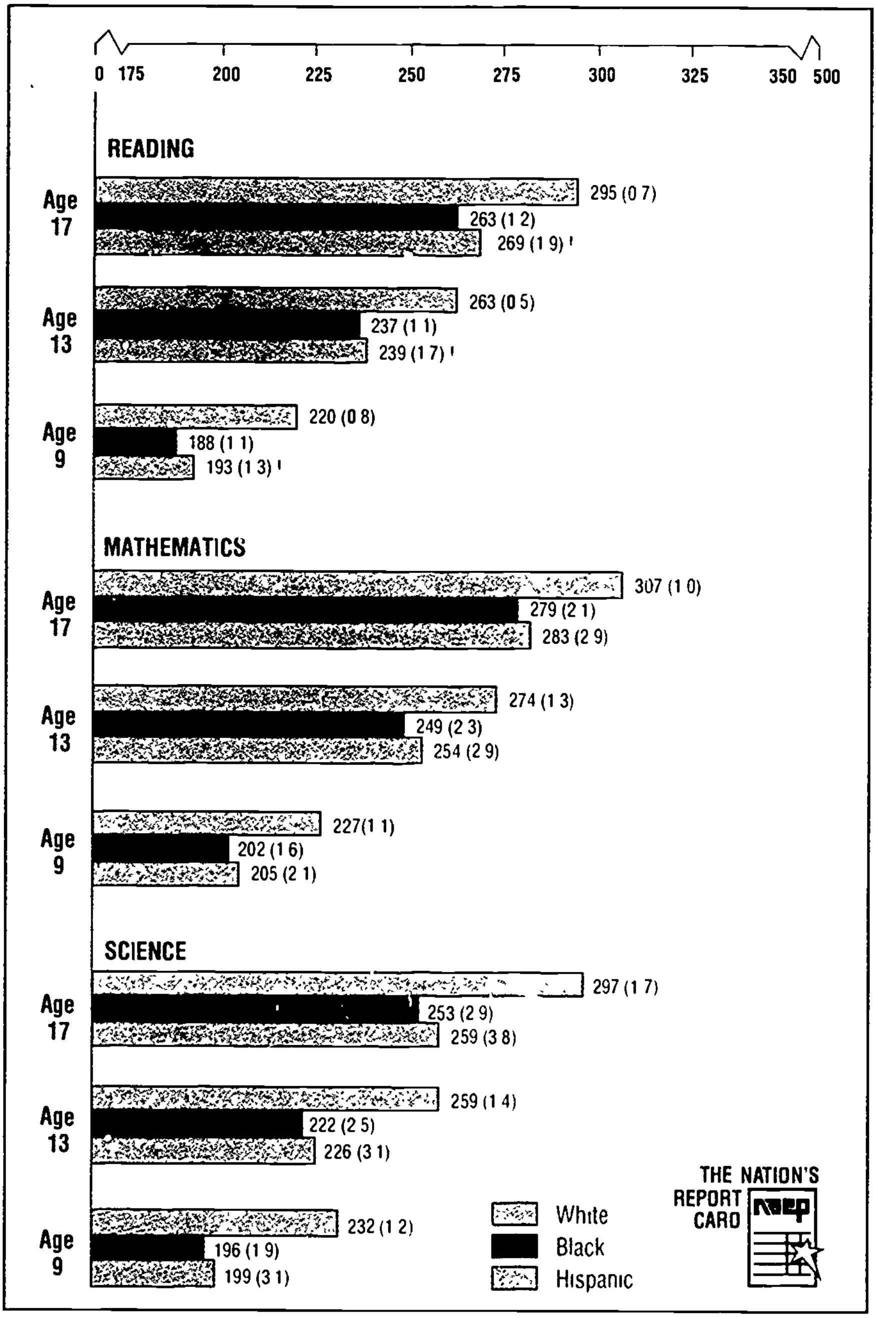

SCIENCE
Difference in Average
Proficiency on the NAEP Scales
AGE 17
1977
35 (3.0)
1982
45 (3.0)
1986
38 (4.0)
10 20 30 40 50 60 70
AGE 13
1977
43 (2.0)
1982
32 (4.0)
1986
33 (3.0)
10 20 30 40 50 60 70
AGE 9
1977
38 (3.0)
1982
40 (5.0)
1986
33 (3.0)
10 20 30 40 50 60 70

Figure 3: Average Reading, Mathematics, and Science Proficiency for White, Black, and Hispanic Students, 1984 and 1986: Ages 9, 13, and 17*

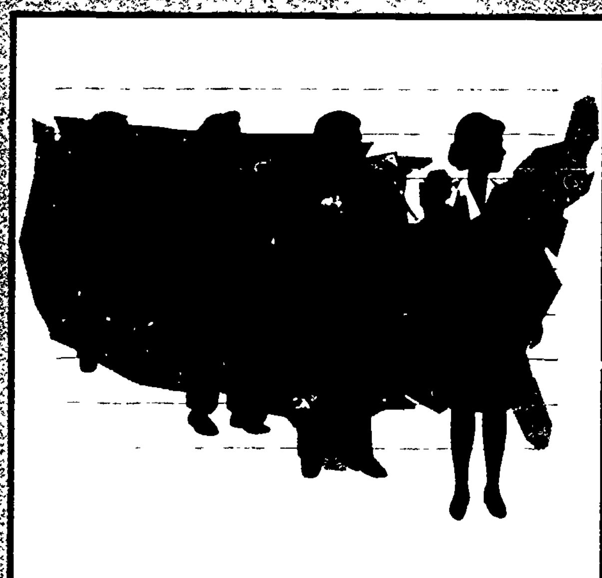


*The reading assessment was conducted in 1984, while the mathematics and science assessments were conducted in 1986 Standard errors are presented in parentheses It can be said with 95 percent certainty that the mean proficiency of the population of interest is within ±2 standard errors

¹ Standard errors are poorly estimated Interpret with caution

Figure 3 compares the actual proficiency levels of these three groups in the most recent assessments of reading, mathematics, and science. There are two things to notice from these results. First, for all three subjects, the performance of the two minority groups is noticeably below that of their White peers at age 9, and the gap remains large (or in the case of science may even increase) by age 17. Second, in all three subjects, the average proficiency levels of Black and Hispanic 17-year-olds are close to those of White 13-year-olds. This means that despite progress in narrowing the performance gaps, at the end of secondary school, the gaps remain equivalent to three to four years of additional schooling.

Although the gradual reduction of these performance gaps since 1970 is a major accomplishment, the unfortunate truth, however, is that the performance gaps are still unacceptably large.



LEVELS OF LEARNING

Reading, Mathematics, and Science

ALTHOUGH CHANGES in average performance on the NAEP scales or in distributions across years or ages indicate improvements or declines in achievement, the numbers on the scales were set to span the range of student performance and say nothing themselves about what students actually know and can do within any particular curriculum area. To give the results meaning and to provide information on what students can and cannot do in each subject. NAEP has attempted to generalize from student performance on assessment questions and to describe the accomplishments represented by five anchor points on the scale — 150, 200, 250, 300, and 350. (Few students performed at the extreme ends of the scale — that is, from 0 to 150 and from 350 to 500.) To anchor each of the scales, NAEP began by empirically selecting items that discriminated between pairs of adjacent proficiency levels. These items were batched for the five levels, and subject-area experts were then asked to interpret the items and describe what students at each level could do that students at the lower levels could not.

Table 1 gives a brief characterization of achievement at each proficiency level for reading, mathematics, and science and shows the percentages of students performing at or above each level in the most recent assessment of these three subjects. More detailed descriptions of proficiency at each anchor point and examples of the items are contained in the appendix.

Table 1: Percentages of Students at or Above Proficiency Levels on the NAEP Scales, 1984 and 1986: Ages 9, 13, and 17*

Scale	READING: 1984 Level Description	Elementary School (Age 9)	Middle School (Age 13)	High School (Age 17)	MATHEMATICS: 1986 Level Description
500					
350	Can synthesize and learn from specialized reading materials.	**0** (0.0)	**0** (0.3)	**5** (0.2)	Can solve multi-step problems and use basic algebra.
300	Can find, understand, summarize, and explain relatively complicated information.	**1** (0.1)	**11** (0.4)	**39** (0.8)	Can compute with decimals, fractions, and percents; recognize geometric figures; and solve simple equations.
250	Can search for specific information, interrelate ideas, and make generalizations.	**18** (0.6)	**60** (0.8)	**84** (0.7)	Can add, subtract, multiply, and divide using whole numbers.
200	Can comprehend specific or sequentially-related information.	**64** (0.9)	**95** (0.3)	**99** (0.1)	Can add and subtract two-digit numbers and recognize relationships among coins.
150	Can carry out simple, discrete reading tasks.	**94** (0.4)	**100** (0.0)	**100** (0.0)	Knows some basic addition and subtraction facts.
0					

*The numerical values on the 0-500 NAEP scales were established on the basis of student performance in the 1984 reading, 1986 mathematics, and 1986 science assessments to describe relative performance within those specific subject areas. Each scale was set to span the range of student performance in that subject-area assessment (e.g., about half of the middle-school students will perform above 250 and about half will perform below 250)

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Elementary School (Age 9)	Middle School (Age 13)	High School (Age 17)
0 (0.0)	0 (0.1)	6 (0.4)
1 (0.2)	16 (1.0)	51 (1.2)
21 (0.9)	73 (1.5)	96 (0.4)
74 (1.1)	99 (0.2)	100 (0.1)
98 (0.2)	100 (0.0)	100 (0.0)

SCIENCE: 1986

Level Description	Elementary School (Age 9)	Middle School (Age 13)	High School (Age 17)
Can infer relationships and draw conclusions using detailed scientific knowledge	0 (0.1)	0 (0.1)	7 (0.6)
Has some detailed scientific knowledge and can evaluate the appropriateness of scientific procedures.	3 (0.4)	9 (0.7)	41 (1.4)
Understands basic information from the life and physical sciences.	28 (1.0)	53 (1.4)	81 (1.2)
Understands some basic principles, for example, simple knowledge about plants and animals.	71 (1.0)	92 (0.9)	97 (0.4)
Knows everyday science facts.	96 (0.3)	100 (0.1)	100 (0.1)

Therefore, any given numerical level on the reading scale is not equivalent to the same level on the science scale or mathematics scale. However, the descriptions of student performance at the five anchor points on each scale do provide some basis for discussing the range of student performance across the three subjects. Standard errors are presented in parentheses.

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Because it is similar to comparing apples and oranges, one cannot use the NAEP scales to determine how much learning in reading equals the same amount of learning in mathematics or science: thus, any given numerical level on the reading scale is not equivalent to the same level on either the science or the mathematics scale. However, the descriptions of student performance at the five anchor points do provide some basis for discussing the range of student performance across the three subjects, and they must carry the burden for determining the educational significance of the results.

For example, in reading, 6 percent of the 9-year-olds cannot carry out simple reading tasks: these students would seem to be at particular risk for future failure in school. Further, the results raise important questions about how well students can comprehend the range of academic material they are likely to encounter in school. For example, the failure of 61 percent of the 17-year-olds to demonstrate the ability to find, understand, summarize, and explain relatively complicated information, including material about topics they study in school, suggests that most students leaving secondary school do not have the comprehension skills often needed in the worlds of higher education, business, or government.

In mathematics, one-quarter of the seventh and eighth graders—representing the performance of more than three-quarters of a million students—may not possess the skills in whole-number addition, subtraction, multiplication, and division necessary to perform everyday tasks. Similarly, given that many students are exposed to decimals, fractions, and percents as well as to basic geometry and algebra in middle and junior high school, one would expect to see a higher percentage of students at age 13 and particularly at age 17 demonstrating success with these kinds of tasks. The fact that nearly half of the 17-year-olds do not appear to have command of these mathematical skills has serious implications. For example, these students nearing graduation are unlikely to be able to match mathematical tools to the demands of various problem situations that permeate life and work.

Results for science achievement are equally discouraging. Only about one-half of the 13-year-olds appear to have a grasp of the basic elements of science; without a better foundation in their middle-school years, these students will likely be unprepared to take more advanced courses as they progress through high school.

Further, a majority of 17-year-olds failed to demonstrate an ability to analyze scientific procedures and data. This suggests that school science is not helping them learn to use what they are being taught to evaluate the appropriateness of procedures or to interpret results. Considering the high demand for skilled technological personnel in our nation's work force, these results are particularly troublesome. While approximately 40 percent of the nation's high school students have a moderate understanding of science, only 7 percent have any degree of sophisticated understanding of the subject.

Writing

Table 2 presents levels of writing proficiency across the grades on the various types of writing tasks included in the most recent assessment. In each case, the table displays the results for the items on which the students did best. Unlike the results in reading, science, and mathematics, the writing results are provided as the percentage of students performing various types of writing tasks at or above "minimal" and "adequate" levels. Students writing at the minimal level recognized some or all of the elements needed to complete the task, but did not manage these elements well enough to assure that the purpose of the task would be achieved. Adequate responses included the information and ideas critical to accomplishing the underlying task and were considered likely to be effective in achieving the desired purpose.

At grade 4, most students performed at or above a minimal level on imaginative tasks and reporting information, but fewer were able to write even minimal pieces in response to analytic and persuasive (refuting) tasks. Writing proficiency at the eighth-grade level was somewhat more discouraging. Although more than three-quarters of these middle school students wrote at or above a minimal level on all but one persuasive task— specifically, a task asking students to refute an opposing position—relatively low percentages of students wrote adequate responses to most of the tasks provided.

Table 2: Highest Percentage of Students Performing at or Above the Minimal and Adequate Levels on Various Types of Writing Tasks, 1984: Grades 4, 8, and 11*

Type of Task	MINIMAL Grade 4	MINIMAL Grade 8	MINIMAL Grade 11	ADEQUATE Grade 4	ADEQUATE Grade 8	ADEQUATE Grade 11
INFORMATIVE						
Reporting:						
From personal experience						
Care for pets	73 (1 1)	89 (0 8)	—	2 (0 4)	19 (1 2)	—
Job Application	—	—	81 (1 1)	—	—	65 (1 2)
From given information						
Describe Science Project	85 (1 0)	—	—	41 (1 4)	—	—
Order T-shirt	—	85 (0 9)	—	—	67 (1 1)	—
Describe House	—	—	87 (1 0)	—	—	59 (1 2)
Analytic:						
From personal information						
Explain Music Preference	53 (1 3)	80 (1 0)	81 (1 0)	2 (0 4)	8 (0 6)	7 (0 7)
From given information						
Compare Frontier Food to Today's Food	40 (1 4)	81 (1 1)	85 (0 6)	2 (0 4)	18 (1 3)	25 (1 2)
PERSUASIVE						
Convincing Others:						
Capture Spaceship	67 (1 7)	—	—	23 (1 3)	—	—
Dissect Frogs	—	85 (0 7)	—	—	18 (1 0)	—
Change School Rule	—	—	90 (0 8)	—	—	22 (1 1)
Refuting an Opposing View:						
Travel with Aunt May	49 (1 3)	—	—	25 (1 2)	—	—
Visit Radio Station	—	71 (1 2)	—	—	33 (1 0)	—
Borrow Uncle's Car	—	—	74 (1 0)	—	—	24 (0 9)
IMAGINATIVE						
Ghost Story	81 (1 1)	89 (0 7)	88 (0 6)	8 (0 8)	37 (1 3)	48 (1 0)

*Standard errors are presented in parentheses

Deficiencies in writing skill that are evident in the eighth-grade results appear to worsen at the eleventh-grade level. Most high-school juniors performed at or above a minimal level in response to the types of writing tasks provided: however, the percentages of students able to write at or above an adequate level fell far short of expectations. More than half of the students at grade 11 wrote adequately in response to informative tasks based either on personal experience (65%) or information provided (59%).

Slightly less than half wrote adequately in response to imaginative tasks. Yet less than one-third of these high-school students performed adequately on any of the other types of tasks provided. The results suggest that a vast number of students nearing high-school graduation do not have a sufficient command of written language to move beyond straightforward explication and communicate a reasoned point of view.

Summary

Although most students appear to have learned the basics in core subject areas, the discrepancy between curricular goals and actual performance in these subjects widens as students progress through school. For example, a considerable percentage of 9-year-olds (approximately one-third) could not yet read simple texts, and approximately one-quarter did not have beginning skills and understandings in mathematics (e.g., could not subtract with regrouping), and did not understand simple scientific principles (e.g., those pertaining to the structure and function of plants and animals).

Thirteen-year-olds fell even farther behind expected levels of performance. In mathematics, more than one-quarter of these middle-school students failed to demonstrate an adequate understanding of the content and procedures emphasized in elementary school; moreover, a majority (84 percent) did not display a grasp of mathematics material generally introduced during the seventh and eighth grades. In reading, 40 percent of the middle-school students could not read passages at an intermediate level of difficulty. In science, only half of these students displayed an understanding of basic scientific information. Finally, while most middle-school students could write a report based on personal experience, only slightly more than half demonstrated that they could use writing in a minimal way to persuade others or analyze information.

Because the achievement of high-school students reflects in part the final product of our K-12 education system, the profile of what America's high-school students appear to know and are able to do is particularly disturbing. Sixty-one percent of the 17-year-old students could not read or understand relatively complicated material, such as that typically presented at the high-school level. Nearly one-half appear to have limited mathematics skills and abilities that go little beyond adding, subtracting, and multiplying with whole numbers. More than one-half could not evaluate the procedures or results of a scientific study, and few included enough information in their written pieces to communicate their ideas effectively. Additionally, assessment results in other curriculum areas indicate that high-school juniors have little sense of historical chronology, have not read much literature, and tend to be unfamiliar with the uses and potential applications of computers.

These cumulative findings provide us with a great deal of food for thought. For example, if so many students are unable to perform relatively difficult tasks in their academic subjects, why are they not doing equally poorly in their classes? One possible reason for the difference between NAEP performance and classroom grades may be that students regard the assessment as incidental to their lives, and therefore are less engaged in these tasks than is usual in everyday class or real world experiences.

Yet other possibilities for the discrepancies may be that evaluation criteria generally used in subject classrooms are based on learning objectives different from those of NAEP, that teachers are unsophisticated evaluators of performance, that school performance standards are low, or that institutional goals have tended to support and reinforce the teaching and learning of less difficult concepts and skills to the neglect of those that are more challenging. Recent reports have tended to support this last contention, and if this is so, the goals, materials, and methods of instruction may need to be reformulated.

FACTORS RELATED TO ACHIEVEMENT

Redefining Our Goals

THESE DATA suggest a remarkable consistency across recent assessments of student achievement in various academic subjects. By and large, students are learning the basics, and Black and Hispanic students are closing the historical gap in performance with their White peers. Yet despite these signs of progress, it remains true that only some of the nation's students can perform moderately difficult tasks and woefully few can perform more difficult ones. As shown in Figure 4, most of the gains in average proficiency represent improvements in basic skills and knowledge rather than higher-level applications. It appears that while students are acquiring basic information in core subject areas, they are not learning to use their knowledge effectively in thinking and reasoning.

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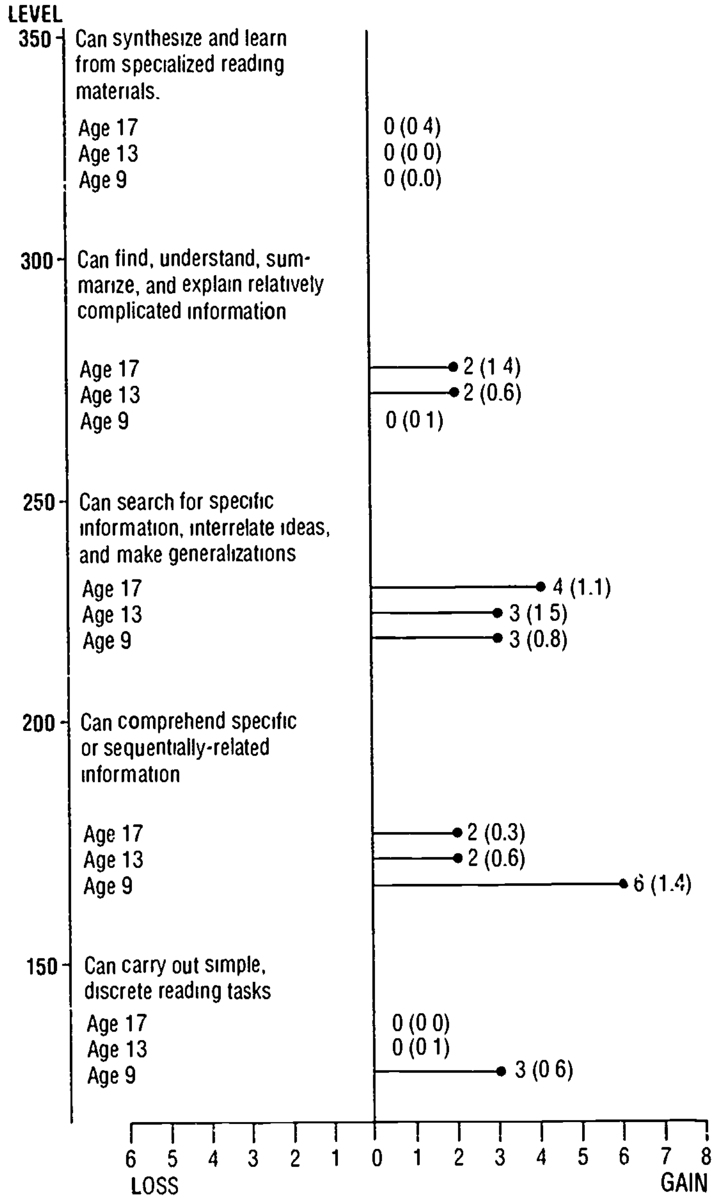
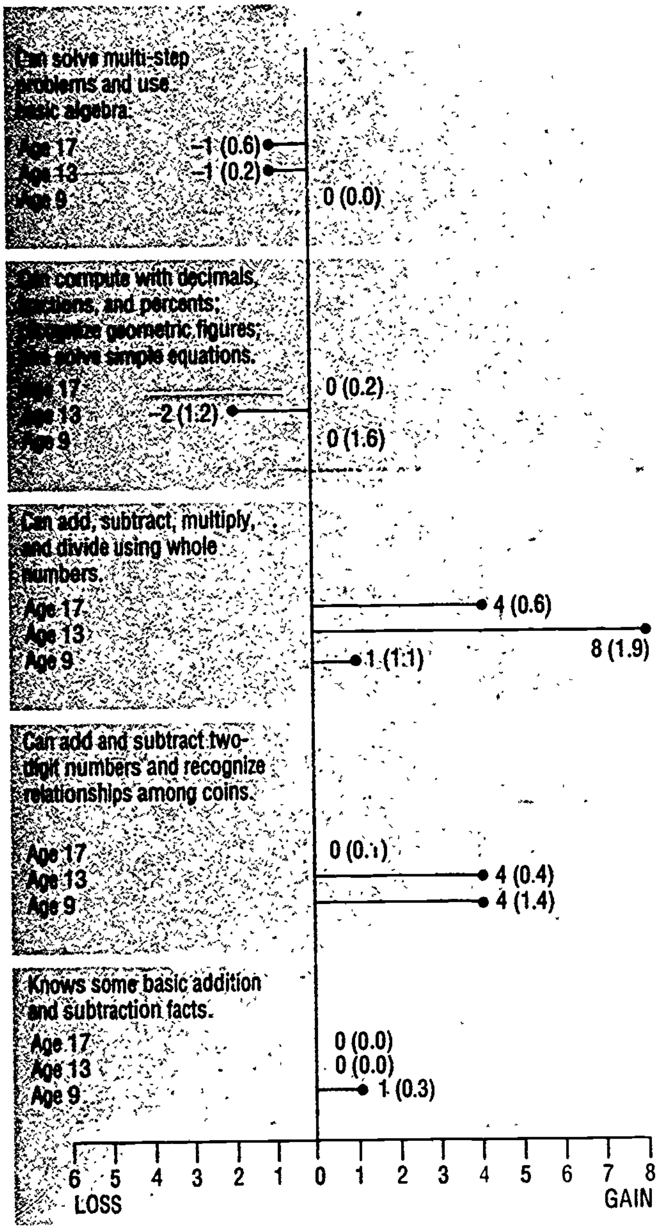
Figure 4: Changes Across Time in the Percentage of Students at or Above Anchor Points on the NAEP Scale: Ages 9, 13, and 17*

Reading: 1971 to 1984

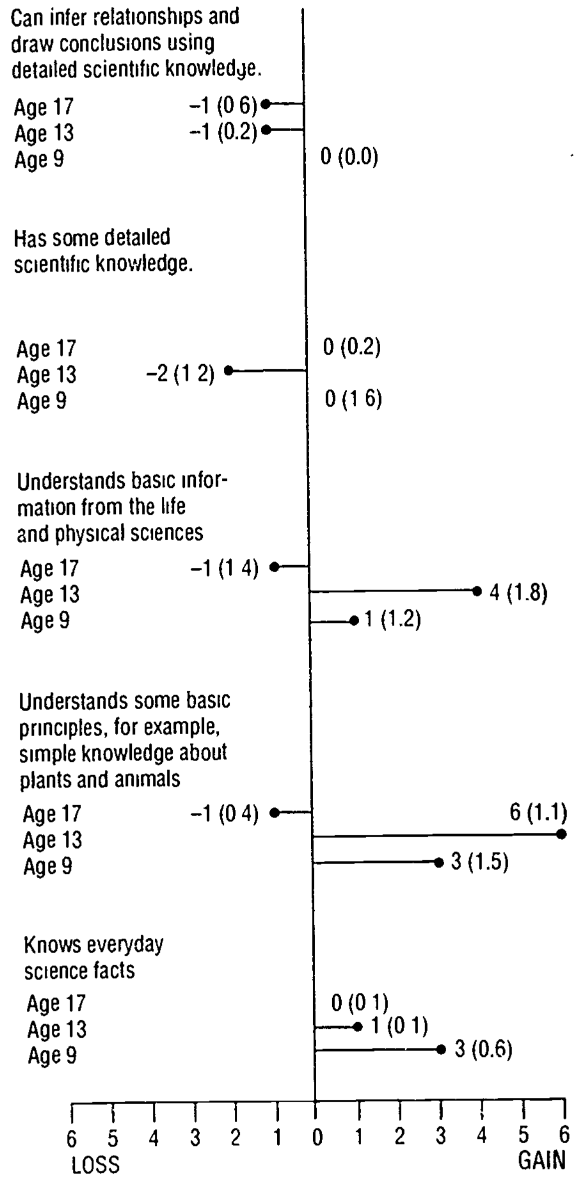


* Standard errors are presented in parentheses
It can be said with 95 percent confidence that the percent difference is within ± 2 standard errors

Mathematics: 1973 to 1986



Science: 1969-70 to 1986



In one sense, schools across the country can be congratulated for having reversed the negative trends in academic achievement evident during the 1970s. But while schools have been working to right the ills of yesterday, the ground rules have been changing. Across grades and subject areas, learning basic facts and procedures is no longer considered sufficient.[3] Rather, there are new expectations for successful academic learning at all ages; students are expected to be capable of using knowledge for purposes that require them to go beyond reciting facts and displaying the routines they have been taught. However, it is in these very areas that students show the least improvement across assessments and may even be losing ground. To fulfill these new expectations, students across the grades need to engage in activities that require them to apply, extend, and evaluate what they are learning and to relate new learning to what they already know.

Even at present, however, schools are not all alike and students are not taught the same things at the same times. There is a great deal of variation across schools in the emphasis on academic achievement and in patterns of course work, teaching practices, and materials—all of which are likely to have an impact on students' academic proficiency. Thus, in addition to studying achievement patterns, the NAEP assessments also have gathered information about the characteristics of differing learning environments and their associations with student achievement. The analyses do not reveal the underlying causes of these associations, which may be influenced by a number of different factors. Therefore, the results are most useful when they are considered in the context of other knowledge about the educational system, such as trends in instruction, changes in the school-age population, and societal demands and expectations.

Emphasizing Academic Achievement

Recent calls for educational reform have stressed the importance of providing students with an environment in which academic achievement is valued and supported. These proposed reforms have included calls for more homework, higher standards for performance, and more course work in traditional academic subjects. As part of its recent assessments, NAEP has asked students about the courses they have taken and about the amount of homework they do for each course. Across all subject areas assessed, there have been clear and consistent relationships between student reports about homework and coursework and their overall levels of subject-area proficiency.

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[1] William J Bennett, *American Education Making It Work* (Washington, D C , U S. Department of Education, April 1988)

National Commission on Excellence in Education, *A Nation At Risk* (Washington, D C, 1983)

Table 3: Average Proficiency Levels by Time Spent on Homework Each Day, 1984 and 1986: Grade 11*

Time Spent on Homework	Science	Mathematics	U S History	Literature	Reading	Writing
None assigned	271 (1 5)	282 (1 3)	265 (2 6)	265 (2 2)	278 (1 0)	213 (1 0)
Did not do	286 (1 9)	299 (1 2)	281 (1 9)	278 (2 1)	287 (1 0)	214 (2 0)
Less than 1 hour	289 (1 3)	302 (0 9)	285 (1 6)	284 (1.3)	291 (1 0)	218 (1 0)
1-2 hours	293 (1 1)	306 (0.9)	287 (1.3)	287 (1.0)	294 (1 0)	222 (1 0)
2 hours or more	300 (2 6)	315 (1.7)	294 (2 2)	296 (2.1)	300 (1.4)	227 (2.0)

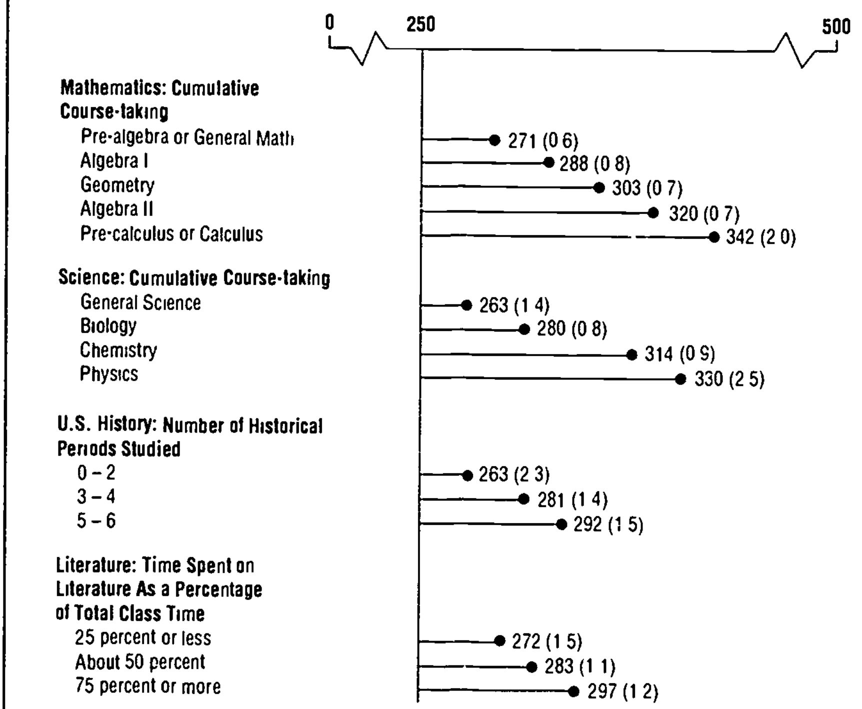
*The reading and writing assessments were conducted in 1984, while the science, mathematics, U S history, and literature assessments were conducted in 1986 All scales range from 0-500 except the writing scale, which ranges from 0-400. Standard errors are presented in parentheses

Table 3 summarizes the relationships between homework and proficiency at Grade 11 in science, mathematics, U.S. history, literature, reading, and writing. Approximately 15 percent of the high-school students reported that they were not assigned homework or did not do it, and these students had noticeably lower proficiency levels than did their classmates who reported regularly spending time on homework. The more homework eleventh-grade students reported, the higher their proficiency levels were likely to be. Results at lower grade levels also showed consistent relationships with proficiency, but the amount of homework associated with optimum performance varied somewhat. In elementary school, students who reported spending up to half an hour per day on homework tended to have the highest proficiency levels, while in middle school, students who reported spending one to two hours each day on homework tended to have the highest proficiency.

The amount of homework reported by students has increased during the past decade. In 1978, some 32 percent of 17-year-old students reported that they were not given homework assignments; in 1986, only 6 percent reported that homework was not assigned. Such shifts reflect a positive response on the part of our schools to calls for more emphasis on academic work.

Figure 5 summarizes similar relationships between amount of course work and levels of achievement for eleventh-grade students. Across the subject areas examined, higher academic proficiency is associated with more course work, greater coverage of topics, and more class time spent on learning rather than diversionary activities.

Figure 5: Average Proficiency in Selected Subject Areas by Amount Studied, 1986: Grade 11*



*Standard errors are presented in parentheses It can be said with 95 percent certainty that the mean proficiency of the population of interest is within ±2 standard errors

The assessment results also suggest that significant proportions of American students are avoiding advanced course work. In mathematics, a quarter of the eleventh graders were not taking a mathematics class in 1986, and of those who were taking classes, a quarter were taking lower-level courses such as General Mathematics, Pre-algebra, or Algebra I. Overall, 19 percent of the 17-year-olds reported that Pre-algebra was the highest-level course they had taken, and another 18 percent had ended their course work at Algebra I. Enrollment patterns have changed only slightly since 1978: In that year, 22 percent of the 17-year-olds stopped at Pre-algebra, compared with 19 percent in 1986. Similarly, 6 percent of the 17-year-olds had gone on to Pre-calculus in 1978, compared with 7 percent in 1986.

Enrollments in science classes have been even lower: Only 58 percent of the eleventh graders were taking a science class at the time of the 1986 assessment. Data from a follow-up transcript study indicated that by graduation, less than half (45 percent) of these high-school students had earned a year's credit in Chemistry, and only 20 percent a year's credit in Physics. Fortunately, trends in science course-taking appear to be on the rise; the mean number of full-year science courses taken by graduating seniors was 2.6 in 1987. compared to a mean of 2.2 in 1982.[4]

Rethinking the Curriculum

Although many educators argue that increased course-taking is essential to strengthen students' academic proficiency, simply increasing the amount of course work is likely to be insufficient to bring proficiency up to expected levels. There are other aspects of the educational system that must also be addressed. For example, curricular reforms may be warranted. In science, curriculum in the United States has frequently been criticized as a "layer cake" in which students study different areas in isolation and then leave them behind for the rest of their school career. Even if they take science every year, American schoolchildren who pass through this layer-cake curriculum fare relatively poorly compared with their peers in other developed nations, where the work of each year builds upon and extends the work of the previous year.[5] The argument against a layer-cake curriculum in science can also be applied to other subject areas. In many cases, the curriculum is treated as a collection of discrete content areas in which teachers move from one topic to another in lockstep fashion. As a result, lessons are often developed in isolation from one another and fail to help students relate their new learnings to what they already know.

There have been many calls for a more integrated approach to content learning in other major subject areas, as well. For example, mathematics educators propose that mathematics instruction be more highly integrated, with linkages between areas of study (e.g., geometry and algebra) made more explicit in the classroom. History educators have emphasized the value of teaching

[4] Westat, Inc. Preliminary data from the 1987 High School Transcript Study (1988).

[5] International Association for the Evaluation of Educational Achievement. *Science Achievement in Seventeen Countries A Preliminary Report* (New York, NY: Teachers College, Columbia University, 1988).

students to think more about the process of historical inquiry rather than simply the chronology of events, and reading and writing educators have called for the integration of reading and writing across the curriculum. Each of these approaches may hold promise for helping more students reach higher levels of subject-matter proficiency. And it is only after attaining these higher levels that students will have learned both the content knowledge and skills of their subject and the ability to use these for a range of purposes.

Providing Home Support

Closely related to high and consistent academic expectations at school is the extent to which expectations at home place a similar emphasis on academic success. NAEP assessments have asked students about levels of parental education, the availability of books and other reading materials at home, and the amount of attention the family gives to student schoolwork. Responses to these questions have shown consistent relationships between home support and academic achievement: The more encouragement and resources provided at home, the more likely students are to do well in school.

Such findings are predictable, yet they should serve as a reminder that attempts to improve student achievement may work best if they do not proceed in isolation but rather involve a working partnership between home and school. The roots of learning may begin at home, and the influence of the home on educational achievement cannot be underestimated. Children are more likely to be successful learners if their parents or care-givers display an interest in what they are learning, provide access to learning materials, and serve as role models interested in their learning experiences.

Not all homes can provide this support, however. At times, the language spoken at home or the educational background or the job demands of parents or other adults mitigate against close involvement in students' learning. Further, the educational goals and practices of schools sometimes conflict with those of the communities. When schools and communities work together, however, they can develop support systems that greatly benefit student learning.[7] For example,

[7] Shirley Brice Heath, *Ways With Words* (Cambridge: Cambridge University Press, 1983).

when students use their mathematical knowledge to count stock and calculate expenses in a local store, collect social histories of elderly neighbors, conduct a survey of languages spoken in a neighborhood, or meet in a community-based computer center where adults and students learn new skills together, they put their subject-matter learning to use while also strengthening home and community support for learning. Teachers, schools, and school districts can initiate such collaborations with individual community members, as well as with local commercial, civic, and religious associations and organizations.

Remodeling Instruction

NAEP has gathered information on instructional approaches in several subject areas using a variety of questions addressed to students and their teachers. Although students lack the technical vocabulary that their teachers use to discuss instruction, their perceptions are useful in understanding overall emphases. When teacher and student reports are compared, the pattern that emerges is consistent: Most students' school experiences are dominated by memorization of content presented by teacher or textbook, and by the practicing of skills in workbook or ditto exercises. Students are given limited opportunities to apply knowledge and procedures for new purposes.[7]

Across subjects, the most frequently-used instructional approaches that students report are teacher presentations to the class as a whole, textbook reading, and the completion of individual exercises presented in workbooks or dittos (See Table 4). In mathematics classes, particularly at the lower grade levels, these are joined by board work, with teachers or students completing exercises while others watch. Such patterns of instruction most often reflect a classroom context in which the goals of instruction rest on discrete facts and isolated skills rather than on a growing body of reasoned knowledge.

Instructional practices that encourage students to use their knowledge effectively are much less frequent. Table 5 summarizes student reports from the writing, mathematics, science, and U.S. history assessments about activities that are likely to develop students' ability to use their newly acquired knowledge.

[7] Arthur N. Applebee, Judith A. Langer, and Edward Haertel, "Policy and Practice in the Teaching of Writing: Explorations of the NAEP Database" (Palo Alto: Stanford University, June 1988).
Ina V.S. Mullis and Lynn B. Jenkins, *The Science Report Card: Elements of Risk and Recovery* (Princeton, NJ: National Assessment of Educational Progress, 1988).

Table 4: Percent of Students Reporting Daily or Weekly Use of Traditional Teaching Practices, 1984 and 1986*

	Elementary School	Middle School	High School
Mathematics			
Teacher explains a math lesson	95 (1.1)	97 (1.0)	94 (1.4)
Teacher works a board problem	90 (1.8)	96 (1.6)	94 (1.5)
Work a board problem.	61 (1.8)	53 (1.9)	47 (1.6)
Use workbook or ditto	81 (2.1)	61 (2.0)	46 (1.8)
Use math textbook	—	94 (1.7)	94 (1.9)
Science			
Teacher lectures	—	70 (1.7)	88 (1.5)
Read science textbooks	60 (2.3)	82 (2.2)	70 (1.7)
U.S. History			
Use textbook	—	—	89 (1.7)
Memorize information	—	—	64 (1.1)
Teacher lectures	—	—	97 (1.0)
Writing			
When reviewing papers, teacher comments on grammar, spelling, and punctuation at least half of the time	84 (2.0)	74 (1.6)	67 (1.9)

* The writing assessment was conducted in 1984, while the mathematics, science, and U.S. history assessments were conducted in 1986. The mathematics and science data represent students in grades 3, 7, and 11, the U.S. history data represent students in grade 11, and the writing data represent students in grades 4, 8, and 11. Standard errors are presented in parentheses.

Although the activities differ across subject areas, a pattern is nonetheless discernible: Relatively small proportions of students are regularly asked by their teachers to engage in small group work, perform laboratory experiments, prepare reports, or engage in projects that provide experience in problem solving. Even in science classes, where laboratory work is a common instructional activity, 41 percent of the eleventh graders and 60 percent of the seventh graders reported that they were never asked to write up a science experiment independently. Further, it should be noted that only about half of the seventh-grade science teachers and one-third of the eleventh-grade science teachers reported having access to laboratory facilities.

Recent calls for more emphasis on varied and participatory instructional approaches assume that students who are given more opportunities to use their

Table 5: Percent of Students Reporting Participation in Classroom Activities that Encourage Use of Knowledge and Procedures, 1984 and 1986*

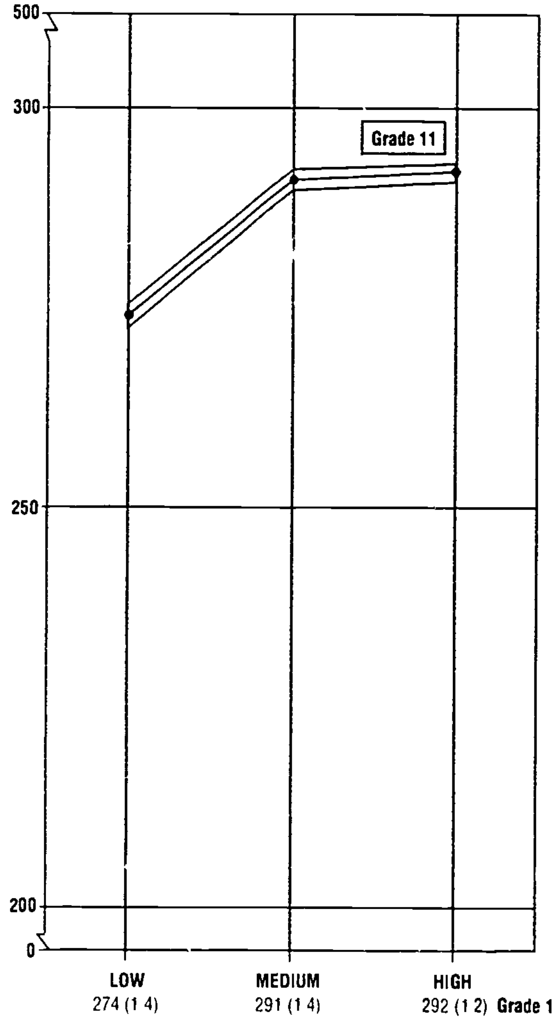
	Elementary School	Middle School	High School
Mathematics			
Work problems in small groups	47 (1 6)	35 (1 8)	41 (2 0)
Make reports or do projects	-	19 (1 2)	13 (0 9)
Do math lab activities	—	23 (1 2)	18 (1 2)
School has calculators for math	15 (1 1)	21 (1 6)	26 (1 9)
Use a computer to practice math	—	39 (2 4)	22 (1 5)
Science			
Do experiments	67 (2 0)	—	—
Do experiments alone	—	50 (1 5)	54 (1 5)
Do experiments with other pupils	—	69 (2 2)	82 (2 1)
Write up experiment	—	40 (1 9)	59 (2 2)
Do oral or written report	53 (1 6)	54 (2 2)	49 (1 6)
Use a computer to do science problems	—	9 (1 0)	11 (0 9)
U.S. History			
Write long reports	—	—	32 (1 1)
Small group work	—	—	57 (1 4)
Individual projects	—	—	59 (1 4)
Writing			
Talk with classmates about paper	51 (1 7)	64 (1 7)	69 (1 8)

*The writing assessment was conducted in 1984, while the mathematics, science, and U S history assessments were conducted in 1986 The mathematics and science data represent students in grades 3, 7, and 11, the U S history data represent grade 11 students only; and the writing data represent students in grades 4, 8, and 11 Standard errors are presented in parentheses.

newly acquired technical knowledge and skills will reach higher levels of proficiency in their subject. NAEP data do not provide tests of such causal explanations. but they do permit examining associations between proficiency and the use of various instructional techniques. Figures 6A and 6B summarize findings from the literature and science assessments on the relationship between students' proficiency and the types of instructional activities they reportedly engage in.

The two scales are not identical because different questions were asked about the teaching of each subject; however, a common pattern is evident. Students who report participatory and varied instructional practices in science and literature classes tend to have higher proficiency levels than their peers in less exploratory classrooms. Again however, it must be cautioned that the NAEP data do not permit addressing questions of cause and effect.

Figure 6A: Relationship Between Literature Proficiency and Varied Instructional Practices, 1986: Grade 11*



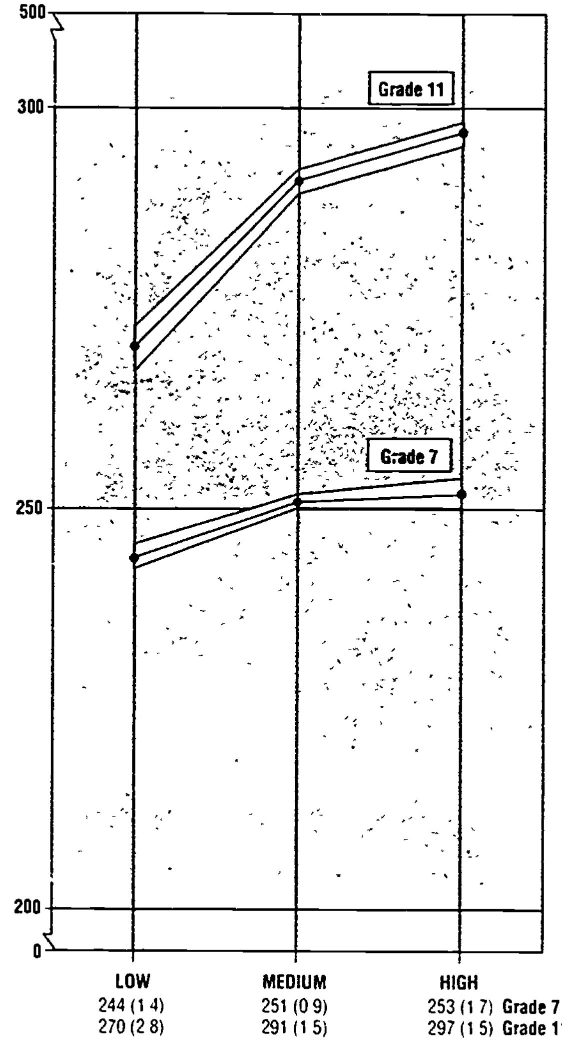
* Students' reports on the number of different approaches and topics of discussion used by their teachers

Estimated population mean literature proficiency and 95% confidence interval It can be said with 95 percent certainty that the mean literature proficiency of the population of interest is within this interval

The use of calculators in mathematics instruction has the potential to substantially change traditional methods of instruction.[5] In 1986, NAEP asked students a number of questions about calculator use at home and at school. Some 97 percent of the eleventh-grade students reported that they or their families owned a calculator, but only 26 percent indicated that their school had

[5] National Council of Teachers of Mathematics, Inc., "Curriculum and Evaluation Standards for School Mathematics" (Reston, VA National Council of Teachers of Mathematics, 1987)

Figure 6B: Relationship Between Science Proficiency and Participatory Instructional Techniques, 1986: Grades 7 and 11*



* Students' reports on how often they solved science problems conducted experiments alone or with other students wrote up the results of experiments read articles on science and presented oral or written reports

Estimated population mean science proficiency and 95% confidence interval It can be said with 95 percent certainty that the mean science proficiency of the population of interest is within this interval

calculators available for use in mathematics classes. Between one-half and two-thirds of the students reported that they used calculators in doing homework, checking answers, performing routine calculations, solving problems, or taking tests. As with the use of varied approaches in literature and science, students who reported more use of calculators showed consistently higher mathematics proficiency than did students who reported less use; however, it cannot be determined from the data whether calculator use strengthens proficiency or whether more proficient students simply have greater exposure to instruction that requires or encourages calculator use.

Conclusions

In general, this synthesis of students' achievement and the environments in which they learn suggests that we are at an educational crossroads, and a comprehensive change *en route* can have an extensive impact on the future of student learning. A number of implications that arise from the composite of reports discussed here can be particularly informative. When school and home variables support academic achievement, students are more likely to be academically successful. Simply emphasizing academic learning, however, may not be enough to ensure that students develop both subject-area knowledge and the ability to use that knowledge effectively. Most classrooms are relatively traditional in their approaches to instruction, relying heavily on teacher presentations, textbooks, and workbook- or teacher-prepared exercises. Such patterns of instruction appear to have been successful in helping large numbers of students attain basic levels of proficiency in each subject area, but they do not seem to have been successful in helping students to achieve higher levels of performance.

For these qualitatively different gains to occur, the goals of instruction need to be reconsidered. Teaching decisions were once guided by a hierarchy suggesting that students must first learn the facts and skills and later learn to apply them. Yet many educators now recognize the limitations of this stepping-stone view of education. Educational theory and research suggest a different pattern of generative teaching and learning, where learning content and procedures and how to use this learning for specific purposes occur interactively.[9] Students learn information, rules, and routines while learning to think about how these operate in the context of particular goals and challenges in their own lives. When students engage in activities that require them to use new learning, both their knowledge of content and skills and their ability to use them develop productively together.

For more thoughtful learning to occur, teachers will need to orchestrate a broader range of instructional experiences than they presently use, providing students with opportunities to prepare for, review, and extend their new learning.

[9] Shirley Brice Heath, *Ways With Words* (Cambridge, Cambridge University Press, 1983)
Judith A. Langer and Arthur N. Applebee "Reading and Writing Instruction: Toward a Theory of Teaching and Learning," *Review of Research in Education* 13 (1986) pp. 171-94
Lev Vygotsky, *Thought and Language* (Cambridge, The MIT Press, 1987)

Such activities might include, but not be limited to, the whole class discussions, workbooks, and dittos that prevail today. Discussion teams, cooperative work groups, individual learning logs, computer networking, and other activities that engage students as active learners will need to be added, and may even predominate. Using these new approaches will require teachers to move away from traditional authoritarian roles and, at the same time, require students to give up being passive recipients of learning. Instead, teachers will need to act more as guides, and students more as doers and thinkers. Some examples of this alternative mode of instruction can be found in current discussions of small group problem-solving experiences, collaborative learning, activity-based learning, and instructional scaffolding.[10]

Since tests and grades send messages to students about what is valued in their course work, the focus of tests also will need to shift. Instead of simply displaying their knowledge of facts and rules, students will need to show that they can think about and use their knowledge. A number of alternative assessment procedures have been suggested. For example, in course work, portfolios of selected work, simulations, problems, or cases can be used as the basis for assessing students' knowledge and abilities.

In short, extensive modifications in curriculum and instruction may be required to expand the range of learning experiences available to students at school. These modifications will undoubtedly be difficult, requiring changes in established procedures and traditions in the curriculum and in systems of evaluation; however, it is apparent that fundamental changes may be needed to help American schoolchildren develop both content knowledge and the ability to reason effectively about what they know — skills that are essential if they are to take an intelligent part in the worlds of life and work. Such changes will involve reshaping current notions of the goals of instruction, the roles of teachers and students, the language of instruction, the nature of instructional activities and materials, the signposts teachers use to know that they have been successful in their profession, and the evidence policymakers, administrators, parents, and the general public use to know that schools are doing their job and that students are learning.

Educators everywhere have the opportunity to use the NAEP results to great advantage—by reflecting upon the deeply entrenched beliefs, policies, and behaviors that impede the very changes we wish to make—and setting a charted course for change.

[10] Elizabeth Cohen, *Designing Group Work: Strategies for the Heterogeneous Classroom* (New York, NY: Teachers College Press, 1986).
Judith A. Langer and Arthur N. Applebee, "Reading and Writing Instruction: Toward a Theory of Teaching and Learning," *Review of Research in Education* 13 (1986), pp. 171-94.
Lauren Resnick, *Education and Learning to Think* (Washington, D.C.: National Academy Press, 1987).

APPENDIX

Descriptions of Proficiency Levels for Reading, Mathematics, and Science

This appendix contains descriptions of five levels of proficiency—Levels 150, 200, 250, 300, and 350—developed on the basis of student performance on NAEP's Reading, Mathematics, and Science scales. For each subject area, a limited number of sample items are also provided to illustrate each level of proficiency. Readers interested in obtaining more detailed information should refer to the most recent reports, which are listed on page 2.

LEVELS OF READING PROFICIENCY

Level 150 — Rudimentary Skills and Strategies

Readers who have acquired rudimentary reading skills and strategies can follow brief written directions. They can also select words, phrases, or sentences to describe a simple picture and can interpret simple written clues to identify a common object. Performance at this level suggests the ability to carry out simple, discrete reading tasks.

Here is a puzzle See if you can solve it

This is something that usually has four legs and that you can sit on It can be made of wood or metal Most people have several of these in their homes Some are soft, and some are hard You usually sit on one of these when you sit down to eat

What is this?

A A chair
B A horse
C A pillow
D A mushroom
E I don't know

Level 200 — Basic Skills and Strategies

Readers who have learned basic comprehension skills and strategies can locate and identify facts from simple informational paragraphs. stories. and new articles. In addition, they can combine ideas and make inferences based on short, uncomplicated passages. Performance at this level suggests the ability to understand specific or sequentially related information.

Read the following article and answer the questions based on it

What Is Quicksand?

Quicksand can swallow a pig, or a human, or even an elephant

Quicksand often looks like plain wet sand But it is really a soupy sand with so much water between the grains that you can't stand on it

If you step into quicksand, you will slowly sink up to your knees If you thrash and squirm, you will sink deeper and deeper. But if you lie flat on your back with your arms stretched out, you can float on the sand, as you can float in water.

Watch out for quicksand on sand bars, on the bottoms of streams, or along sandy seacoasts.

You can test for quicksand by poking it with a long stick or pole If the sand shakes and quakes, don't try to walk on it! It may be quicksand

According to the article, how can you test to see if sand is really quicksand?

A Stick your hand into it
B Step lightly on it
C Poke it with a stick
D Look at it.
E I don't know.

What is quicksand?

A Wet sand you can walk on
B Soupy sand you can't stand on
C Sand that forms clouds in the wind
D Dry sand which flows quickly through your fingers
E I don't know

Level 250 — Intermediate Skills and Strategies

Readers with the ability to use intermediate skills and strategies can search for, locate, and organize the information they find in relatively lengthy passages and can recognize paraphrases of what they have read. They can also make inferences and reach generalizations about main ideas and author's purpose from passages dealing with literature, science, and social studies. Performance at this level suggests the ability to search for specific information, interrelate ideas, and make generalizations.

Read the article below and answer the questions based on it

Boxball

Have you ever heard of the National Boxball Association, the Los Angeles boxball team, or Kareem Abdul-Jabbar, the famous boxball player? Or have you ever heard of boxball at all? Well, it is the game that almost was

Today we call the game basketball, of course, but it almost became known as boxball When Dr James A Naismith, a teacher at the International YMCA Training School in Springfield, Massachusetts, first invented the game in 1891, he had no name for it He had simply made up a sport that all his students could enjoy—one that could be played indoors by both boys and girls and was not as rough as football

Dr Naismith wanted his students to experiment with the new game, but he first had to find the right kind of ball and two boxes He decided to have the players use a leather soccer ball—about twenty-eight inches around—to toss into the goals He then asked Mr Stebbins, the building superintendent, to find two boxes that had openings about nine inches across—wide enough for the soccer ball But Mr Stebbins could not find the right-sized wooden boxes anywhere, and as the time for the first game came near, there were still no goals hanging from the gymnasium balcony Dr Naismith finally decided to use two peach baskets that were handy After all, he reasoned, it was only a trial game, boxes could always be found later to replace the temporary baskets

When the first game finally began, the players enjoyed the challenge of shooting the soccer ball at the peach baskets and earning a point each time the ball went into the basket The peach baskets did present a bit of a problem, however, since each time a goal was made, someone had to climb a ladder and retrieve the ball before the game could continue After a few games, someone finally realized that the bottoms of the baskets could be cut out to allow the ball to fall through

Naismith had simply called his invention "a new game," but, because of the peach-basket goals, it soon became known as basketball Fortunately, those peach baskets were never replaced with wooden boxes as the inventor had originally planned What a difference it would have made had Mr Stebbins been able to find wooden boxes for that very first game! Instead of basketball, boxball would be one of the most popular sports of all time

Who invented the game of basketball?

A A Massachusetts teacher
B A YMCA student
C A building superintendent
D A Los Angeles player
E I don't know

What is the purpose of the article?

A To explain the rules of basketball
B To describe how much fun boxball can be
C To tell how basketball was invented
D To give a history of outdoor sports
E I don't know

We can tell from the article that which of the following statements is true?

A Basketball was invented before football
B Football was invented before basketball
C Soccer was invented before football
D Soccer and football were invented at the same time
E I don't know

Why were the bottoms cut out of the peach baskets that were being used for goals?

A To make it easier for the players to score points
B Because the bottoms of baskets were wearing out
C Because the baskets were too small
D To make it easier to continue the game
E I don't know

48

Level 300 — Adept Skills and Strategies

Readers with adept reading comprehension skills and strategies can understand complicated literary and informational passages, including material about topics they study at school. They can also analyze and integrate less familiar material and provide reactions to and explanations of the text as a whole. Performance at this level suggests the ability to find, understand, summarize, and explain relatively complicated information.

Read the story below and answer the questions based on it.

Throwing the Javelin

The scent of honeysuckle seemed to linger in the air and joined itself with the sweet odor of freshly cut grass. I slipped out of my bright red sweats and flung them to the base of the tree. I picked up the javelin, stuck point down in the turf. The cross which hung about my neck swung back and forth as I stretched my arms with the javelin behind my neck. Out of habit, I stood and held the javelin in my left hand, and with the thumb of my right forced small clumps of dirt from the tip. I searched for a target. Picking a spot in a cloud moving towards me I cocked the javelin above my shoulder and regulated my breathing. My right foot was placed on the first mark and my left foot rested behind. My eyes were focused on one abstract point in the sky. Pierce it I built up energy Slowly, my legs flowed in motion, like pistons waiting for full power and speed I could feel my legs churning faster, the muscles rippling momentarily, only to be solidified when foot and turf met like gears Hitting the second mark, I escaped from the shadow of the tree and was bathed in sunlight. . . Left foot forward . . . javelin back, straight back, . . . turn now, five steps . . . three, four stretch, the clouds, the point . . turn back, throw the hips chest out . . . explode through the javelin . . . terminate forward motion, release.

The muscles of my right leg divided in thirds just above my knee, as the full weight of my body in motion was left to its support. Skipping, I followed through and watched the quivering javelin climb as it floated in the oncoming wind. My cross swung. For a moment, it reflected the sunlight and I lost sight of the javelin The javelin landed quickly, piercing the ground. I heaved in exhaustion, and perspiration flowed from my face and hands Before me the field stretched and I attempted to evaluate my throw I was pleased The smell of honeysuckle again drifted into my senses and somehow, I had a feeling of accomplishment I could just as easily have experienced had I thrown poorly

What is the main reason the writer wrote this story?

A To express an athlete's feeling of failure

B To provide information about javelin throwing

C To describe how it feels to throw the javelin

D To encourage people to take up javelin throwing

E I don't know

Level 350 — Advanced Skills and Strategies

Readers who use advanced reading skills and strategies can extend and restructure the ideas presented in specialized and complex texts. Examples include scientific materials, literary essays, historical documents, and materials similar to those found in professional and technical working environments. They are also able to understand the links between ideas even when those links are not explicitly stated and to make appropriate generalizations even when the texts lack clear introductions or explanations. Performance at this level suggests the ability to synthesize and learn from specialized reading materials.

Read the passage below and answer the questions based on it

In the years between 1940 and 1960, literature, the arts, and culture in general became increasingly oriented to the many In an economy of high productivity, deluging millions of people daily with movies, magazines, books, and television programs, American culture achieved a degree of homogeneity never dreamed of before However, if such cultural homogeneity spelled loss of individuality —which it undoubtedly did—and if mass culture was often produced primarily for profit and only secondarily for aesthetic reasons, nevertheless mass production of "art" made available to millions of people what in previous times had been the privilege only of the aristocratic few Good radio and phonograph music was available where there had been no music before, there were more symphony orchestras and chamber music groups than ever, and toward the end of this period more Americans purchased tickets to classical concerts than to baseball games Paintings and items of sculpture were being turned out en masse in moderately good reproductions The world's literature was being distributed in inexpensive paperback editions in every bookshop, drugstore, and transportation terminal On balance it seemed that mass production, while it might not raise mass culture, would not destroy the growth of genuine taste either

What does the passage imply the arts were before 1940?

A Homogeneous

B Generally enjoyed

C Oriented to an elite

D Oriented to the average person

E I don't know

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LEVELS OF MATHEMATICS PROFICIENCY

Level 150 — Simple Arithmetic Facts

Learners at this level know some basic additional and subtraction facts, and most can add two digit numbers without regrouping. They recognize situations in which addition and subtraction apply. They also are developing rudimentary classification skills.

Which of these numbers is closest to 30?

- ○ 20
- ● 28
- ○ 34
- ○ 40

Add

$$\begin{array}{r} 35 \\ +42 \\ \hline \end{array}$$

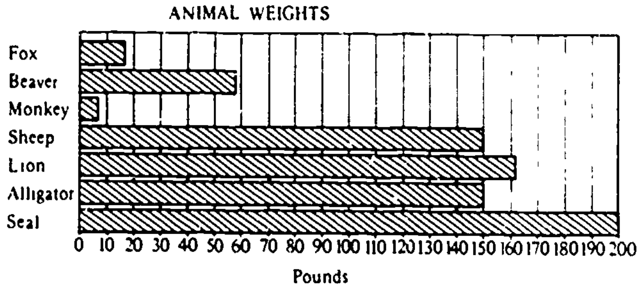
ANSWER 77

Level 200 — Beginning Skills and Understanding

Learners at this level have considerable understanding of two-digit numbers. They can add two-digit numbers, but are still developing an ability to regroup in subtraction. They know some basic multiplication and division facts, recognize relations among coins, can read information from charts and graphs, and use simple measurement instruments. They are developing some reasoning skills.

Which coins are the same amount of money as a quarter?

- ○ 2 dimes
- ● 3 nickels and 1 dime
- ○ 3 dimes
- ○ 4 nickels
- ○ I don't know



Which animal is heavier than a lion?

○ Fox

● Seal

○ Alligator

○ Sheep

The animals that weigh less than 100 pounds are

○ alligator, sheep, lion

○ monkey, sheep, lion

● fox, beaver, monkey

○ fox, lion, seal

Level 250 — Basic Operations and Beginning Problem Solving

Learners at this level have an initial understanding of the four basic operations. They are able to apply whole number addition and subtraction skills to one-step word problems and money situations. In multiplication, they can find the product of a two-digit and a one-digit number. They can also compare information from graphs and charts, and are developing an ability to analyze simple logical relations.

Sam has 68 baseball cards Juanita has 127 Which number sentence could be used to find how many more cards Juanita has than Sam?

● $127 - 68 = \square$

○ $127 + \square = 68$

○ $68 - \square = 127$

○ $68 + 127 = \square$

○ I don't know

At the store, the price of a carton of milk is 40¢, an apple is 25¢, and a box of crackers is 30¢. What is the cost of an apple and a carton of milk?

○ 55¢

● 65¢

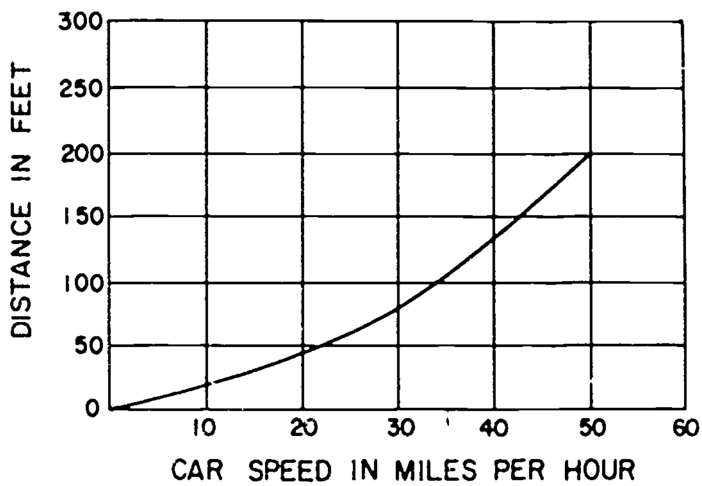
○ 70¢

○ 95¢

Level 300 — Moderately Complex Procedures and Reasoning

Learners at this level are developing an understanding of number systems. They can compute with decimals, simple fractions, and commonly encountered percents. They can identify geometric figures, measure lengths and angles, and calculate areas of rectangles. These students are also able to interpret simple inequalities, evaluate formulas, and solve simple linear equations. They can find averages, make decisions on information drawn from graphs, and use logical reasoning to solve problems. They are developing the skills to operate with signed numbers, exponents, and square roots.

Refer to the following graph. This graph shows how far a typical car travels after the brakes are applied.



A car is traveling 55 miles per hour. About how far will it travel after applying the brakes?

○ 25 feet

○ 200 feet

● 240 feet

○ 350 feet

○ I don't know

Which of the following is true about 87% of 10?

- It is greater than 10.
- ● It is less than 10.
- It is equal to 10.
- Can't tell.
- I don't know.

Level 350 — Multi-step Problem Solving and Algebra

Learners at this level can apply a range of reasoning skills to solve multi-step problems. They can solve routine problems involving fractions and percents, recognize properties of basic geometric figures, and work with exponents and square roots. They can solve a variety of two-step problems using variables, identify equivalent algebraic expressions, and solve linear equations and inequalities. They are developing an understanding of functions and coordinate systems.

Christine borrowed $850 for one year from the Friendly Finance Company. If she paid 12% simple interest on the loan, what was the total amount she repaid?

ANSWER $952

The number of tomato plants (t) is twice the number of pepper plants (p). Which equation best describes the sentence above?

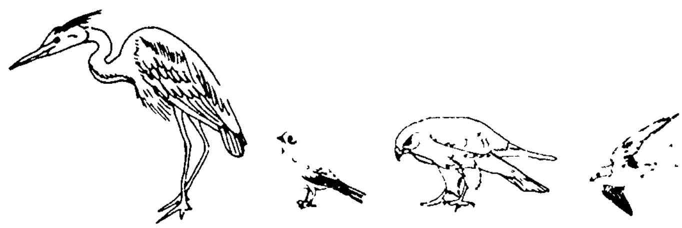
- ● $t = 2p$
- $2t = p$
- $t = 2 + p$
- $2 + t = p$

LEVELS OF SCIENCE PROFICIENCY

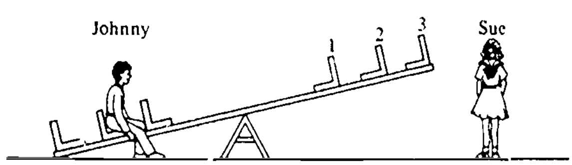
Level 150 — Knows Everyday Science Facts

Students at this level know some general scientific facts of the type that could be learned from everyday experiences. They can read simple graphs, match the distinguishing characteristics of animals, and predict the operation of familiar apparatus that work according to mechanical principles.

Which of the birds pictured below probably lives around ponds and eats snails and small fish?



Heron ● Sparrow ○ Hawk ○ Swallow ○



Look at the picture above John weighs 90 pounds and Sue weighs 75 pounds If Sue wants to make her end of the seesaw go down, should she sit at 1, or at 2, or at 3?

○ 1

○ 2

● 3

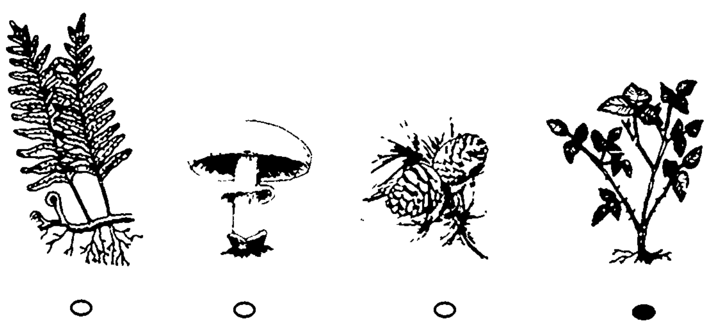
Level 200 — Understands Simple Scientific Principles

Students at this level are developing some understanding of simple scientific principles, particularly in the Life Sciences. For example, they exhibit some rudimentary knowledge of the structure and function of plants and animals.

What is the main function of the heart?

- ● To pump the blood to all parts of the body
- ○ To keep a person warm in winter by beating fast
- ○ To store extra blood until it is needed
- ○ To take waste food out of the blood

Which of the following plants would probably produce flowers?

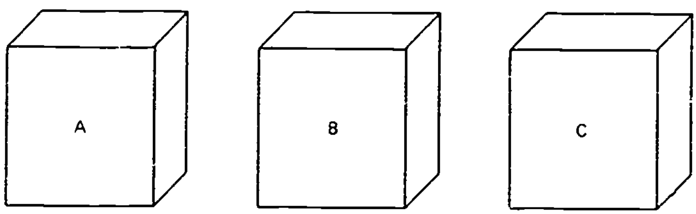


Level 250 — Applies Basic Scientific Information

Students at this level can interpret data from simple tables and make inferences about the outcomes of experimental procedures. They exhibit knowledge and understanding of the Life Sciences, including a familiarity with some aspects of animal behavior and of ecological relationships. These students also demonstrate some knowledge of basic information from the Physical Sciences.

Ten plants were placed in sandy soil and ten others were placed in clay soil. Both groups of plants were kept at room temperature, given the same amount of water, and placed in a sunny room. This experiment tests the effect of

- ○ sunlight on plant growth.
- ○ temperature on plant growth
- ● different soils on plant growth
- ○ water on plant growth



Blocks A, B, and C are the same size Blocks B and C float on water Block A sinks to the bottom Which one of the following do you know is TRUE?

- ● Block A weighs more than block B
- ○ Block B weighs more than block C.
- ○ Block C weighs more than block A
- ○ Block B weighs more than block A
- ○ I don't know

Level 300 — Analyzes Scientific Procedures and Data

Students at this level can evaluate the appropriateness of the design of an experiment. They have more detailed scientific knowledge, and the skill to apply their knowledge in interpreting information from text and graphs. These students also exhibit a growing understanding of principles from the Physical Sciences.

The new product Super Plant Food has been advertised. Claims have been made that Super Plant Food will cause plants to grow to giant sizes Directions on the label of this new product say: "Simply add 1 teaspoon of Super Plant Food powder to each gallon of water used to water your seeds or growing plants Plants watered with Super Plant Food solution will grow faster and become twice as large as normal plants"

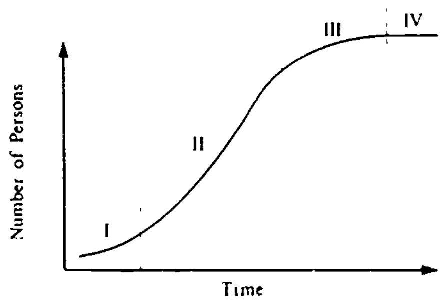
Suppose you wish to test scientifically the claims of the makers of Super Plant Food Which of the following experiments would best test whether Super Plant Food helps the growth of bean plants?

○ Place 1 bean seed in each of two identical pots of soil Water each pot with the same amount of Super Plant Food solution each day

○ Plant 10 bean seeds in a pot of soil Water with the same amount of Super Plant Food solution each day.

● Plant 10 bean seeds in each of two identical pots of soil Water one pot with a cup of Super Plant Food solution each day, and water the other pot with a cup of water each day

○ Place 100 bean seeds on a sponge Keep the sponge moistened with Super Plant Food solution



In the population growth curve above, in which interval is the population in equilibrium (the death rate equal to the birth rate)?

○ I

○ II

○ III

● IV

Level 350 — Integrates Specialized Scientific Information

Students at this level can infer relationships and draw conclusions using detailed scientific knowledge from the Physical Sciences, particularly Chemistry. They also can apply basic principles of genetics and interpret the societal implications of research in this field.

$$2Na + S \rightarrow Na_2S$$

The mass of 1 0 mole of sodium, Na, is 23 0 grams The mass of 1 0 mole of sulfur is 32.1 grams Approximately what mass of sodium is required to react completely with 32 1 grams of sulfur in the reaction above?

- ○ 11 5 grams
- ○ 23 0 grams
- ○ 32 0 grams
- ● 46 0 grams

A female white rabbit and a male black rabbit mate and have a large number of baby rabbits About half of the baby rabbits are black, and the other half are white If black fur is the dominant color in rabbits, how can the appearance of white baby rabbits best be explained?

- ○ The female rabbit has one gene for black fur and one gene for white fur
- ● The male rabbit has one gene for black fur and one gene for white fur
- ○ The white baby rabbits received no genes for fur color from the father
- ○ The white baby rabbi, are result of accidental mutations

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