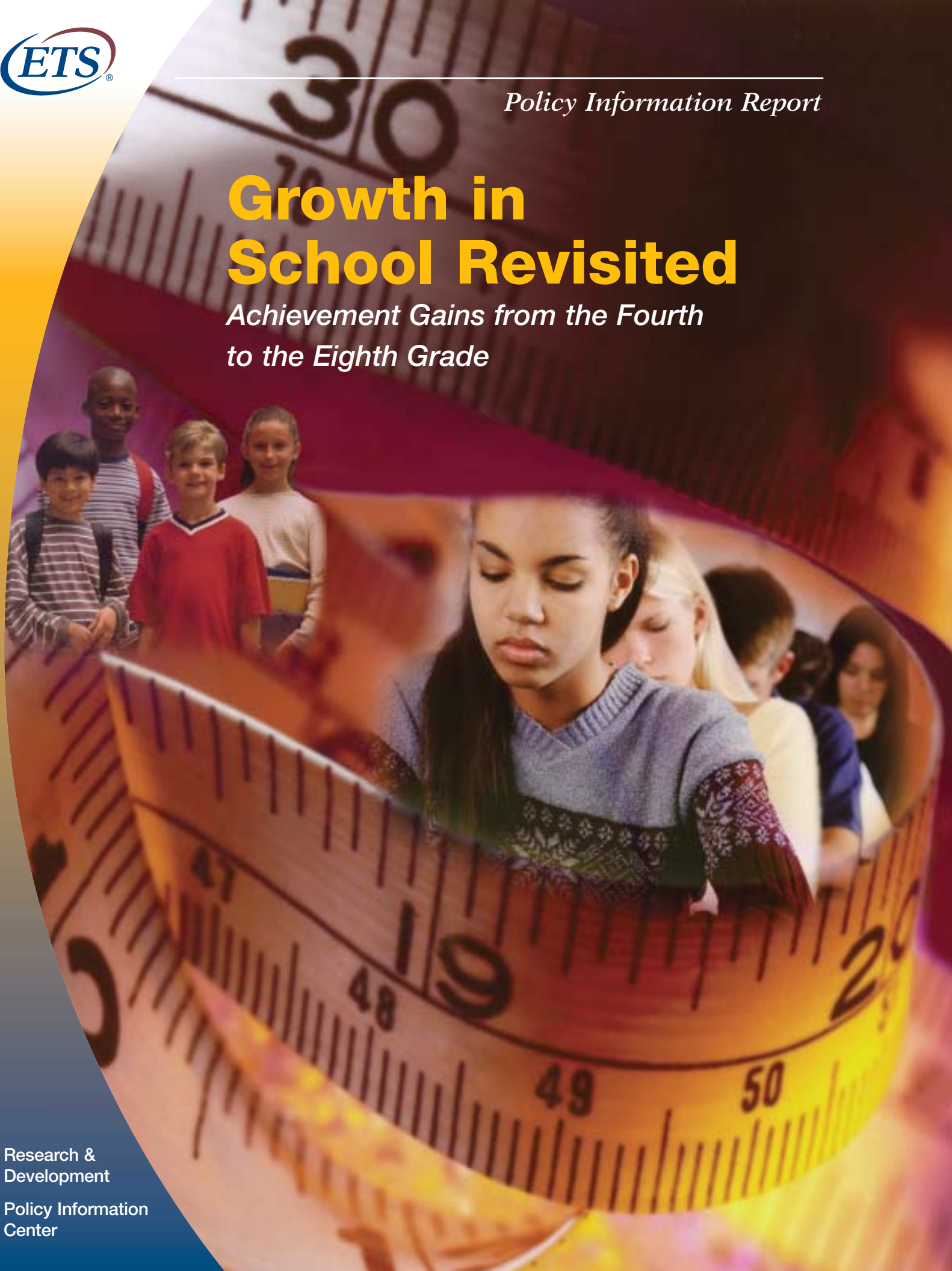
ETS

Policy Information Report

Growth in School Revisited

Achievement Gains from the Fourth to the Eighth Grade



Research & Development

Policy Information Center

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Preface

The goal of ETS's Policy Information Center is to shed light on the critical educational issues of our time. At the forefront in the United States today are two issues: the achievement gap, and the value of educational influencers, such as schools, teachers, and state policies, on that gap. Typically, these issues are addressed in distinct analyses, making it difficult to build a coherent picture of how students are actually faring. While we know that the overall performance of racial, ethnic, and geographic groups in this country varies greatly, we have much less of an understanding of how students from each of these groups develop over time.

Richard Coley has taken a clever approach in using data from the National Assessment of Educational Progress (NAEP) to track the performance of groups of individuals from varying demographic groups and different states to concurrently examine the achievement gap as well as the academic attainment of these groups over time. By looking at fourth graders in one year and eighth graders four years later, on a common scale, he helps us understand both the progress and the challenges we face in addressing the achievement gap. This analysis also helps us understand the problematic nature of simply equating educational quality with test scores attained at a given time. Coley provides many illustrations of relatively low-performing groups that are, in fact, showing greater growth over a four-year period than their higher-performing peer groups.

Coley's analysis shows that these important policy issues are more textured than the political rhetoric often would have us believe. With public and political attention focused so much on the quality of education and educational providers, we hope that this study contributes to a more comprehensive debate on both the achievement gap and educational quality.

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Introduction

The signal feature of the No Child Left Behind Act (NCLB) is its focus on accountability and results with the aim of steadily increasing the proportion of students who reach academic proficiency and improving the performance of poorly performing schools. The law requires states to demonstrate progress from year to year for various student subgroups, including economically disadvantaged students, students with limited English proficiency, students with disabilities, and students in major racial and ethnic groups. Performance on reading and math assessments is the main indicator of whether progress is being made, but graduation rates and at least one additional indicator for elementary schools (decided on by the state) must also be included.[1]

Although there have been prior state and federal efforts to increase accountability and also address the large gaps in achievement among subgroups of students, the new law is pervasive and exacting in its requirements to set targets, test in all grades from three to eight, and disaggregate scores—requiring progress for all groups. The law puts the spotlight on gaps in achievement, and on measures of progress toward meeting the goal that all students become "proficient" by 2012.

There are different angles from which to view student progress, however, and different ways to measure equality in achievement. The testing system that has evolved in the United States typically compares students in the same grade over a period of time, answering the question: Do this year's eighth-grade students score as well as last year's students, or as well as students of five years ago? The state of Tennessee, among others, has used a different approach, measuring the progress of the same students from the beginning of the year to the end of the year, so that the "value added" by the education system can be measured and compared over time.

The National Assessment of Educational Progress (NAEP) has traditionally reported on how the achievement of this year's students compares with that of students in the same grade in past years.[2] But NAEP also has the capability, seldom exploited, of showing how a cohort of students progresses over a four-year period, say, from the fourth to the eighth grade, and comparing this four-year gain to earlier periods of four-year gain, or comparing the gains among different subgroups of students or among states. Through NAEP, we can examine progress in terms of both approaches—change at the same grade level, and change in the gain in achievement for a cohort of students as they move from one grade to another. This may help illuminate the different approaches to measuring progress that are possible.

In the redesign of NAEP by Educational Testing Service, beginning with the 1984 assessment, a conscious effort was made to enable NAEP to track the educational achievement of the *same cohort* of students. This was done by spacing the grade or age levels assessed four years apart (e.g., fourth, eighth, and twelfth grades), and conducting the assessment in each subject at least every four years. Although this assessment pattern has not always been followed precisely, it has been used closely enough to permit some comparisons based on following a *cohort* of students during a four-year period of schooling.[3]

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1 For a summary of the provisions of the Act, see *The No Child Left Behind Act, A Special Report*, Washington, DC: Educational Testing Service, State and Federal Relations Office, February 2002. For a description of some of the methodological and practical challenges of the law, see Robert L. Linn, Eva L. Baker, and Damian W. Betebenner, "Accountability Systems: Implications of Requirements of the No Child Left Behind Act of 2001," *Educational Researcher*, Vol. 31, No. 6, August/September 2002.

2 The National Assessment of Educational Progress was established by Congress in 1969 to provide national data on the academic performance of the nation's students in core subjects. In 1990, Congress authorized the administration of NAEP at the state level on a voluntary basis, allowing states to see how they compare with each other and to the nation as a whole. State NAEP now tests mathematics and science, alternating with reading and writing at the fourth and eighth grades, on a four-year alternating cycle. Beginning in 2003, reading and mathematics assessments will be conducted every two years and writing and science every four years. NAEP is the only national source of comparable state-by-state data on student achievement.

3 Although it is unlikely that very many of the same students would be assessed at both grade levels, students are drawn from a representative sample of the same group of students.

Another key feature of the NAEP redesign that allows us to measure cohort growth is the use of a single score scale (from 0 to 500) for students at all grade and age levels. Comparing the progress of cohorts was one of the reasons for moving to this developmental scale.[4] The combination of these features allows us to see, for example, how much the cohort of fourth graders in 1996 gained on the NAEP mathematics scale by the time they were eighth graders in 2000. We can compare this gain across different demographic subgroups of students and across the states that participated in NAEP during those two time periods.

Although this kind of NAEP cohort analysis is not frequently undertaken, it provides a different and important perspective on differences in educational achievement. In 1998, the ETS Policy Information Center issued a report entitled *Growth in School: Achievement Gains from the Fourth to the Eighth Grade*, by Paul Barton and Richard Coley, which reviewed the available data on cohort growth between the fourth and eighth grades in several subjects.[5] That report focused on changes between 1992 and 1996 and also compared those changes with changes for earlier cohorts of students going back to the 1970s.

In short, the analyses revealed that over the past two decades or so, growth in achievement between the fourth and eighth grades was basically flat. And although states varied widely in the average scores of their students, there was little difference among states in the value added between the fourth and eighth grades. The analyses provided in this report update those comparisons.

It should be noted at the outset that following a cohort of students over a four-year period poses both statistical and measurement challenges. A typical approach in several government-sponsored programs is a "longitudinal" design, in which the performance of groups of students is tracked over time. A difficulty encountered in this design is finding the same students four years later. In NAEP, the assessment design utilizes probability samples of the fourth- and eighth-grade students nationwide. In comparing students four years later there is the possibility of changes in exclusion rates (states can exclude students from the assessment because of language difficulties or handicapping conditions) or changes in cohort composition because of student mobility in or out of a particular state, with a significant score difference between those leaving and those entering. It should be noted, however, that these same problems challenge NAEP when it compares the scores of fourth or eighth graders over some period of time.

NAEP has traditionally used a common "developmental" scale (0-500) in its reading and mathematics assessments, and all three grades assessed (4, 8, and 12) are put on that scale. Thus, comparisons can be made across the grade levels. In this report, for example, the NAEP math scale is used to compare fourth graders in 1996 to eighth graders in 2000. The NAEP scales were designed to be of "equal intervals," so that 50 points of growth, say, from a score of 200 to a score of 250, represents the same amount of growth as from a score of 250 to a score of 300. Some might argue that seemingly equivalent score gains are not always truly equivalent—for example, that a 50-point gain for Hispanic students is greater than a 50-point gain for White students, because the gain for Hispanic students represents a larger proportional increase. Others might argue in the other direction, however, reasoning that since the Hispanic gain was made at the lower end of the scale, the gains were "easier" to make. It is important to remember that the gains made by students who are the least prepared academically may be as hard to achieve as gains for those students who are among best prepared.

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4 This scale has been replaced in several NAEP assessments. For example, the science and writing assessments have within-grade 0-300 scales.

5 Paul E. Barton and Richard J. Coley, *Growth in School: Achievement Gains from the Fourth to Eighth Grade*, Policy Information Report, Policy Information Center, Educational Testing Service, 1998.

This report is organized as follows. In reading, the report reviews the score gains made by the cohort of students who were fourth graders in 1994 and eighth graders in 1998 (Class of 2002). In mathematics, the report reviews the score gains made by the cohort of students who were fourth graders in 1996 and eighth graders in 2000 (Class of 2004). For mathematics, the report also compares the gains of the Class of 2004 with the gains of the Class of 2000 (the cohort of students who were fourth graders in 1992 and eighth graders in 1996). As will be required by No Child Left Behind, the gains are disaggregated by student demographic groups and by state. Finally, the results are placed in the context of item maps, showing the kinds of reading and mathematics skills that students demonstrate along various points on the NAEP scales.

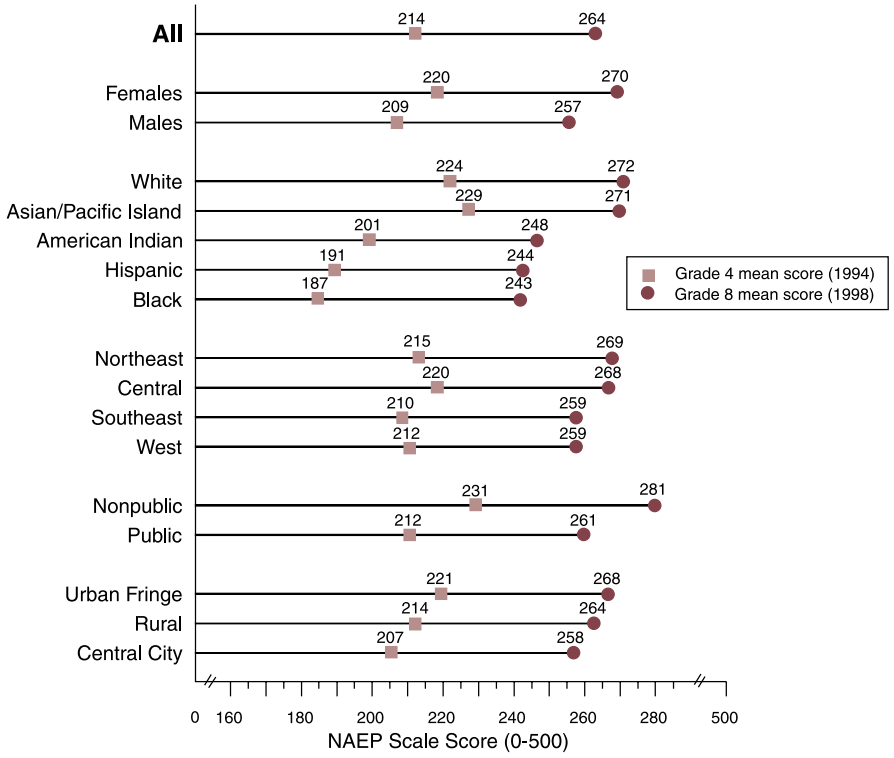
Reading

Because NAEP conducted reading assessments at grades 4, 8, and 12 in 1994 and 1998, it is possible to analyze performance trends for the cohort of students who were in fourth grade in 1994 and in eighth grade in 1998, four years later. At each of these grades, we can compare students on the basis of available demographic characteristics, like their gender and race/ethnicity. We are also able to compare their growth, or improvement, between the fourth and eighth grades. This latter comparison adds another important dimension to the comparisons that are typically made among students.

Figure 1 shows the average NAEP reading scores for this cohort of students, at both the fourth and eighth grades. In 1994, the average score for fourth graders was 214. In comparisons of subgroups of fourth-grade students:

- females outscored males
- White and Asian students outscored Black, Hispanic, and American Indian students
- students attending nonpublic schools outscored public school students
- students attending schools in urban fringe/large town areas outscored students attending schools in central cities.[6]

Figure 1: Average NAEP Reading Scores at Grade 4 in 1994 and Grade 8 in 1998, by Standard NAEP Reporting Groups



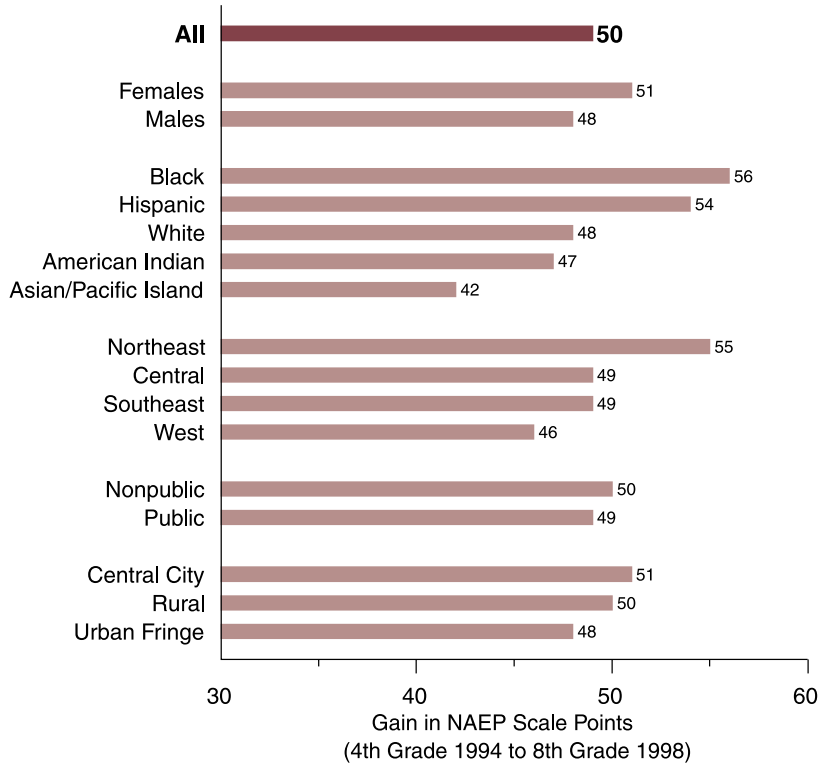
Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

6 See Jay R. Campbell et al., *NAEP 1994 Reading Report Card for the Nation and the States, Findings from the National Assessment of Educational Progress and Trial State Assessments*, prepared by Educational Testing Service under contract with the National Center for Education Statistics, January 1996.

In 1998, four years later, when these students reached the eighth grade, their average score increased to 264, an increase of 50 points on the NAEP scale. Differences in mean scores for subgroups of students remained basically the same as in fourth grade; the pattern changed very little.[7] So one part of the story is that the achievement gaps seen at the fourth grade persisted through the eighth grade. But another part of the story involves examining whether there are differences among various groups of students, or among states, in **growth** in reading scores between the fourth and eighth grades.

Figure 2 shows the growth, in NAEP scale points, between the fourth and eighth grades for this cohort of students, broken out into the same subgroups. With this view of the value added between the fourth and eighth grades, the pattern changes. Of particular interest are the racial/ethnic comparisons. Black students gain more (56 points) over the four-year period than do White students (48 points) and Asian students (42 points).[8] This is an important addition to the achievement picture. Although they start behind, Black fourth graders, on average, increase their reading scores at a greater rate than do White and Asian students over the next four years.

Figure 2: Cohort Growth in NAEP Reading, Grades 4 to 8, by Standard NAEP Reporting Groups



Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

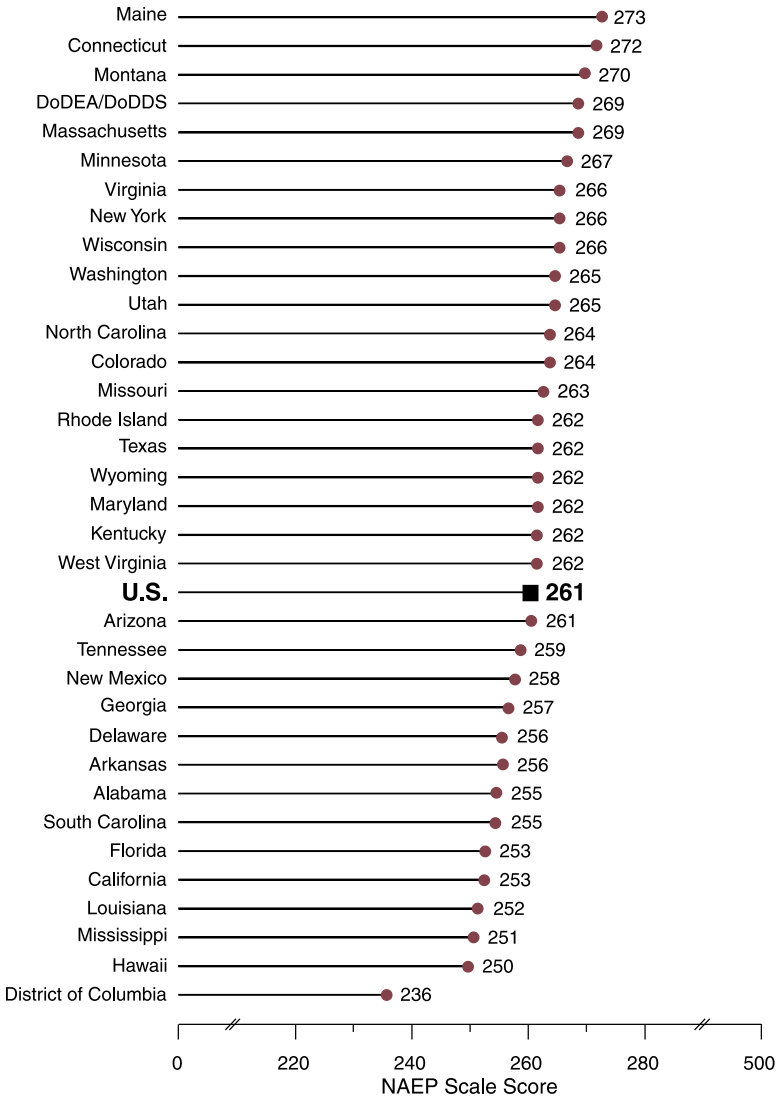
7 See Patricia L. Donohue et al., *NAEP 1998 Reading Report Card for the Nation and the States*, Washington, DC: National Center for Education Statistics, March 1999.

8 These differences are statistically significant based on t-tests; the difference between Black and Asian students is not statistically significant, however, when the False Discovery Rate (FDR) technique, a more conservative approach for making multiple comparisons, is used.

It is noteworthy that public and nonpublic schools add about the same value between the fourth and eighth grades, although nonpublic schools score higher, on average. Further, it is interesting to note that schools in the Northeast show more growth in reading than do schools in the West.

We can also view reading achievement across states, by examining the average scores of states that participated in the NAEP state assessment in both 1994 and 1998. To begin, a comparison of the states on reading achievement will typically examine the distribution of mean scores. Figure 3 shows average NAEP reading scores for eighth graders in 1998.

Figure 3: Average NAEP Reading Scores, Grade 8, 1998, by State, Public Schools



Note: Jurisdictions that participated in both the 1994 and 1998 assessments are shown.

Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

Maine and Connecticut top the list; other high-scoring states include Montana, Massachusetts, Minnesota, Virginia, New York, and Wisconsin (along with DoDEA/DoDDS schools[9]). Meanwhile, the District of Columbia falls considerably short of any other state or jurisdiction. Other states scoring at the bottom include Florida, California, Louisiana, Mississippi, and Hawaii.

What about growth between the fourth and eighth grades? Figure 4 shows the growth in NAEP reading scores for the same states and jurisdictions for the cohort of students who were in fourth grade in 1994 and in eighth grade in 1998. A different picture emerges as the rankings change considerably. The District of Columbia, California, Louisiana, and South Carolina jump from the bottom of the rankings toward the top. On the other hand, Maine, Massachusetts, Wisconsin, Montana, Minnesota, Wisconsin, and Utah move from above average in eighth-grade reading to below average in growth between the fourth and eighth grades. Connecticut, Virginia, New York, Washington, and DOD schools maintain their above-average rankings.

Appendix Table 1 shows the results of statistical significance testing for Figure 4. The District of Columbia outperforms 26 states, California outperforms 20, and Louisiana outperforms 19. Reversing the focus reveals that the above-average-scoring states of Wyoming, Wisconsin, and Rhode Island show less gain than 27, 25, and 25 states, respectively. Additional differences among jurisdictions can be observed in the Appendix Tables 1 and 2.[10]

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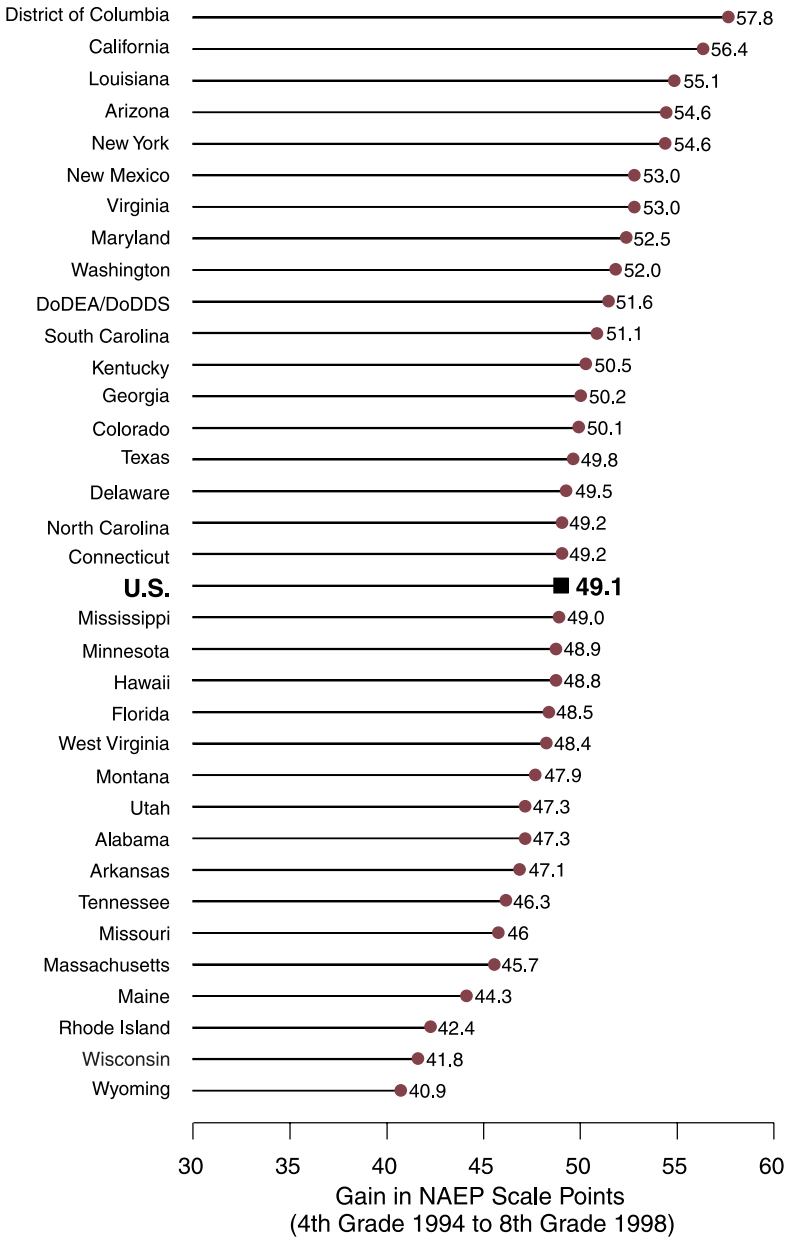
9 The following acronyms are used for schools run by the U.S. Department of Defense: DoDEA refers to Department of Defense Education Activities; DoDDS refers to Department of Defense Dependent Schools (overseas); and DDESS refers to Department of Defense Elementary and Secondary Schools.

10 These results are based on t-tests. Using the more conservative FDR procedure, the District of Columbia outperforms 20 of the 35 participating jurisdictions, California outperforms 11, and Louisiana outperforms 10. At the other end, Wyoming does worse than 23 jurisdictions, Rhode Island and Wisconsin do worse than 15 jurisdictions, and Maine does worse than 10. (See Appendix Table 2).

Figure 4: Cohort Growth in NAEP Reading, Grades 4 to 8, by State, Public Schools



Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

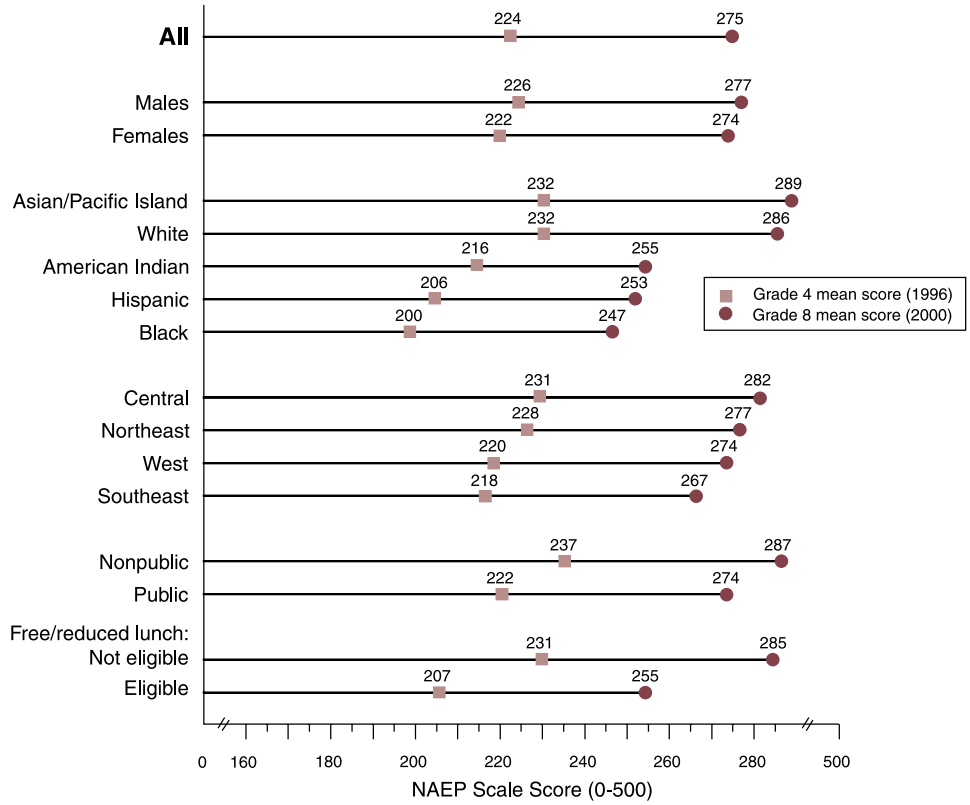
Mathematics

NAEP mathematics results are also available for cohort analysis, at both the national and state levels. We can compare the scores of fourth graders in 1996 with the scores of eighth graders four years later, in 2000. We can call this group the Class of 2004. In addition, we can compare the growth of this cohort with that of an earlier cohort—eighth graders in 1996 who were fourth graders in 1992.[11] This group is called the Class of 2000.

Figure 5 shows the national picture of mathematics scores for various demographic groups at the fourth (1996) and eighth grades (2000), or the Class of 2004. In 2000, there were several statistically significant differences among groups of eighth graders:

- males scored higher than females
- White students scored higher than Black, Hispanic, and American Indian students

Figure 5: Average NAEP Mathematics Scores at Grade 4 in 1996 and Grade 8 in 2000, by Standard NAEP Reporting Groups



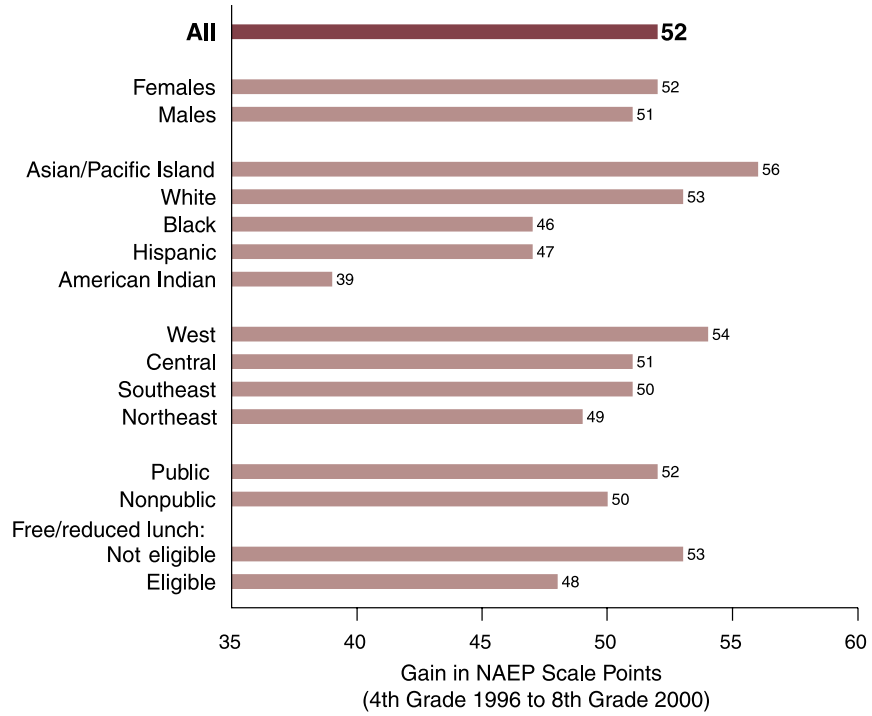
Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

[11] For analysis of the 1992 to 1996 cohort, see Barton and Coley, 1998.

- students attending nonpublic schools scored higher, on average, than students attending public schools
- students not eligible for free/reduced price lunches scored higher than students eligible for that benefit
- students attending schools in the Southeast scored lower than students attending schools in other parts of the country.[12]

But what about the growth between the fourth and eighth grades for the Class of 2004? Figure 6 shows the mathematics score gain between the fourth grade in 1996 and the eighth grade in 2000. Overall, students gain about 50 points on the NAEP score over that time. As Figure 6 shows, there are some differences among groups of students, but most of these are not statistically significant. A statistically significant difference is that the growth for White students is greater than the growth for Black and Hispanic students. In addition, students who are not eligible for free or reduced price lunches gain more, on average, than students who are eligible for this subsidy.[13] These findings are troubling, because these poor and minority students are already at a disadvantage when their mean grade-level scores are compared. Not only do they

Figure 6: Cohort Growth in NAEP Mathematics, Grades 4 to 8, by Standard NAEP Reporting Groups



Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

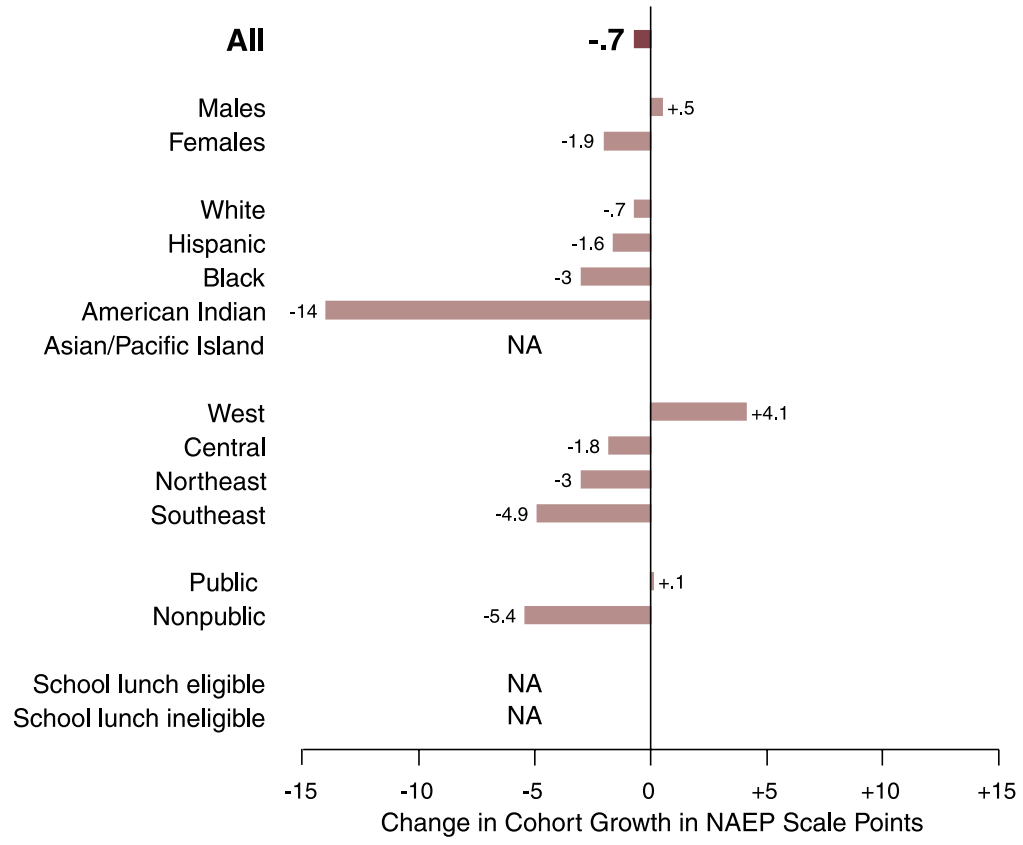
[12] For results of the 2000 mathematics assessment, see James S. Braswell et al., *The Nation's Report Card: Mathematics 2000*, Washington, DC: National Center for Education Statistics, August 2001.

[13] These differences are statistically significant based on t-tests; no significant differences are found using the FDR method.

score lower, on average; they also show less growth between the fourth and eighth grades.

Cohort change data in mathematics were also examined for the Class of 2000—fourth graders in 1992 who were eighth graders in 1996.[14] This allows us to see whether the growth of two cohorts of students has changed (the Class of 2000 compared with the Class of 2004). Change between these two cohorts of students is shown, for various demographic groups, in Figure 7. Whereas this graph shows that most of the change is on the negative side of the axis, with American Indian students losing 14 points over the time period, none of these changes are statistically significant. In other words, across all groups examined, the fourth- to eighth-grade change in scores for the Class of 2004 was not significantly different from that change for the Class of 2000.

Figure 7: Change in Cohort Growth in NAEP Mathematics Between 1992 to 1996 and 1996 to 2000



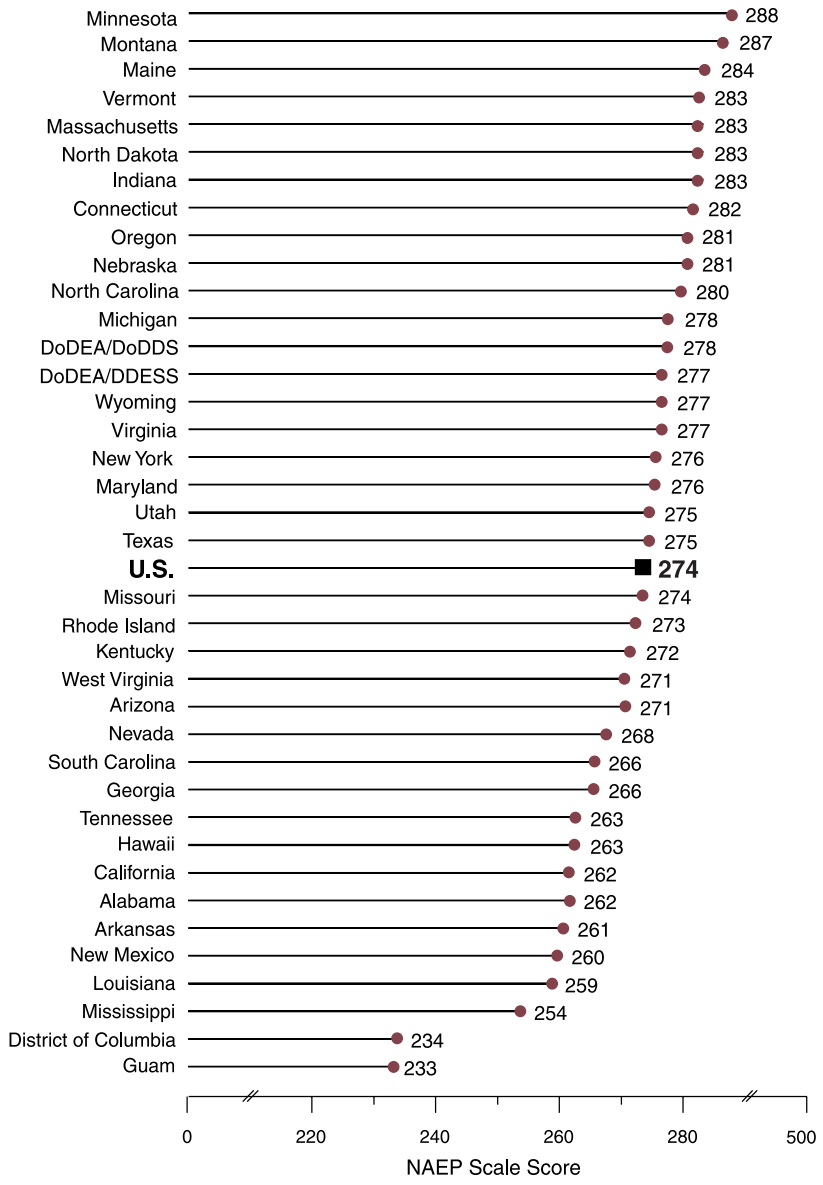
Note: None of the changes are statistically significant.

Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

[14] See Barton and Coley, 1998.

At the state level, we can begin by looking at the average eighth-grade mathematics scores, in 2000, for states that also participated in NAEP in 1996. These results are shown in Figure 8. Minnesota and Montana scored higher than all of the other participating states.[15] But what about the value added between the fourth and eighth grades?

Figure 8: Average NAEP Mathematics Scores, Grade 8, 2000, by State, Public Schools



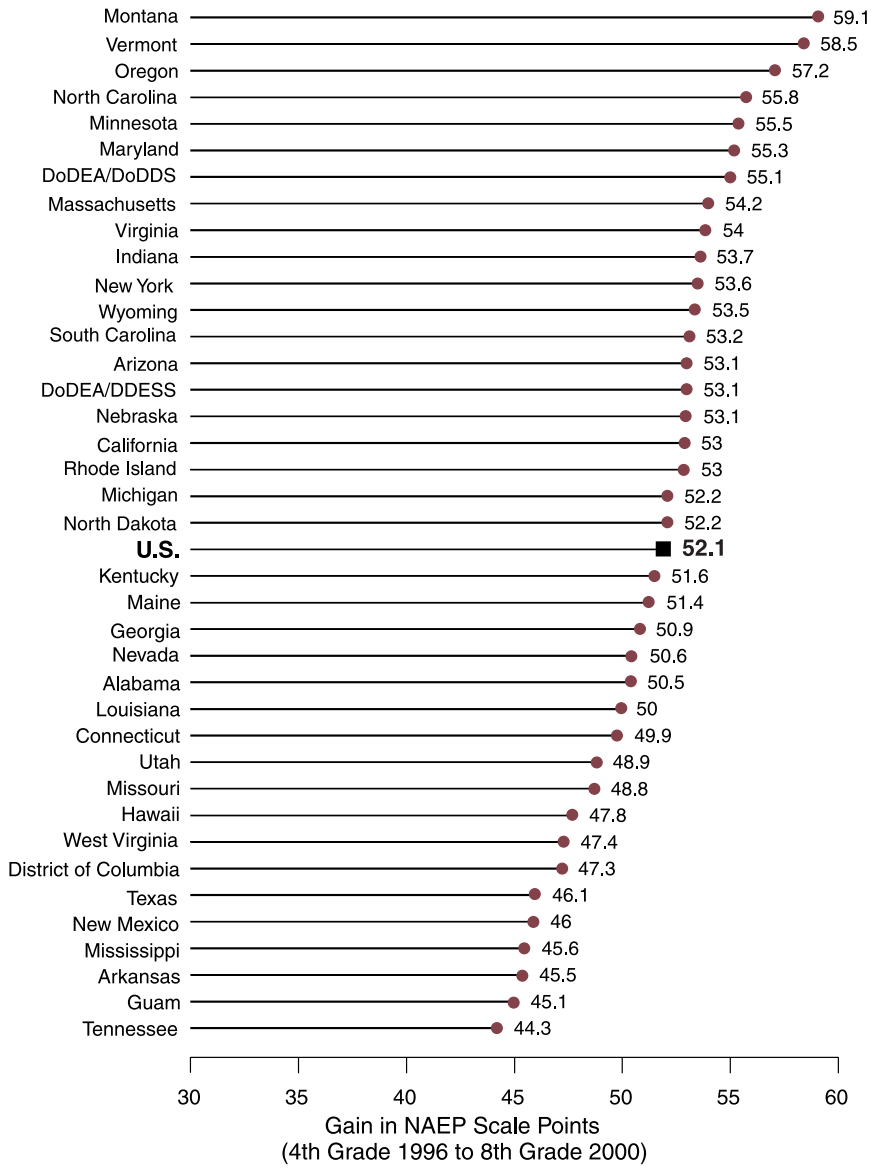
Note: Jurisdictions that participated in both the 1996 and 2000 assessments are shown.

Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

[15] For further comparisons among the states, see Braswell et al., 2001.

Figure 9 ranks the participating states on the gain in NAEP mathematics scale points between grades 4 and 8 for the Class of 2004. Montana and Vermont show higher growth between the fourth grade and eighth grade than do 26 of the other jurisdictions that participated in both assessments. Other states that significantly outperform a number of others include Oregon, North Carolina, Minnesota, Maryland, DoDEA/DoDDS, Massachusetts, Virginia, and Indiana. At the bottom, Tennessee, Guam, Arkansas, Mississippi, New Mexico, Texas, and West Virginia do less well than several states (for additional comparisons, see Appendix Table 3).[16]

Figure 9: Cohort Growth in NAEP Mathematics, Grades 4 to 8, by State, Public Schools

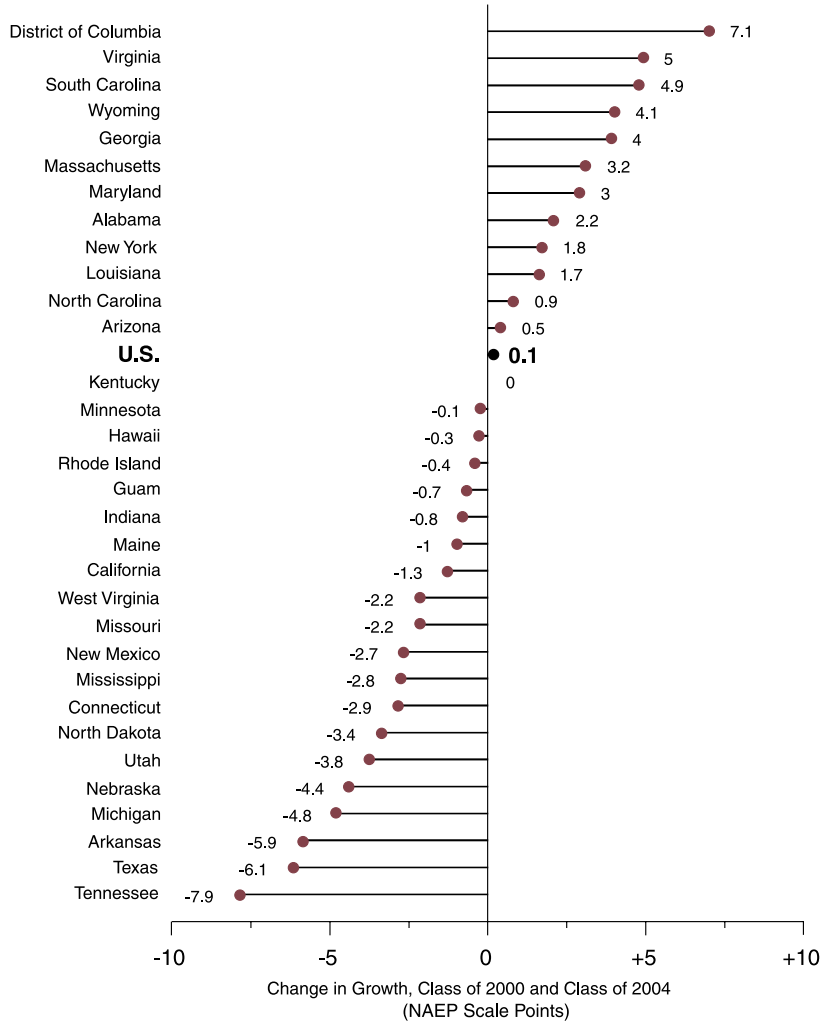


Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

[16] These differences are based on t-tests. Even under the more conservative FDR procedure, Montana and Vermont outperform 19 jurisdictions, while Tennessee, Arkansas, and Mississippi do less well than several other jurisdictions (see Appendix Table 4).

In addition to looking at this one cohort, we can ask if states are making progress over these two time periods in adding value between the fourth and eighth grades. Figure 10 shows the difference in fourth- to eighth-grade growth between the 1992 to 1996 cohort (Class of 2000) and the 1996 to 2000 cohort (Class of 2004). As the figure shows, the District of Columbia, Virginia, South Carolina, Wyoming, and Georgia improve over the two cohorts by 4 NAEP scale points or more, significantly better than several other states.[17] For example, D.C. did better than 14 states, and Virginia, South Carolina, and Wyoming did better than 11. At the other end of Figure 10, Tennessee did worse than 14 states and Texas did worse than 8.[18]

Figure 10: Difference in the NAEP Mathematics Growth Between the 4th and 8th Grades for the Class of 2000 and the Class of 2004, Public Schools



Note: Jurisdictions that participated in both the 1996 and 2000 assessments are included.

Source: Data from the National Assessment of Educational Progress analyzed by the ETS Policy Information Center.

[17] Based on t-tests. Using the FDR procedure, there were no statistically significant differences in gains.

[18] Appendix Tables 5 and 6 provide a matrix of comparisons using both t-tests and FDR methods.

Exploring Cohort Growth

The above analyses raise some important issues about growth in school. As a way to understand and visualize the kinds of cohort growth described here, we can examine some examples of the kinds of mathematics and reading items that different groups of students are able to perform as fourth graders, and then look at the kinds of items the groups can perform as eighth graders.

This type of analysis is possible because each item administered in the NAEP assessments can be assigned a scale score based on how well students in the assessment performed on that item. For example, items that require basic reading or mathematical skills are assigned low scale scores, reflecting the fact that most students with proficiency levels near the value assigned were able to perform them correctly. (By convention, NAEP defines "most" as approximately two-thirds.) At the other end of the spectrum, items requiring complex reading or mathematical operations are assigned higher scale scores, reflecting the fact that only students at these higher proficiency levels were consistently able to perform successfully on the items.

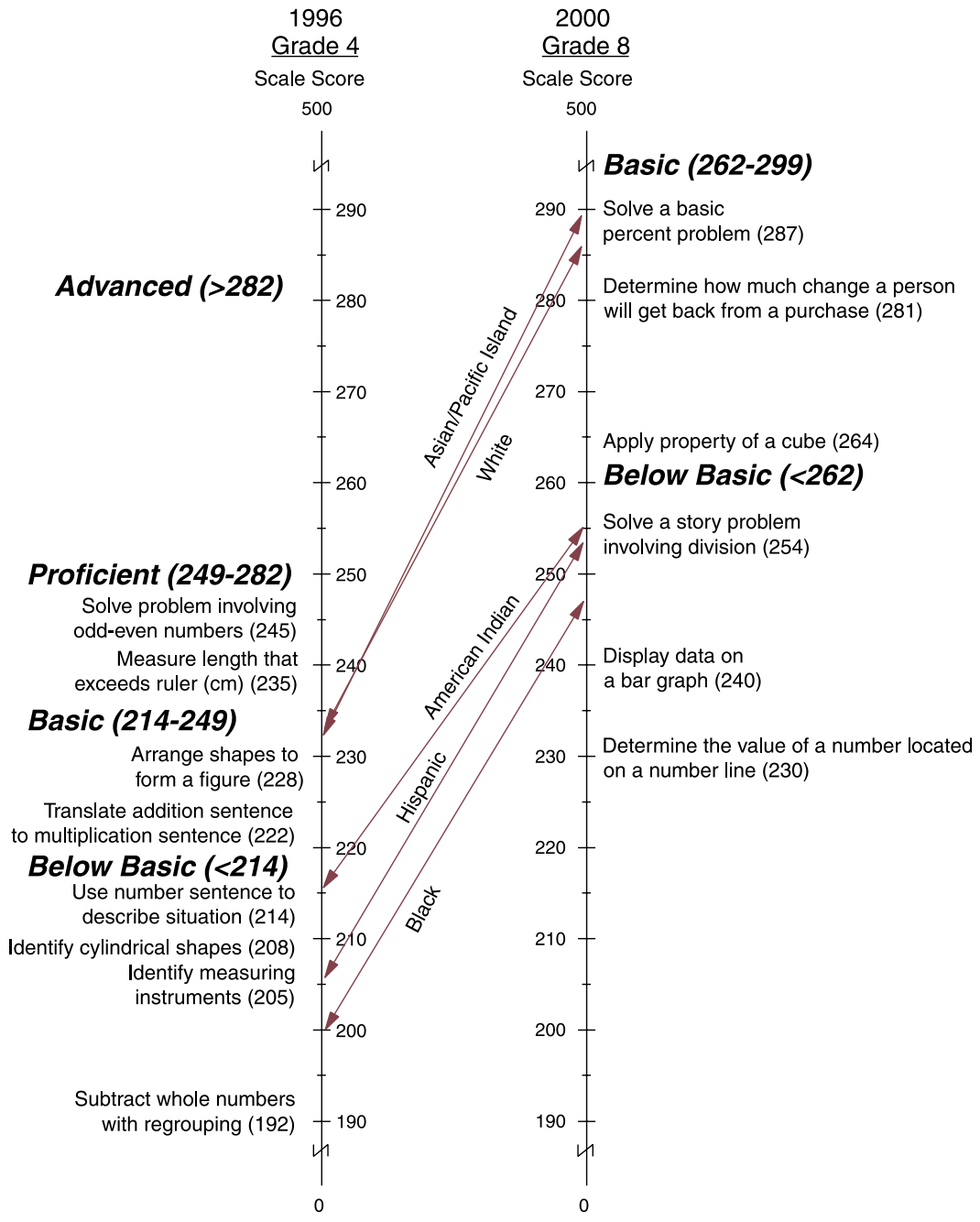
Interpretation of the NAEP scales is also facilitated by the use of achievement levels, which are established by the National Assessment Governing Board. These levels, which range from "below basic," to "advanced," are used to describe the types of skills demonstrated by students with similar proficiency scores.

Figure 11 shows an item map for mathematics. An item map is a representation of the skills and abilities demonstrated by students at various levels of the NAEP mathematics scale. The map indicates which kinds of questions students can likely answer correctly at each level of the scale. On the left side of the figure, examples of mathematics items are shown along with their level of difficulty on the NAEP scale for the cohort of students who were fourth graders in 1996. Note (as shown by the arrows) that Black, Hispanic, and American Indian students scored, on average, at the "below basic" level. At this level, these students could do things like identify measuring instruments. Asian/Pacific Island and White fourth graders, on the other hand, had average scores in the "basic" range and were likely to be able to "measure length that exceeds a ruler" and "arrange shapes to form a figure."

The right side of Figure 11 shows the kinds of mathematics tasks that these students can handle four years later when they are in eighth grade. Black and Hispanic students remain at the below basic level and American Indian students score, on average, at this level as well. These students are likely to be able to perform tasks like "solving a story problem involving division." Asian/Pacific Island and White eighth graders maintain their position at the "basic" level on the NAEP scale and are likely to be able to "solve a basic problem using percent."

The arrows connecting the fourth- and eighth-grade scales show the **growth** in NAEP scale points over those grades. Although there are significant differences in average mathematics scores among groups of fourth and eighth graders, there is little difference in their **growth**, or improvement, from the fourth to the eighth grades. While the gains are similar, however, the levels can be quite different. For example, for Black students, the average score improvement of 47 NAEP scale points brought them to a point in the eighth grade where they are only slightly above the level of fourth-grade White and Asian/Pacific Island students.

Figure 11: NAEP Mathematics Item Map Showing Growth from Grade 4 in 1996 to Grade 8 in 2000, by Racial/Ethnic Group



Sources: Clyde M. Reese et al., *NAEP 1996 Mathematics Report Card for the Nation and the States*, Washington, DC: National Center for Education Statistics, 1997, and James S. Braswell et al., *The Nation's Report Card: Mathematics 2000*, Washington, DC: National Center for Education Statistics, August 2001. Note: The position of an item on the scale represents the scale score attained by students who had a 65 percent probability of successfully answering the item. (The probability was 74 percent for 4-option questions and 72 percent for 5-option questions.)

Figure 12 is useful in further conveying mathematics growth from the fourth to eighth grade, the kinds of mathematics tasks involved in the 2000 mathematics assessment for grades 4 and 8, the proficiency levels set by NAEP's governing board, and the points along the score scale where selected groups of students score. Although the questions asked of eighth graders were not asked of fourth graders, the array can illustrate the level of difficulty at different parts of the NAEP scale.

Arraying average proficiencies in this manner can be revealing. To highlight a few of the findings:

- The average score of eighth graders in the District of Columbia is about even with the average score of White fourth graders nationally.

- The top-scoring state, Minnesota, scores, on average, as well as the highest scoring racial/ethnic group—Asian/Pacific Islanders.

- American Indian, Hispanic, and Black eighth graders score below the "basic" level, on average.

A similar pair of charts helps to illustrate the cohort growth that took place in reading between the fourth and eighth grades and provides examples of the kinds of reading tasks the students can or cannot perform. Figure 13 shows a NAEP reading item map, depicting selected items that fall along the points of the NAEP scale, for both fourth and eighth grades.

On the left-hand side of the chart we see that the average scores for American Indian, Hispanic, and Black fourth graders fall into the "below basic" range, and the average scores for White and Asian/Pacific Islander students fall in the "basic range." The item descriptions provide examples of the kinds of skills included in each range.

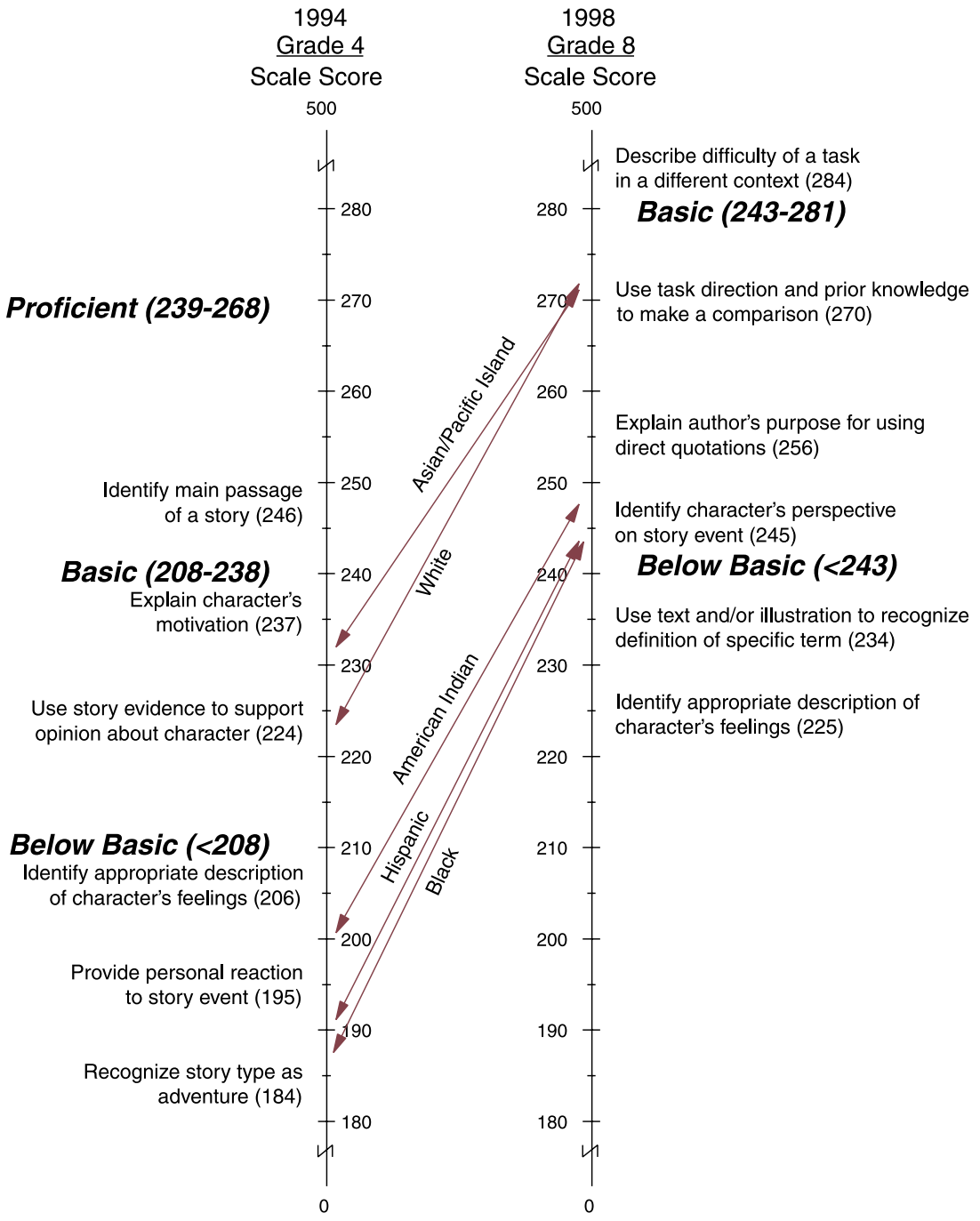
The right side of the chart shows the reading proficiencies of these groups of students four years later, when they are in the eighth grade. Note that the arrows go up at roughly equivalent angles, meaning that growth is fairly even. However, American Indian, Hispanic, and Black students who scored "below basic," on average, in fourth grade, have average scores in the eighth grade that move into the "basic" range. The advantages held by Asian/Pacific Islander and White students persist over the four-year period.

Finally, Figure 14 is helpful in viewing the reading proficiency of fourth and eighth graders in terms of their average scale scores and the kinds of NAEP reading items the students can successfully answer. The left side of the chart shows selected reading items used in the fourth and eighth grades, and the right side shows average scores for subgroups of students and for selected states. As with mathematics, arraying the data in this way identifies some striking differences in average scores among subgroups of students.

Figure 12: Map of Selected Items on the NAEP Mathematics Scale and Average Scale Scores for Selected Groups of Students, 2000

James S. Braswell et al., *The Nation's Report Card: Mathematics 2000*, Washington, DC: National Center for Education Statistics, August 2001.
Note: The position of an item on the scale represents the scale score attained by students who had a 65 percent probability of successfully answering the item. (The probability was 74 percent for 4-option questions and 72 percent for 5-option questions.)

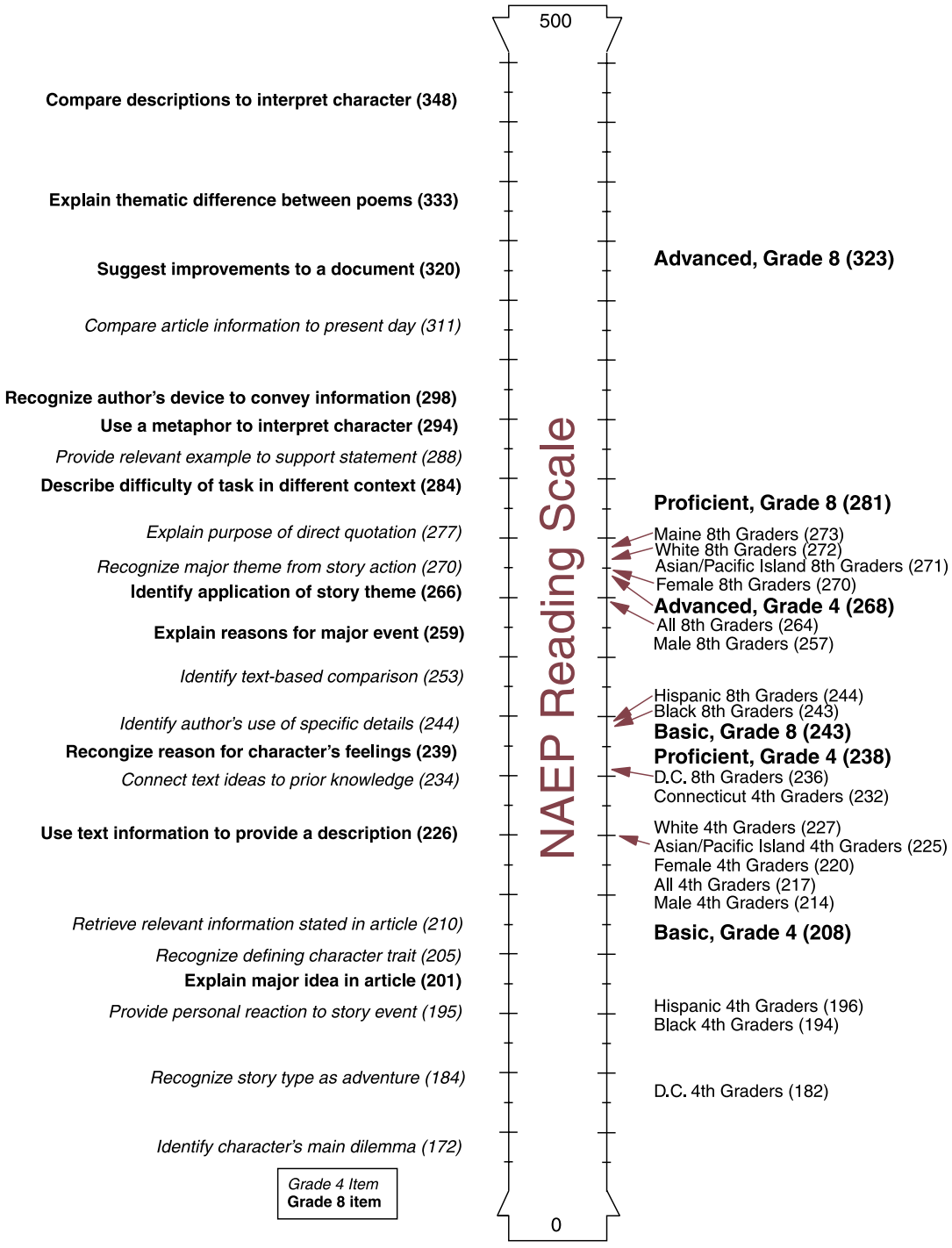
Figure 13: NAEP Reading Item Map Showing Growth from Grade 4 in 1994 to Grade 8 in 1998, by Racial/Ethnic Group



Note: The position of an item on the scale represents the scale score attained by students who had a 65 percent probability of successfully answering the item. (The probability was 74 percent for 4-option questions and 72 percent for 5-option questions.)

Source: Patricia L. Donahue et al., *NAEP 1998 Reading Report Card for the Nation and the States*, Washington, DC: National Center for Education Statistics, 1999.

Figure 14: Map of Selected Items on the NAEP Reading Scale and Average Scale Scores for Selected Groups, 1998



Note: The position of an item on the scale represents the scale score attained by students who had a 65 percent probability of successfully answering the item. (The probability was 74 percent for 4-option questions and 72 percent for 5-option questions.)

Source: Patricia L. Donahue et al., *NAEP 1998 Reading Report Card for the Nation and the States*, Washington, DC: National Center for Education Statistics, 1999.

Summary and Conclusions

Although many differences in average NAEP reading scores exist among subgroups of students, the growth in average scores between the fourth and eighth grades is about the same for all subgroups of students, except Black students. Black students gained more NAEP scale points (56) than did White (48 points) and Asian (42 points) students between the fourth and eighth grades. This difference is equivalent to roughly one year in school.[19] It is good news and shows improvement from an analysis of an earlier cohort that found no differences in growth among racial/ethnic groups.[20] And whereas students attending nonpublic schools score higher, on average, than those in public schools, both groups of schools add about the same value between the fourth and eighth grades.

Looking at cohort growth in reading across states, as opposed to average state NAEP scores, provides a very different picture of achievement. The District of Columbia, California, Louisiana, and South Carolina, for example, jump from the bottom of the list (based on average scores) to the top of the list (based on cohort growth). Some of the highest achieving states (in terms of average scores) drop far down the list when ranked on score growth between grades 4 and 8.

In mathematics, the analyses reveal a slightly different pattern. Some of the advantages in average scores held by several subgroups of students remain when cohort growth is examined. White students, for example, show more growth than do Black and Hispanic students.[21] In addition, for all groups, growth for the 1996 to 2000 period was not significantly different from growth for the 1992 to 1996 cohort.

Across the states that participated in both mathematics assessments, Montana and Vermont outperform many states on both average mathematics scores and on cohort growth between grades 4 and 8. Several states also show improvement in growth between the Class of 2000 and 2004 cohorts. These include the District of Columbia, Virginia, South Carolina, Wyoming, and Georgia.

Although traditional data on educational achievement trends provide one set of views about the relative achievement of various subgroups of students in reading and mathematics, data on cohort growth provide another and somewhat different set of views. Both perspectives are important in judging how the educational system is performing. The view provided by looking at average NAEP scores and how they have changed over time tells us whether students know more or less than their counterparts in an earlier period. This is valuable information, quite apart from the question of whether it is the best measure of **school** effectiveness. Student achievement is also affected by factors outside of school—what occurs in the home, in the family, and in the community.

The view of achievement provided by looking at cohort growth gets us closer to measuring what really happens in school. Although there are differences in average achievement across the states, about two-thirds of the states participating in NAEP are within plus or minus 3 scale points of the average growth in both reading and mathematics. This implies that most states do similar jobs in adding value (as measured by NAEP) between the fourth and eighth grades.

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19 A rule of thumb often used in NAEP analyses is that one year of school is equivalent to 12 points on the NAEP scale, or, put another way, each point on the NAEP scale is equivalent to one month of school. See Paul W. Holland, "How Big Is Big When It Comes to Gaps in Scores," Appendix B of the *Report of the Ad Hoc Committee on Confirming Test Results*, National Assessment Governing Board, March 1, 2002. However, NAEP makes no attempt to translate its scores into grade equivalencies.

20 Barton and Coley, 1998.

21 Based on t-tests; the differences are not significant based on FDR comparisons.

Thus, it appears to be important to examine both average score trends and cohort growth (and trends in cohort growth when the data are available). NAEP allows us to do this, in part, by using a single, developmental scale. This common scale is being phased out, however, and may not be used in future assessments. As states develop and refine their assessment systems in response to the No Child Left Behind Act, it would be advantageous to incorporate the capability to measure cohort growth in school, either in terms of progress from one year to the next, or from the beginning of a year until the end.

Measuring and evaluating cohort growth provides a different and important dimension in understanding achievement differences and trends. These efforts, however, provide no information about **why** students achieve or grow at different levels and rates. Research can help identify the factors related to these cohort score changes.

Appendix Table 1:
Statistically Significant Differences in NAEP Reading Cohort Growth Between the 4th Grade in 1994 and the 8th Grade in 1998, Using t-tests

	Growth in Mean	SE	District of Columbia	California	Louisiana	Arizona	New York	New Mexico	Virginia	Maryland	Washington	DoDEA/DoDDS	South Carolina	Kentucky	Georgia	Colorado	Texas	Delaware	North Carolina	Connecticut	Mississippi	Minnesota	Hawaii	Florida	West Virginia	Montana	Utah	Alabama	Arkansas	Tennessee	Missouri	Massachusetts	Maine	Rhode Island	Wisconsin	Wyoming
DC	57.8	2.1									+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
California	56.4	2.5														+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Louisiana	55.1	2.0																+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Arizona	54.6	2.2																							+	+	+	+	+	+	+	+	+	+	+	+
New York	54.6	2.1																							+	+	+	+	+	+	+	+	+	+	+	+
New Mexico	53.0	2.1																									+			+	+	+	+	+	+	+
Virginia	53.0	1.8																									+	+	+	+	+	+	+	+	+	+
Maryland	52.5	2.4																													+	+	+	+	+	+
Washington	52.0	2.0	-																												+	+	+	+	+	+
DoDDS	51.6	1.3	-																											+	+	+	+	+	+	+
S. Carolina	51.1	1.9	-																														+	+	+	+
Kentucky	50.5	2.0	-																														+	+	+	+
Georgia	50.2	2.8	-																															+	+	+
Colorado	50.1	1.7	-	-																													+	+	+	+
Texas	49.8	2.4	-																															+	+	+
Delaware	49.5	1.7	-	-	-																												+	+	+	+
N. Carolina	49.2	1.9	-	-	-																													+	+	+
Connecticut	49.1	2.0	-	-	-																													+	+	+
Mississippi	49.0	2.2	-	-	-																													+	+	+
Minnesota	48.9	1.9	-	-	-																													+	+	+
Hawaii	48.8	2.1	-	-	-																													+	+	+
Florida	48.5	2.4	-	-	-																													+	+	+
W. Virginia	48.4	1.6	-	-	-	-	-																											+	+	+
Montana	47.9	1.8	-	-	-	-	-																											+	+	+
Utah	47.3	1.7	-	-	-	-	-	-	-			-																						+	+	+
Alabama	47.3	2.0	-	-	-	-	-		-																											+
Arkansas	47.1	2.2	-	-	-	-	-		-																											+
Tennessee	46.3	2.2	-	-	-	-	-	-	-			-																								
Missouri	46.0	2.0	-	-	-	-	-	-	-	-	-	-																								
Mass.	45.7	2.1	-	-	-	-	-	-	-	-	-	-																								
Maine	44.3	1.8	-	-	-	-	-	-	-	-	-	-	-	-		-		-																		
Rhd Island	42.4	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
Wisconsin	41.8	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
Wyoming	40.9	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-						

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- in cell means that the row jurisdiction is lower than the column jurisdiction.

Blank cell means that there is no statistically significant difference between the row jurisdiction and the column jurisdiction.

Appendix Table 2:
Statistically Significant Differences in NAEP Reading Cohort Growth Between the 4th Grade in 1994 and the 8th Grade in 1998, Using False Discovery Rate Method

	Growth in Mean	SE	District of Columbia	California	Louisiana	Arizona	New York	New Mexico	Virginia	Maryland	Washington	DoDEA/DoDDS	South Carolina	Kentucky	Georgia	Colorado	Texas	Delaware	North Carolina	Connecticut	Mississippi	Minnesota	Hawaii	Florida	West Virginia	Montana	Utah	Alabama	Arkansas	Tennessee	Missouri	Massachusetts	Maine	Rhode Island	Wisconsin	Wyoming
DC	57.8	2.1														+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
California	56.4	2.5																								+	+	+	+	+	+	+	+	+	+	+
Louisiana	55.1	2.0																									+	+	+	+	+	+	+	+	+	+
Arizona	54.6	2.2																													+	+	+	+	+	+
New York	54.6	2.1																												+	+	+	+	+	+	+
New Mexico	53.0	2.1																															+	+	+	+
Virginia	53.0	1.8																															+	+	+	+
Maryland	52.5	2.4																															+	+	+	+
Washington	52.0	2.0																															+	+	+	+
DoDDS	51.6	1.3																															+	+	+	+
S. Carolina	51.1	1.9																																+	+	+
Kentucky	50.5	2.0																																+	+	+
Georgia	50.2	2.8																																		+
Colorado	50.1	1.7	-																															+	+	+
Texas	49.8	2.4																																		+
Delaware	49.5	1.7	-																															+	+	+
N. Carolina	49.2	1.9	-																															+	+	+
Connecticut	49.1	2.0	-																																	+
Mississippi	49.0	2.2	-																																	+
Minnesota	48.9	1.9	-																																	+
Hawaii	48.8	2.1	-																																	+
Florida	48.5	2.4	-																																	
W. Virginia	48.4	1.6	-																																	+
Montana	47.9	1.8	-	-																																+
Utah	47.3	1.7	-	-	-																															
Alabama	47.3	2.0	-	-	-																															
Arkansas	47.1	2.2	-	-	-																															
Tennessee	46.3	2.2	-	-	-		-																													
Missouri	46.0	2.0	-	-	-	-	-																													
Mass.	45.7	2.1	-	-	-	-	-																													
Maine	44.3	1.8	-	-	-	-	-	-	-	-	-	-																								
Rhd Island	42.4	1.6	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-																	
Wisconsin	41.8	1.9	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-																	
Wyoming	40.9	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-										

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Appendix Table 3:
Statistically Significant Differences in NAEP Mathematics Cohort Growth Between the 4th Grade in 1996 and the 8th Grade in 2000, Using t-tests

	Growth in Mean	SE	Montana	Vermont	Oregon	North Carolina	Minnesota	Maryland	DoDEA/DoDDS	Massachusetts	Virginia	Indiana	New York	Wyoming	South Carolina	Arizona	DoDEA/DDESS	Nebraska	California	Rhode Island	Michigan	North Dakota	Kentucky	Maine	Georgia	Nevada	Alabama	Louisiana	Connecticut	Utah	Missouri	Hawaii	West Virginia	District of Columbia	Texas	New Mexico	Mississippi	Arkansas	Guam	Tennessee
Montana	59.1	1.7										+		+	+	+		+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Vermont	58.5	1.6										+		+	+			+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Oregon	57.2	2.1																					+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
N. Carolina	55.8	1.6																								+		+	+	+	+	+	+	+	+	+	+	+	+	+
Minnesota	55.5	1.8																								+		+	+	+	+	+	+	+	+	+	+	+	+	+
Maryland	55.3	2.1																												+	+	+	+	+	+	+	+	+	+	+
DoDDS	55.1	1.3																								+		+	+	+	+	+	+	+	+	+	+	+	+	+
Mass.	54.2	1.8																												+	+	+	+	+	+	+	+	+	+	+
Virginia	54.0	2.0																														+	+	+	+	+	+	+	+	+
Indiana	53.7	1.8	-	-																												+	+	+	+	+	+	+	+	+
New York	53.6	2.4																															+		+	+	+	+	+	+
Wyoming	53.5	1.8	-	-																												+	+	+	+	+	+	+	+	+
S. Carolina	53.2	1.9	-	-																													+		+	+	+	+	+	+
Arizona	53.1	2.3	-																														+		+	+	+	+	+	+
DDESS	53.1	2.5																																	+		+	+	+	+
Nebraska	53.1	1.6	-	-																												+	+		+	+	+	+	+	+
California	53.0	2.7																																	+		+	+	+	+
Rhd Island	53.0	1.8	-	-																													+		+	+	+	+	+	+
Michigan	52.2	2.0	-	-																															+		+	+	+	+
N. Dakota	52.2	1.6	-	-																													+		+	+	+	+	+	+
Kentucky	51.6	1.8	-	-	-																														+		+	+	+	+
Maine	51.4	1.6	-	-	-																														+		+	+	+	+
Georgia	50.9	1.9	-	-	-																																			+
Nevada	50.6	1.6	-	-	-	-	-		-																												+			+
Alabama	50.5	2.2	-	-	-																																			+
Louisiana	50.0	1.9	-	-	-	-	-		-																															
Connecticut	49.9	1.8	-	-	-	-	-		-																															
Utah	48.9	1.6	-	-	-	-	-	-	-	-																														
Missouri	48.8	1.8	-	-	-	-	-	-	-	-																														
Hawaii	47.8	2.0	-	-	-	-	-	-	-	-	-	-		-				-																						
W. Virginia	47.4	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-		-																		
DC	47.3	2.4	-	-	-	-	-	-	-	-	-	-		-																										
Texas	46.1	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-															
New Mexico	46.0	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-		-																		
Mississippi	45.6	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-													
Arkansas	45.5	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-															
Guam	45.1	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-															
Tennessee	44.3	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-												

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Appendix Table 4:
Statistically Significant Differences in NAEP Mathematics Cohort Growth Between the 4th Grade in 1996 and the 8th Grade in 2000, Using False Discovery Rate Method

	Growth in Mean	SE	Montana	Vermont	Oregon	North Carolina	Minnesota	Maryland	DoDEA/DoDDS	Massachusetts	Virginia	Indiana	New York	Wyoming	South Carolina	Arizona	DoDEA/DDESS	Nebraska	California	Rhode Island	Michigan	North Dakota	Kentucky	Maine	Georgia	Nevada	Alabama	Louisiana	Connecticut	Utah	Missouri	Hawaii	West Virginia	District of Columbia	Texas	New Mexico	Mississippi	Arkansas	Guam	Tennessee
Montana	59.1	1.7																				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Vermont	58.5	1.6																				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Oregon	57.2	2.1																												+	+	+	+	+	+	+	+	+	+
N. Carolina	55.8	1.6																												+	+	+	+	+	+	+	+	+	+
Minnesota	55.5	1.8																														+	+		+	+	+	+	+
Maryland	55.3	2.1																															+		+	+	+	+	+
DoDDS	55.1	1.3																												+	+	+	+	+	+	+	+	+	+
Mass.	54.2	1.8																															+		+		+	+	+
Virginia	54.0	2.0																																	+		+	+	+	+
Indiana	53.7	1.8																																	+		+	+	+	+
New York	53.6	2.4																																					+
Wyoming	53.5	1.8																																			+	+	+
S. Carolina	53.2	1.9																																			+	+	+
Arizona	53.1	2.3																																					+
DDESS	53.1	2.5																																					
Nebraska	53.1	1.6																																			+	+	+
California	53.0	2.7																																					
Rhd Island	53.0	1.8																																			+	+	+
Michigan	52.2	2.0																																					
N. Dakota	52.2	1.6	-	-																																			+
Kentucky	51.6	1.8	-	-																																			
Maine	51.4	1.6	-	-																																			
Georgia	50.9	1.9	-	-																																			
Nevada	50.6	1.6	-	-																																			
Alabama	50.5	2.2	-	-																																			
Louisiana	50.0	1.9	-	-																																			
Connecticut	49.9	1.8	-	-																																			
Utah	48.9	1.6	-	-	-	-			-																														
Missouri	48.8	1.8	-	-	-	-			-																														
Hawaii	47.8	2.0	-	-	-	-	-		-																														
W. Virginia	47.4	1.4	-	-	-	-	-	-	-	-																													
DC	47.3	2.4	-	-	-	-			-																														
Texas	46.1	2.0	-	-	-	-	-	-	-	-	-	-																											
New Mexico	46.0	2.5	-	-	-	-	-	-	-																														
Mississippi	45.6	1.8	-	-	-	-	-	-	-	-	-	-		-	-			-		-																			
Arkansas	45.5	2.0	-	-	-	-	-	-	-	-	-	-		-	-			-		-																			
Guam	45.1	2.5	-	-	-	-	-	-	-	-	-	-																											
Tennessee	44.3	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-		-																	

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Appendix Table 5:
Statistically Significant Differences in Changes in Cohort Growth in NAEP Mathematics Between the 4th and 8th Grades for the Class of 2000 and Class of 2004, Using t-tests

	Change in Growth	SE	District of Columbia	Virginia	South Carolina	Wyoming	Georgia	Massachusetts	Maryland	Alabama	New York	Louisiana	North Carolina	Arizona	Kentucky	Minnesota	Hawaii	Rhode Island	Guam	Indiana	Maine	California	West Virginia	Missouri	New Mexico	Mississippi	Connecticut	North Dakota	Utah	Nebraska	Michigan	Arkansas	Texas	Tennessee
DC	7.1	2.8																		+	+		+	+	+	+	+	+	+	+	+	+	+
Virginia	5.0	2.9																					+			+	+	+	+	+	+	+	+
S. Carolina	4.9	2.7																					+			+	+	+	+	+	+	+	+
Wyoming	4.1	2.2																					+			+	+	+	+	+	+	+	+
Georgia	4.0	2.8																										+	+	+	+	+	+
Mass.	3.2	2.8																												+		+	+
Maryland	3.0	3.3																														+	+
Alabama	2.2	3.4																															+
New York	1.8	3.2																															+
Louisiana	1.7	2.8																														+	+
N. Carolina	0.9	2.4																															+
Arizona	0.5	3.0																															+
Kentucky	0.0	2.3																															+
Minnesota	-0.1	2.4																															+
Hawaii	-0.3	2.6																															
Rhd Island	-0.4	2.5																															
Guam	-0.7	3.1																															
Indiana	-0.8	2.5	-																														
Maine	-1.0	2.3	-																														
California	-1.3	3.7																															
W. Virginia	-2.2	2.0	-	-	-	-																											
Missouri	-2.2	2.6	-																														
New Mexico	-2.7	3.1	-																														
Mississippi	-2.8	2.4	-	-	-	-																											
Connecticut	-2.9	2.4	-	-	-	-																											
N. Dakota	-3.4	2.0	-	-	-	-	-																										
Utah	-3.8	2.2	-	-	-	-	-																										
Nebraska	-4.4	2.3	-	-	-	-	-	-																									
Michigan	-4.8	3.2	-	-	-	-	-																										
Arkansas	-5.9	2.7	-	-	-	-	-	-	-																								
Texas	-6.1	2.7	-	-	-	-	-	-	-			-																					
Tennessee	-7.9	2.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-																	

+ in cell means that the row jurisdiction is higher than the column jurisdiction.

- in cell means that the row jurisdiction is lower than the column jurisdiction.

Blank cell means that there is no statistically significant difference between the row jurisdiction and the column jurisdiction.

Appendix Table 6:
Statistically Significant Differences in Changes in Cohort Growth in NAEP Mathematics Between the 4th and 8th Grades for the Class of 2000 and Class of 2004, Using False Discovery Rate Method

	Change in Growth	SE	District of Columbia	Virginia	South Carolina	Wyoming	Georgia	Massachusetts	Maryland	Alabama	New York	Louisiana	North Carolina	Arizona	Kentucky	Minnesota	Hawaii	Rhode Island	Guam	Indiana	Maine	California	West Virginia	Missouri	New Mexico	Mississippi	Connecticut	North Dakota	Utah	Nebraska	Michigan	Arkansas	Texas	Tennessee
DC	7.1	2.8																															
Virginia	5.0	2.9																															
S. Carolina	4.9	2.7																															
Wyoming	4.1	2.2																															
Georgia	4.0	2.8																															
Mass.	3.2	2.8																															
Maryland	3.0	3.3																															
Alabama	2.2	3.4																															
New York	1.8	3.2																															
Louisiana	1.7	2.8																															
N. Carolina	0.9	2.4																															
Arizona	0.5	3.0																															
Kentucky	0.0	2.3																															
Minnesota	-0.1	2.4																															
Hawaii	-0.3	2.6																															
Rhd Island	-0.4	2.5																															
Guam	-0.7	3.1																															
Indiana	-0.8	2.5																															
Maine	-1.0	2.3																															
California	-1.3	3.7																															
W. Virginia	-2.2	2.0																															
Missouri	-2.2	2.6																															
New Mexico	-2.7	3.1																															
Mississippi	-2.8	2.4																															
Connecticut	-2.9	2.4																															
N. Dakota	-3.4	2.0																															
Utah	-3.8	2.2																															
Nebraska	-4.4	2.3																															
Michigan	-4.8	3.2																															
Arkansas	-5.9	2.7																															
Texas	-6.1	2.7																															
Tennessee	-7.9	2.9																															

+ in cell means that the row jurisdiction is higher than the column jurisdiction.

- in cell means that the row jurisdiction is lower than the column jurisdiction.

Blank cell means that there is no statistically significant difference between the row jurisdiction and the column jurisdiction.

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