

The Long-Term Trend Assessment in Mathematics



The NAEP long-term trend mathematics assessment required students to respond to a variety of age-appropriate questions. The assessment was designed to measure a student's

- knowledge of basic mathematical facts,
- ability to carry out computations using paper and pencil,
- knowledge of basic formulas such as those applied in geometric settings, and
- ability to apply mathematics to daily-living skills such as those involving time and money.

Students' mathematics skills were measured using mostly multiple-choice questions and some constructed-response questions. Each student took only a part of the assessment, consisting of three 15-minute sections. The complete 2008 mathematics

assessment contained between 103 and 126 multiple-choice questions and between 30 and 36 constructed-response questions at each age (table 4). Unlike certain sections in the main NAEP assessment, students were not permitted to use a calculator in the long-term trend mathematics assessment. Sample questions are presented later in this section.

TABLE 4. Number of multiple-choice and constructed-response questions in NAEP mathematics assessment, by student age group: 2008

Age group	Multiple-choice questions	Constructed-response questions
Age 9	103	33
Age 13	120	36
Age 17	126	30

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

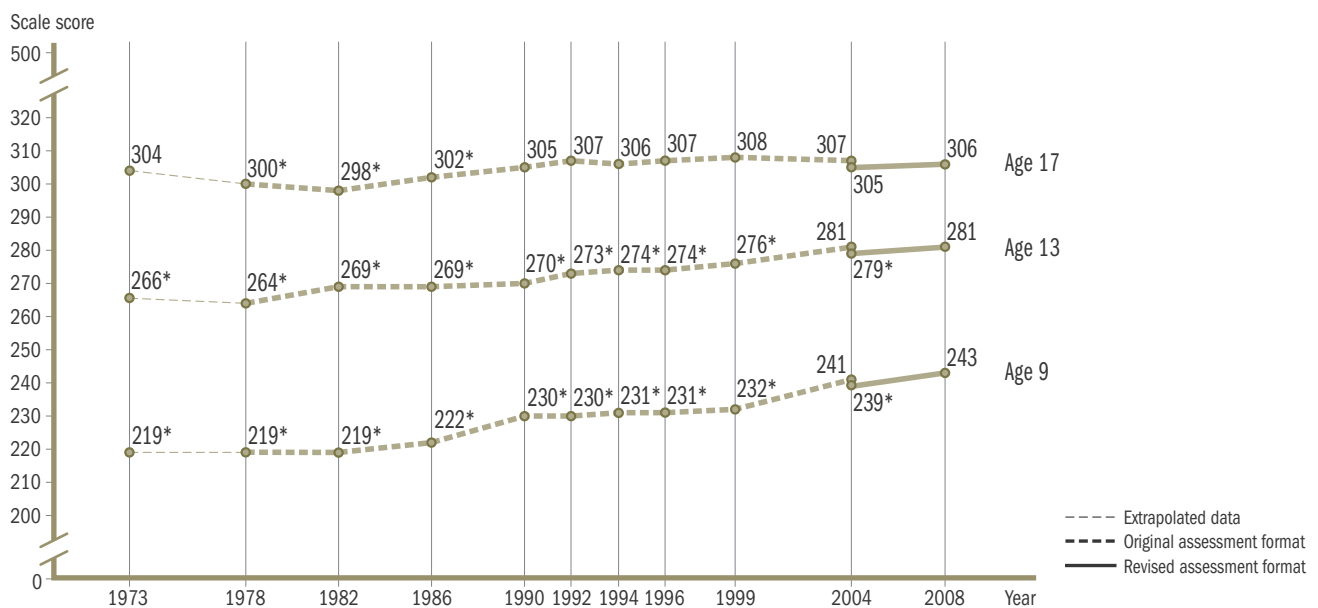
Scores increase for 9- and 13-year-olds

Overall, average scores in mathematics for 9- and 13-year-olds were higher in 2008 than in all previous assessment years (figure 7). The average score for 9-year-olds in 2008 increased 4 points since 2004 and 24 points compared to 1973. Thirteen-year-olds scored 3 points⁵

higher than in 2004 and 15 points higher than in 1973. In contrast, the average score for 17-year-olds in 2008 was not significantly different from the scores in 2004 and 1973.

⁵ The score-point change is based on the difference between unrounded scores as opposed to the rounded scores shown in the figure.

FIGURE 7. Trend in NAEP mathematics average scores for 9-, 13-, and 17-year-old students



* Significantly different ($p < .05$) from 2008.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1973–2008 Long-Term Trend Mathematics Assessments.



Extrapolated Results

The mathematics results from 1973 were extrapolated using a mean proportion correct to calculate average scores for students overall and by race/ethnicity and gender. All other results, including percentile and performance-level data, are shown beginning in 1978. See the Technical Notes for more information.

Improvement for lower-, middle-, and higher-performing students varies by age

The overall gain in mathematics since 2004 for 9-year-olds was also seen in increases for all but the lowest-performing students (figure 8). While there was no significant change in the score for 9-year-olds performing at the 10th percentile from 2004 to 2008, the score in 2008 was 27 points higher than in 1978. Scores were higher in 2008 than in all previous assessment years for students at the 25th, 50th, 75th, and 90th percentiles.

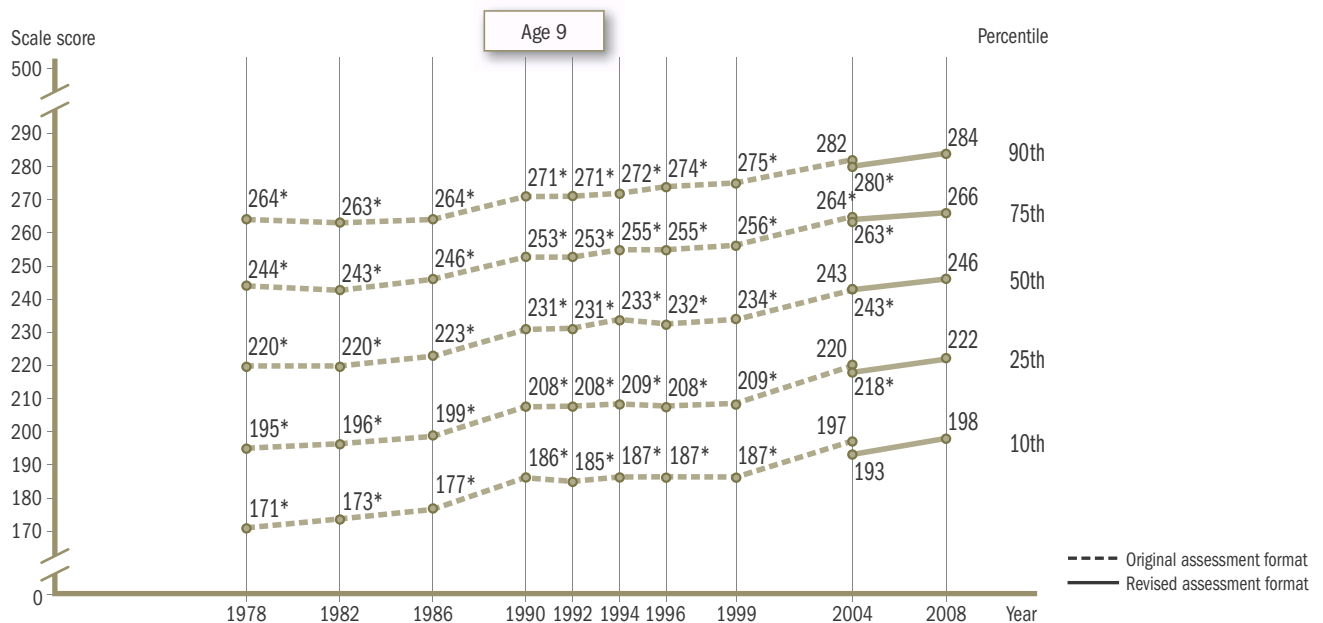
While the overall average score for 13-year-olds was higher in 2008 than in both 2004 and 1978, the results varied for students performing at different percentile levels. Scores

increased since 2004 for students at the 10th and 50th percentiles, but there were no significant changes for students who scored at the 25th, 75th, and 90th percentiles over the same period. Students performing at all five percentile levels scored higher in 2008 compared to 1978.

As in the overall scale score results for 17-year-olds, there were no significant changes in scores from 2004 to 2008 for students at any of the five percentile levels. Scores for lower- and middle-performing 17-year-olds (at the 10th, 25th, and 50th percentiles) were higher in 2008 than in 1978.

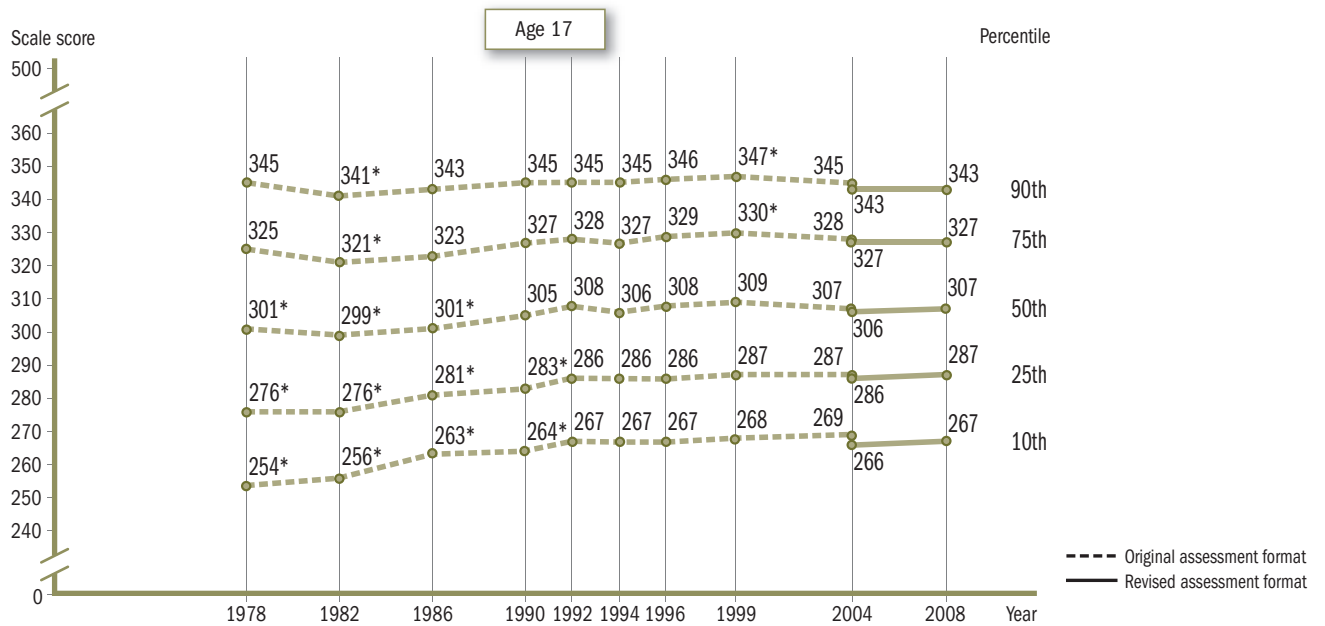
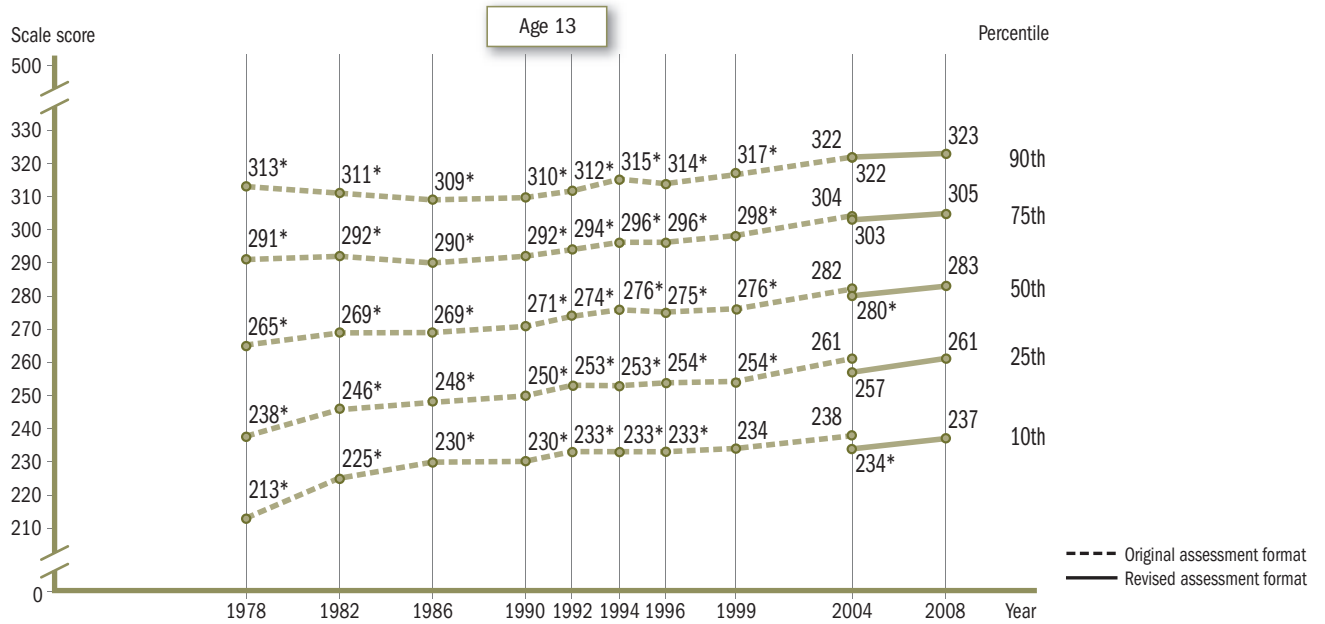


FIGURE 8. Trend in NAEP mathematics percentile scores for 9-, 13-, and 17-year-old students



See notes at end of figure.

FIGURE 8. Trend in NAEP mathematics percentile scores for 9-, 13-, and 17-year-old students—Continued



* Significantly different ($p < .05$) from 2008.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1978–2008 Long-Term Trend Mathematics Assessments.

Students' understanding of basic operations improves compared to 1978

The skills and knowledge demonstrated by students performing at different points on the mathematics scale help provide additional context for understanding changes in students' performance over time.

In each assessment year since 1978, at least 97 percent of 9-year-old students demonstrated the knowledge of simple arithmetic facts described for performance level 150 (figure 9). The percentage of students performing at this level or above in 2008 was not significantly different from the percentage in 2004 but was higher than in 1978.

The beginning mathematical skills and understandings described for performance level 200 were demonstrated by 89 percent of 9-year-olds in 2008. This was an increase of 2 percentage points since 2004 and an increase of 19 percentage points in comparison to 1978.

In addition to demonstrating the skills and knowledge described for levels 150 and 200, students performing at or above performance level 250 demonstrated the ability to begin to apply basic mathematical operations. The percentage of 9-year-olds performing at or above this level was higher in 2008 than in both 2004 and 1978.

The percentages of 13-year-olds performing at or above the 200 and 250 levels in 2008 were not significantly different from the percentages in 2004 but were higher than the percentages in 1978. In addition to demonstrating the skills and knowledge described for the 200 and 250 levels, 30 percent of 13-year-olds were able to use the moderately complex procedures and reasoning indicative of performance described for level 300. Although not significantly different from the percentage in 2004, this percentage was higher than in 1978.

Ninety-six percent of 17-year-olds performed at or above level 250 in 2008, and 59 percent performed at or above level 300. These percentages were not significantly different from the percentages in 2004 but were higher than in 1978.

Six percent of 17-year-olds in 2008 demonstrated the skills associated with multistep problem solving and algebra described at level 350. This percentage was not significantly different from the percentages in 2004 or 1978.

Mathematics Performance-Level Descriptions

LEVEL 350: Multistep Problem Solving and Algebra

Students at this level can apply a range of reasoning skills to solve multistep 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.

LEVEL 300: Moderately Complex Procedures and Reasoning

Students 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 based 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.

LEVEL 250: Numerical Operations and Beginning Problem Solving

Students 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.

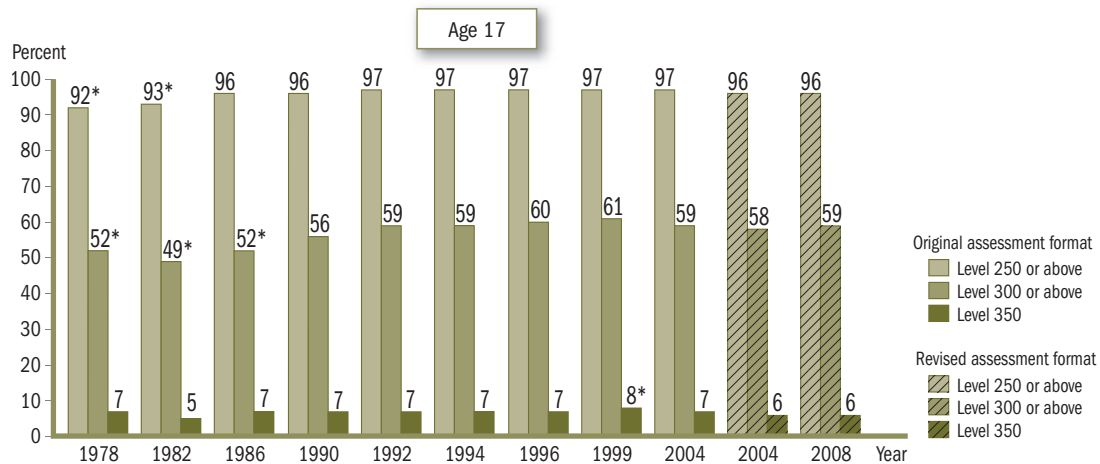
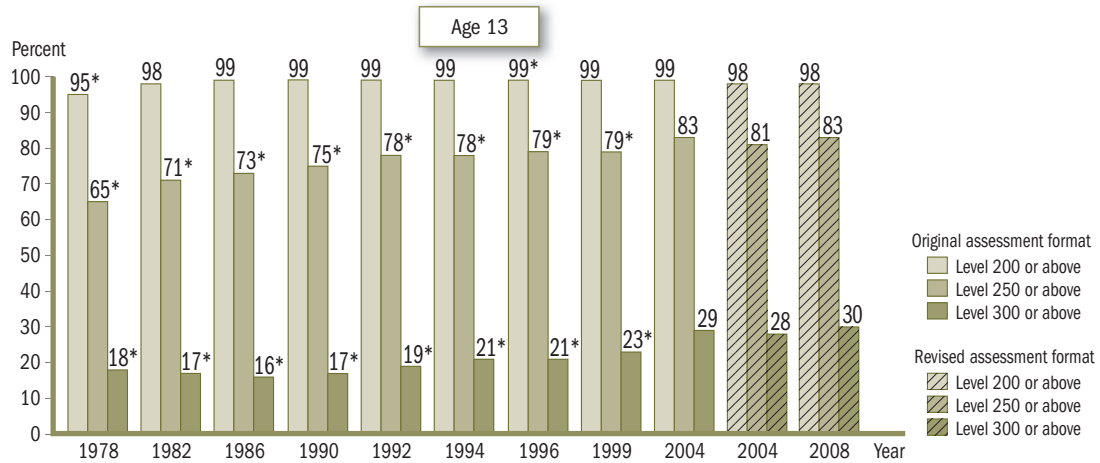
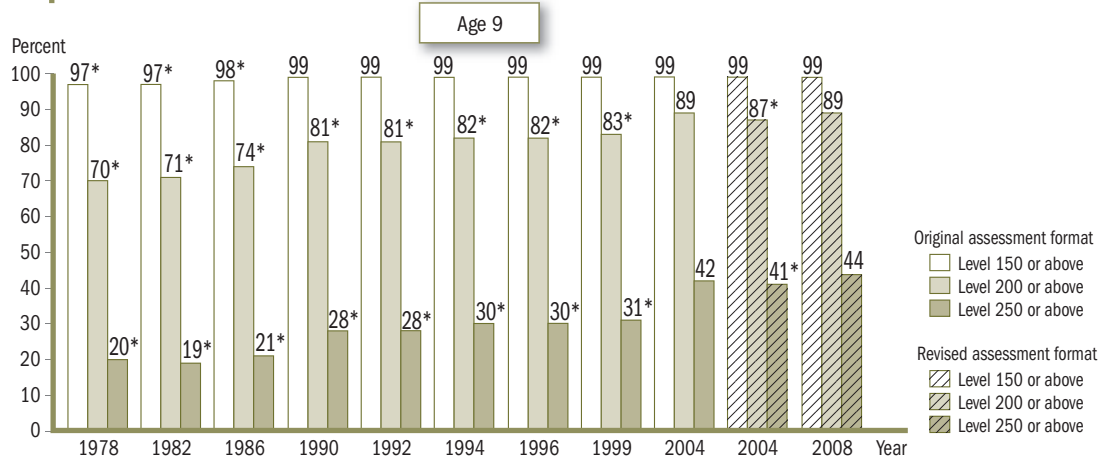
LEVEL 200: Beginning Skills and Understandings

Students 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.

LEVEL 150: Simple Arithmetic Facts

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

FIGURE 9. Trend in NAEP mathematics performance-level results for 9-, 13-, and 17-year-old students



* Significantly different ($p < .05$) from 2008.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1978–2008 Long-Term Trend Mathematics Assessments.

Black students make greater gains than White students compared to 1973

At age 9, the average mathematics score increased from 2004 to 2008 for White students but showed no significant change for Black students (figure 10). In comparison to 1973, scores in 2008 were 25 points higher for White students and 34 points higher for Black students.

At age 13, neither White nor Black students' scores showed a significant change from 2004 to 2008. However, comparing 1973 to 2008,

White students gained 16 points compared to 34 points for Black students.

Similarly, at age 17, the score for neither White nor Black students showed a significant change between 2004 and 2008, while the score was 4 points higher for White students in 2008 compared to 1973, and 17 points higher for Black students over the same period.

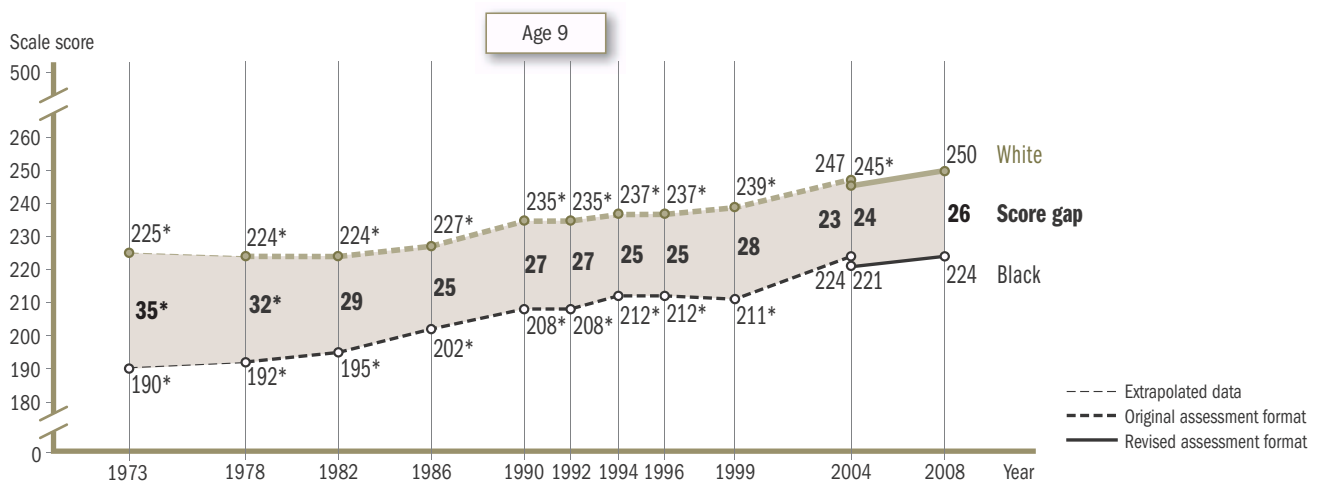
No significant change in White – Black score gaps since 2004

While the score gaps between White and Black students at all three ages showed no significant change between 2004 and 2008, the gaps did narrow in 2008 compared

to 1973. In comparison to the gaps in 1973, the White – Black gaps in 2008 narrowed by 9 points at age 9, by 18 points at age 13, and by 14 points at age 17.

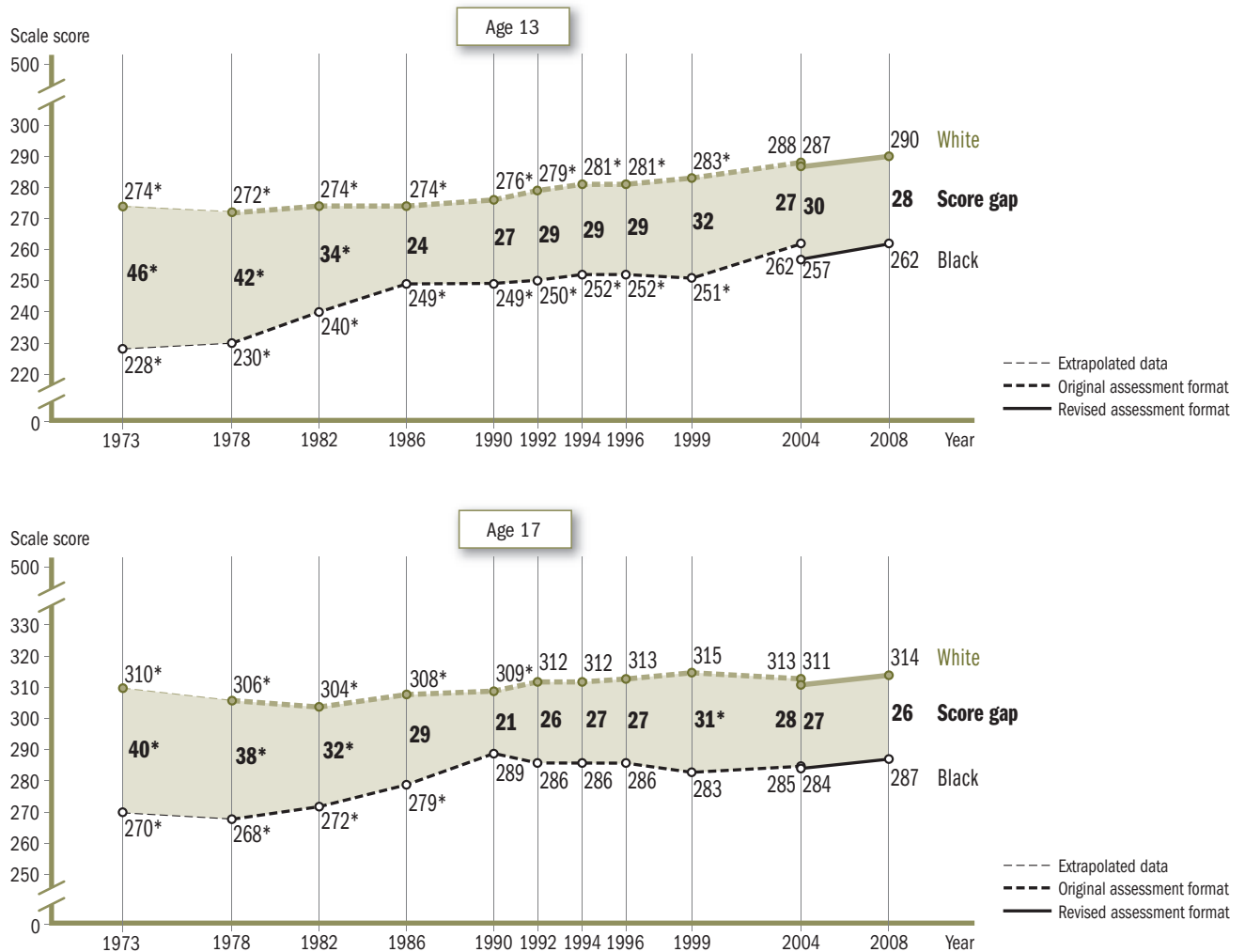


FIGURE 10. Trend in White – Black NAEP mathematics average scores and score gaps for 9-, 13-, and 17-year-old students



See notes at end of figure.

FIGURE 10. Trend in White – Black NAEP mathematics average scores and score gaps for 9-, 13-, and 17-year-old students—Continued



* Significantly different ($p < .05$) from 2008.

NOTE: Score gaps are calculated based on differences between unrounded average scores. Black includes African American. The White and Black race categories exclude Hispanic origin.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1973–2008 Long-Term Trend Mathematics Assessments.

About Student Demographics

Each assessment year, NAEP gathers information on student demographics. For the mathematics assessment, the percentages of students assessed by race/ethnicity are available going back to 1978. Because results for Asian/Pacific Islander students were not reportable for some of the previous assessment years, they are not included in this report. In the assessments administered between 1978 and 2004, students were assigned to a racial/ethnic category based on the assessment administrator’s observation. One of the changes introduced as part of the revised assessment format in 2004 was the reporting of students’ race/ethnicity based on information collected from school records (see the Technical Notes for more information).

Changes in student population over time show decreases in the percentages of White students in 2008 compared to 1978 at all three ages. In contrast, the percentages of Hispanic students increased, and the percentages of Black students showed no significant changes over the same period of time. For example, the percentage of White 9-year-olds decreased from 79 percent in 1978 to 54 percent in 2008, and the percentage of Hispanic 9-year-olds increased from 5 to 23 percent over the same period (see appendix table A-2).

Hispanic students make greater gains than White students compared to 1973

At all three ages, there were no significant changes in scores for Hispanic students since 2004, but scores were higher in 2008 than in 1973 (figure 11). Compared to 1973, gains for Hispanic students

of 32 points, 29 points, and 16 points at ages 9, 13, and 17, respectively, were larger than the gains made by their White counterparts over the same period of time.

No significant change in White – Hispanic score gaps since 2004

For all three age groups, there were no significant changes in the White – Hispanic score gaps from 2004 to 2008. However, when compared to 1973, the gaps in 2008 narrowed by 7 points at age 9 and by 12 points at ages 13 and 17.

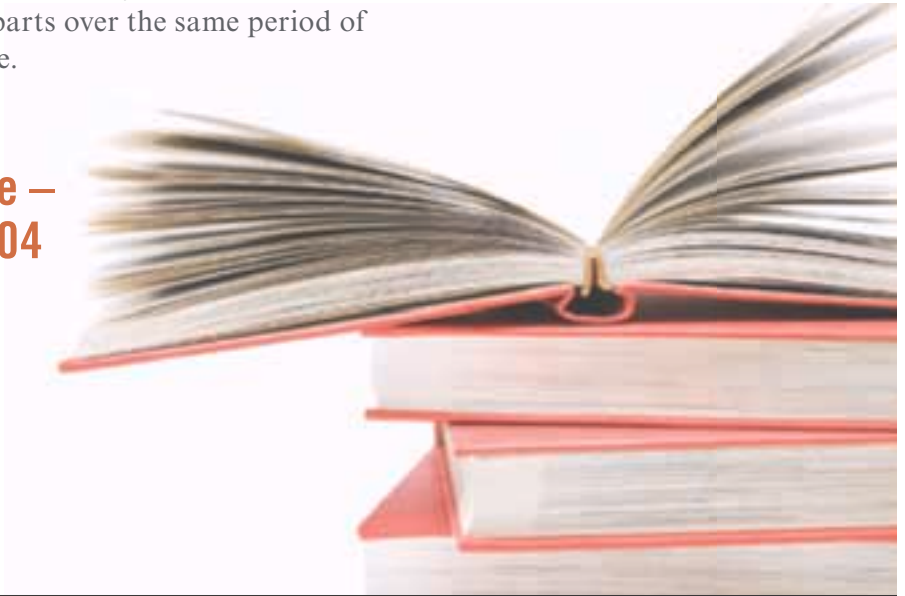
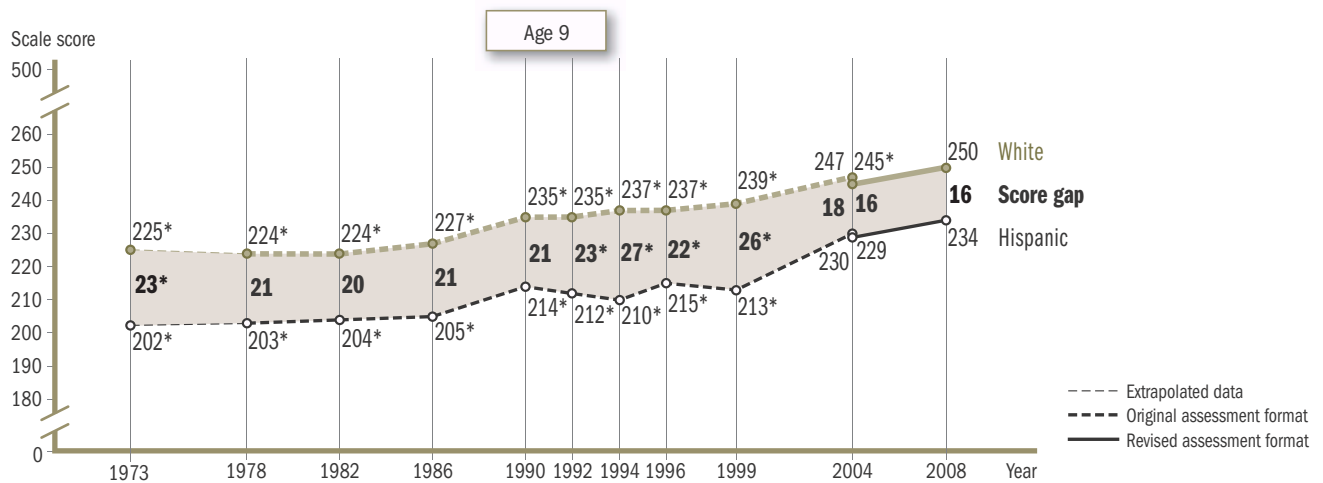
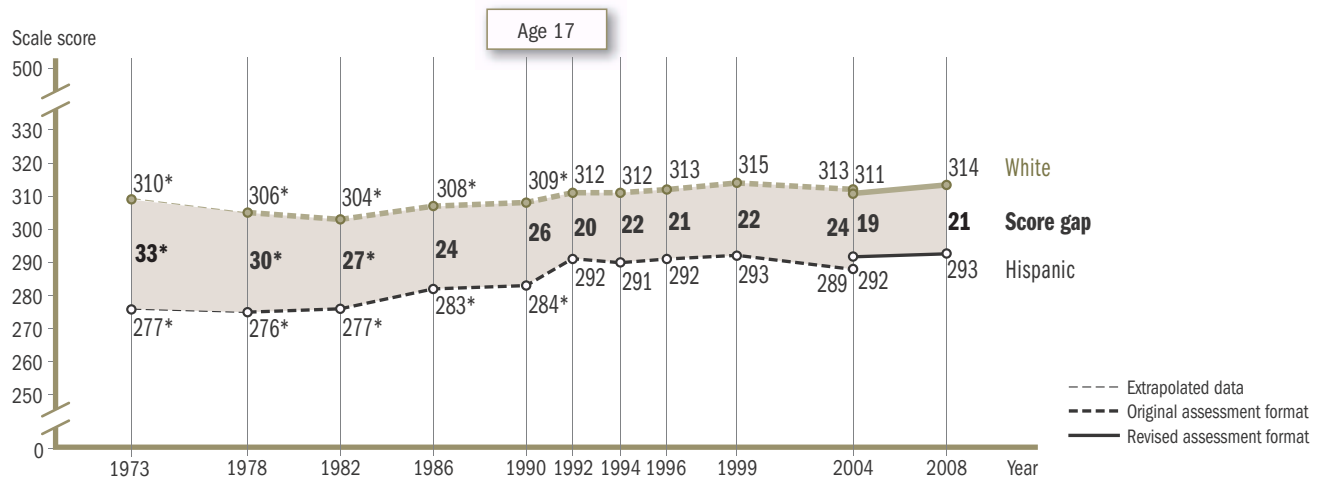
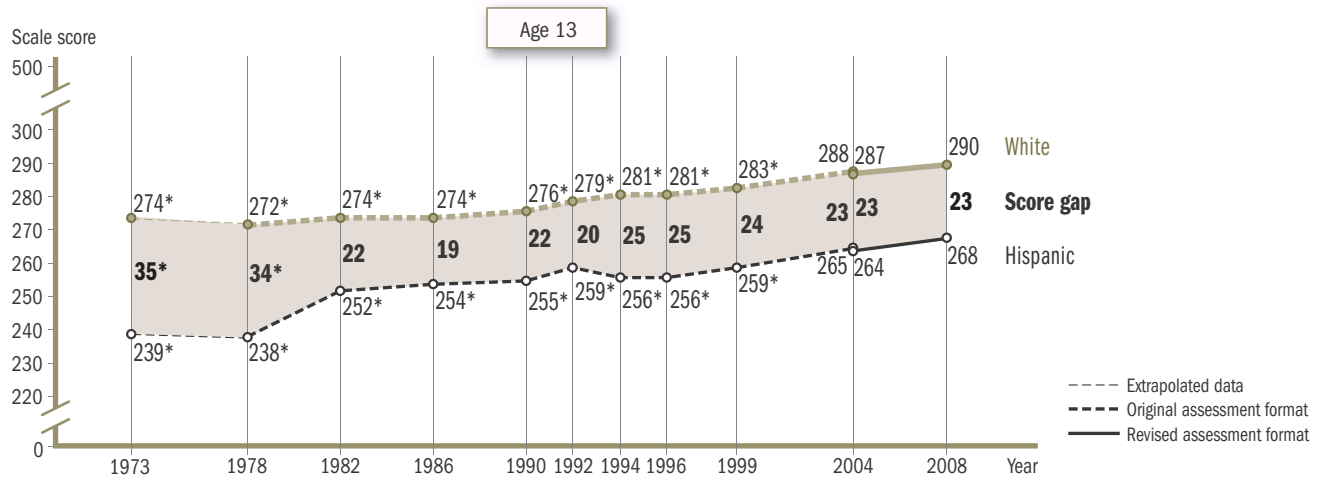


FIGURE 11. Trend in White – Hispanic NAEP mathematics average scores and score gaps for 9-, 13-, and 17-year-old students



See notes at end of figure.

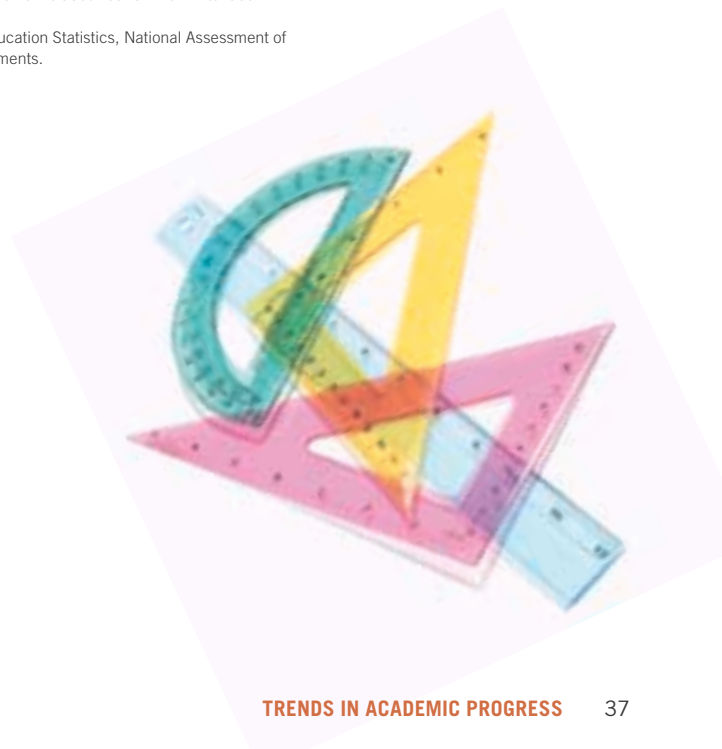
FIGURE 11. Trend in White – Hispanic NAEP mathematics average scores and score gaps for 9-, 13-, and 17-year-old students—Continued



* Significantly different ($p < .05$) from 2008.

NOTE: Score gaps are calculated based on differences between unrounded average scores. Hispanic includes Latino. The White race category excludes Hispanic origin.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1973–2008 Long-Term Trend Mathematics Assessments.



Progress for male and female students varies by age

The overall improvement in mathematics for 9-year-olds was also seen in the results for both male and female students. Both male and female 9-year-olds scored higher in 2008 than in any previous assessment year (figure 12).

At age 13, the pattern of improvement was mixed. Compared to 2004, the average mathematics score for male students was higher

in 2008, but the score for female students did not show a significant change. Average scores for both male and female students were higher in 2008 than in 1973.

At age 17, the average mathematics scores for both male and female students in 2008 were not significantly different from their scores in 2004 or 1973.

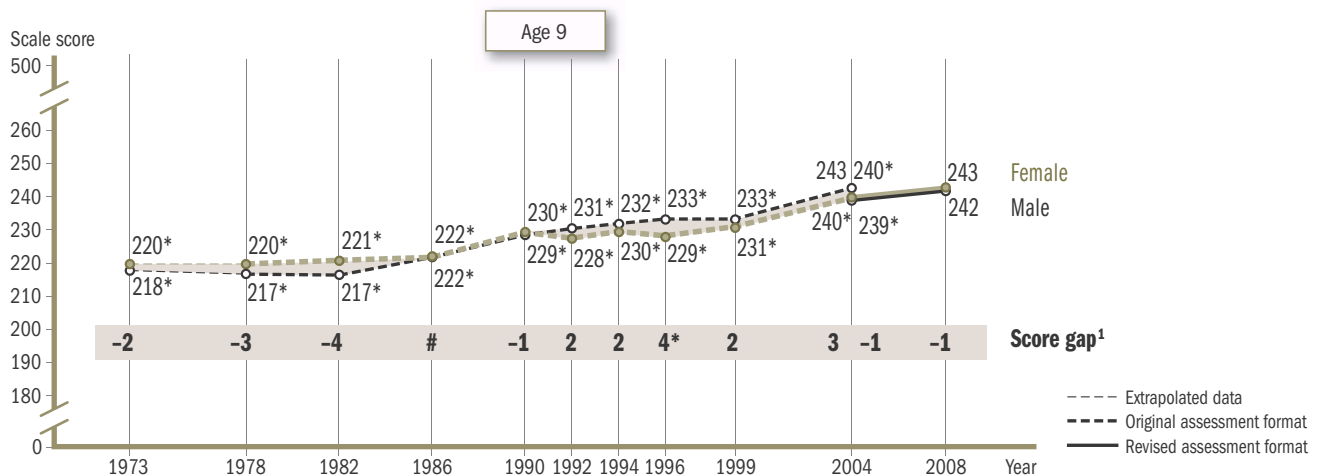
No significant change in most gender gaps

While there was no significant difference in the average mathematics scores for male and female 9-year-olds in 2008, male students did score higher than female students at ages 13 and 17. At age 13, the male – female gap in

2008 was not significantly different when compared to 2004 but was larger than in 1973. At age 17, the gender score gap in 2008 was not significantly different from the gaps in previous assessment years.

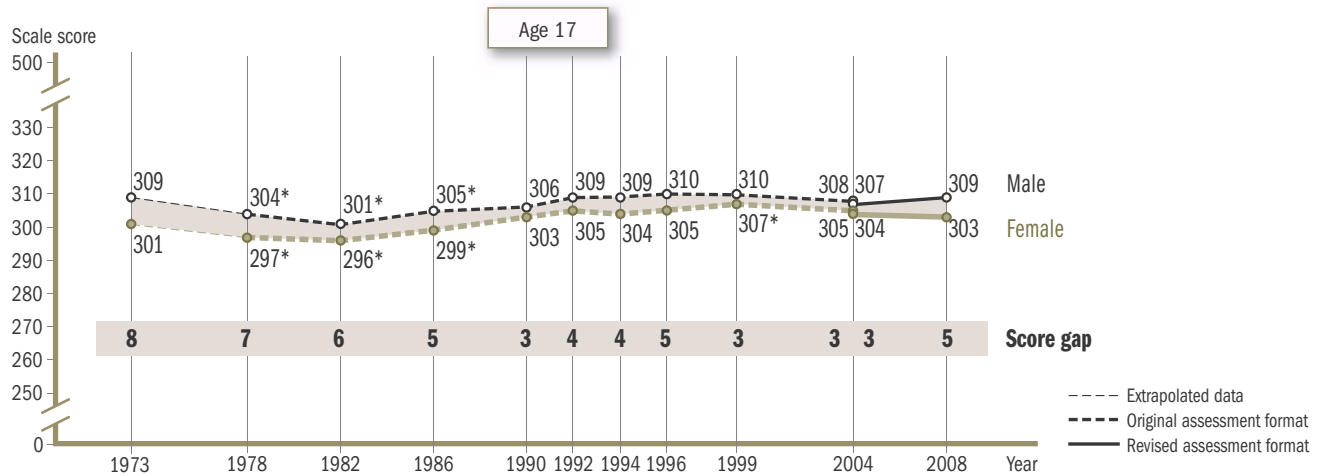
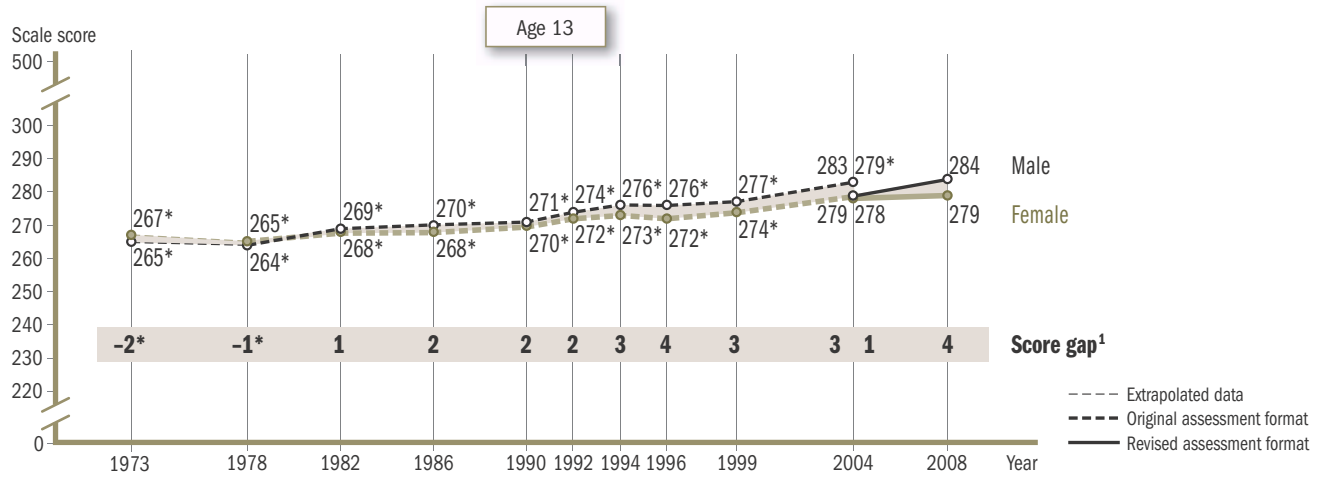


FIGURE 12. Trend in Male – Female NAEP mathematics average scores and score gaps for 9-, 13-, and 17-year-old students



See notes at end of figure.

FIGURE 12. Trend in Male – Female NAEP mathematics average scores and score gaps for 9-, 13-, and 17-year-old students—Continued



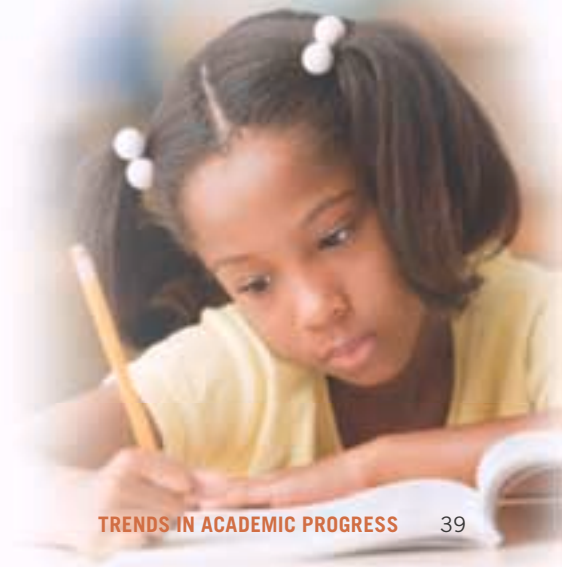
Rounds to zero.

* Significantly different ($p < .05$) from 2008.

¹ Negative numbers indicate that the average score for male students was lower than the score for female students.

NOTE: Score gaps are calculated based on differences between unrounded average scores.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1973–2008 Long-Term Trend Mathematics Assessments.



Score increases for 17-year-olds whose parents did not finish high school

Both 13- and 17-year-old students were asked to indicate the highest level of education of at least one of their parents. See the Technical Notes for more information about the questions that students were asked. Students at age 9 were not asked about their parents' education level because their responses in previous NAEP assessments were not reliable.

In the 2008 assessment, 48 percent of 13-year-olds and 46 percent of 17-year-olds indicated that at least one parent graduated from college (see appendix table A-2). At both ages, these percentages were higher in 2008 compared to 1978.

While the average mathematics score for 17-year-olds overall did not change significantly since 2004, the score for students who indicated that their parents did

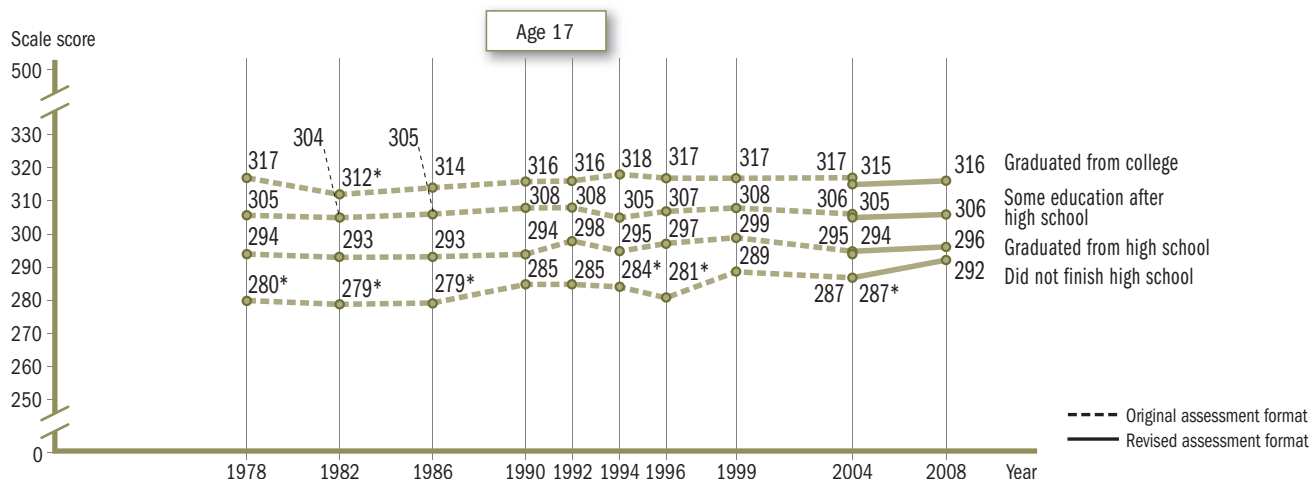
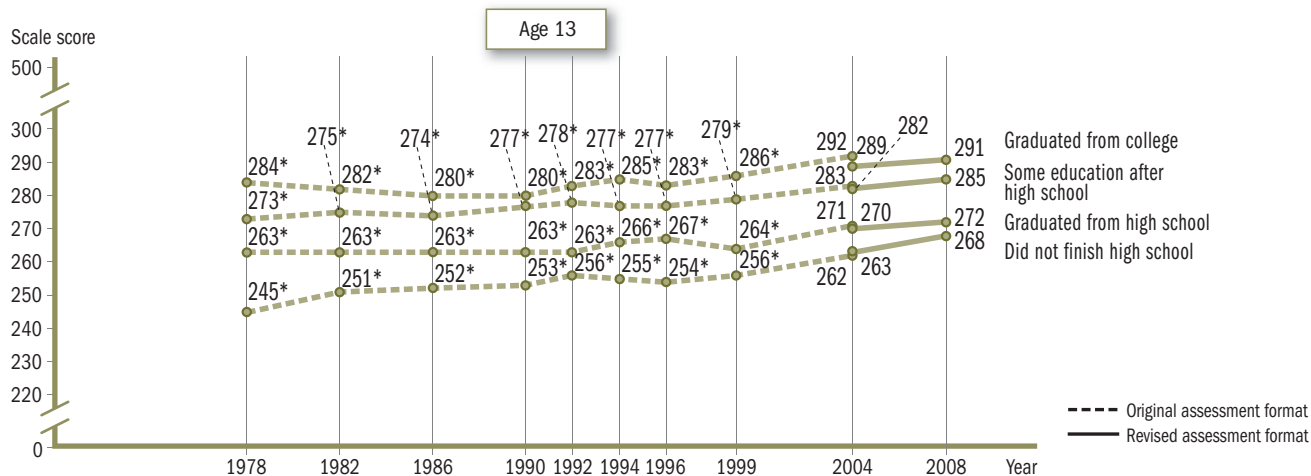
not finish high school was higher in 2008 than in 2004 and 1978 (figure 13). There were no significant changes in average scores in 2008 compared to 2004 or 1978 for all the other student-reported levels of parental education.

At age 13, there were no significant changes in average scores since 2004 regardless of the student-reported level of parental education. However, average scores were higher in 2008 than in 1978 across all student-reported levels of parental education.

Overall, higher average mathematics scores were associated with higher levels of parental education in 2008. At both ages, students who reported that at least one parent graduated from college scored higher than students who reported lower levels of parental education.



FIGURE 13. Trend in NAEP mathematics average scores for 13- and 17-year-old students, by highest level of parental education



* Significantly different ($p < .05$) from 2008.
 SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1978–2008 Long-Term Trend Mathematics Assessments.

About Parents' Education Level

Changes in the student population since 1978 show a decrease in the percentages of students who reported that neither parent had finished high school, and a corresponding increase in the percentages of students who reported that at least one parent had graduated from college. For example, the percentage of 17-year-olds who reported that neither parent had finished high school decreased from 13 percent in 1978 to 9 percent in 2008. During the same time period, the percentage of 17-year-olds who reported that at least one parent had graduated from college increased from 32 percent to 46 percent. Similar patterns are evident among 13-year-olds as well (see appendix table A-2).

Mathematics scores higher than in 1978 for public and Catholic school students at all three ages

In 2008, between 90 and 92 percent of 9-, 13-, and 17-year-olds attended public schools, and between 4 and 5 percent attended Catholic schools (see appendix table A-2). While the percentages of students attending public schools have not changed significantly in comparison to 1978 at any of the three ages, the percentage of 9-year-olds attending Catholic schools was lower in 2008 than in 1978.

The average mathematics score for public school students increased by 3 points at age 9 from 2004 to 2008, with no significant changes in the scores for students at ages 13 and 17 over the same time period (table 5). The scores for public school students at all three ages were higher in 2008 compared to 1978.

Results for students attending private schools⁶ showed an increase in the average mathematics scores from 1978 to 2008 for 9- and 13-year-olds. Scores for Catholic school students were higher in 2008 than in 1978 at all three ages.

In 2008, public school students scored lower than their private school counterparts at ages 9 and 13. Public school students scored lower than Catholic school students at all three ages in 2008.

⁶ Private schools include Catholic schools.



School Participation in NAEP

Results by the type of school that students attended are available for the long-term trend mathematics assessments back to 1978. Participation rates fell below the required standard for reporting results for 9- and 13-year-olds attending private schools in 2004, for 17-year-olds attending private schools in all the assessment years, and for 17-year-olds attending Catholic schools in 2004. In 1996, results for 17-year-old students attending Catholic schools are not reported because the sample size was insufficient to permit a reliable estimate. See the section on School and Student Participation Rates in the Technical Notes for more information.

TABLE 5. Average scores in NAEP mathematics, by student age group and type of school: Various years, 1978–2008

Age group and type of school	1978	1982	1986	1990	1992	1994	1996	1999	2004 ¹	2004 ²	2008
Age 9											
Public	217*	217*	220*	229*	228*	229*	230*	231*	241	239*	242
Private	230*	232*	232*	238*	242*	245*	239*	242*	‡	‡	252
Catholic	230*	232*	233*	235*	241*	243*	239*	241*	242*	247	251
Age 13											
Public	263*	267*	269*	269*	272*	273*	273*	274*	280	278	280
Private	279*	281*	276*	280*	283*	285*	286*	288*	‡	‡	295
Catholic	279*	280*	273*	279*	280*	283*	285	288	289	289	293
Age 17³											
Public	300*	297*	301*	304	305	304	306	307	306	304	305
Catholic	309*	309*	314	311	320	317	‡	320	‡	‡	317

‡ Reporting standards not met.

* Significantly different ($p < .05$) from 2008.¹ Original assessment format. Results prior to 2004 are also from the original assessment format.² Revised assessment format. Results after 2004 are also from the revised assessment format.³ For students at age 17, results are not shown for private schools because the minimum participation guidelines for reporting were not met.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1978–2008 Long-Term Trend Mathematics Assessments.



Higher-level courses associated with higher scores

Students at ages 13 and 17 responded to questions about the mathematics courses they were currently taking or had taken. Responses for age 13 are available beginning in 1986 and for age 17 in 1978.

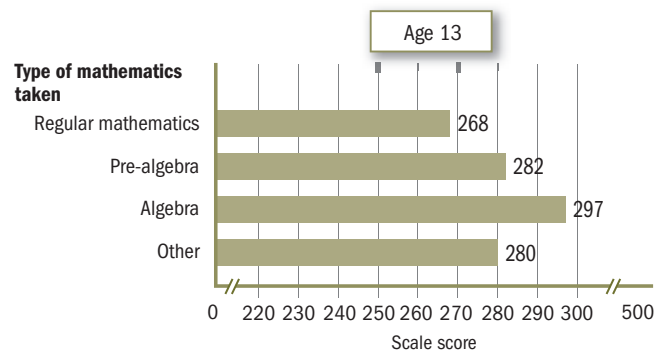
At age 13, students were asked, “What kind of mathematics are you taking this year?” They chose from the following options:

- I am not taking mathematics this year
- Regular mathematics
- Pre-algebra
- Algebra
- Other

Taking higher-level mathematics courses was associated with higher scores on the long-term trend mathematics assessment in 2008 (figure 14). Students at age 13 who were enrolled in algebra classes scored higher on average than those in pre-algebra, and

students in pre-algebra scored higher than their counterparts taking regular mathematics courses.

FIGURE 14. Average scores in NAEP mathematics for 13-year-old students, by type of mathematics they have taken during the school year: 2008



NOTE: An average score is not shown for students who selected the “not taking mathematics” response because the sample size was insufficient to permit a reliable estimate.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

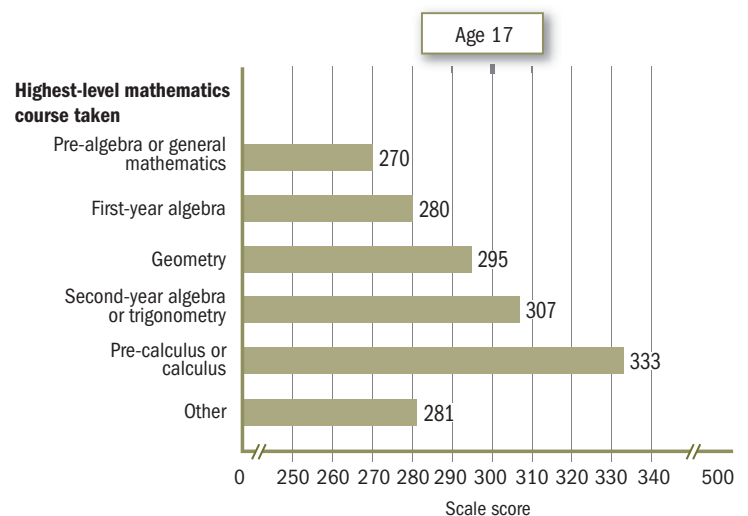
At age 17, students were asked, “Counting what you are taking now, have you ever taken any of the following mathematics courses?”

- General, business, or consumer mathematics
- Pre-algebra or introduction to algebra
- First-year algebra
- Second-year algebra
- Geometry
- Trigonometry
- Pre-calculus or calculus

The highest-level mathematics course was determined from the student’s responses to the question above.

Higher levels of mathematics coursetaking were associated with higher mathematics scores in 2008 (figure 15). For example, students who had taken pre-calculus or calculus had a higher average score than students who had taken second-year algebra or trigonometry. Students whose highest-level mathematics course was pre-algebra or general mathematics scored lower than students in the other coursetaking categories.

FIGURE 15. Average scores in NAEP mathematics for 17-year-old students, by highest-level mathematics course they have ever taken: 2008



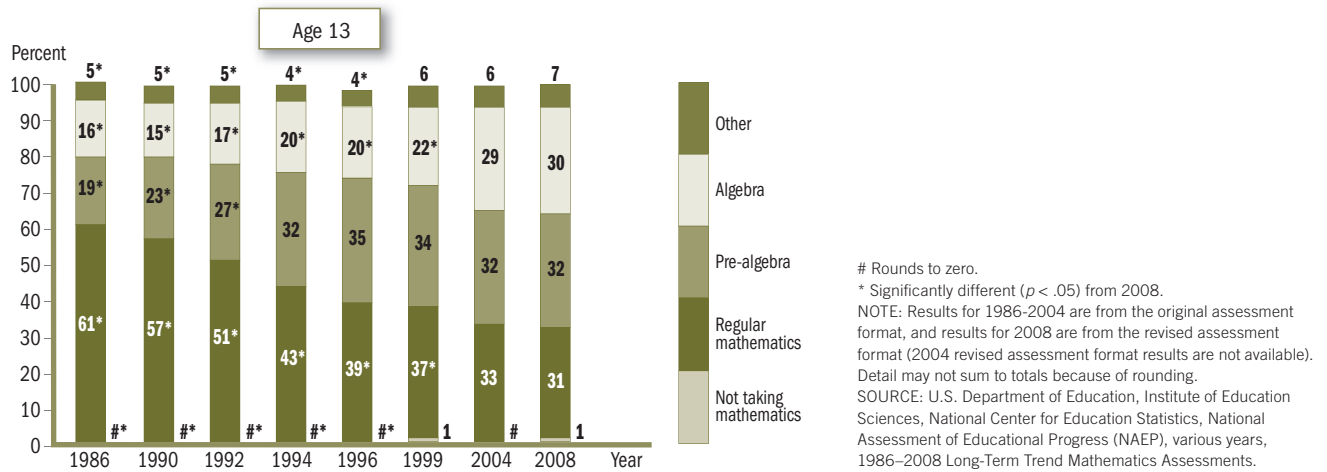
NOTE: The “pre-algebra or general mathematics” response category includes “pre-algebra or introduction to algebra” and “general, business, or consumer mathematics” and students who did not take any of the listed courses. The “other” response category includes students for whom the highest-level mathematics course could not be determined due to missing or inconsistent responses.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

Increasing percentages of students taking higher-level mathematics

The trend in the coursetaking at age 13 shows that higher percentages of students were taking higher-level mathematics courses in 2008 compared to 1986 (figure 16). The percentage of 13-year-olds taking

algebra increased from 16 to 30 percent, and the percentage taking pre-algebra increased from 19 to 32 percent. The percentage of students taking regular mathematics decreased from 61 percent in 1986 to 31 percent in 2008.

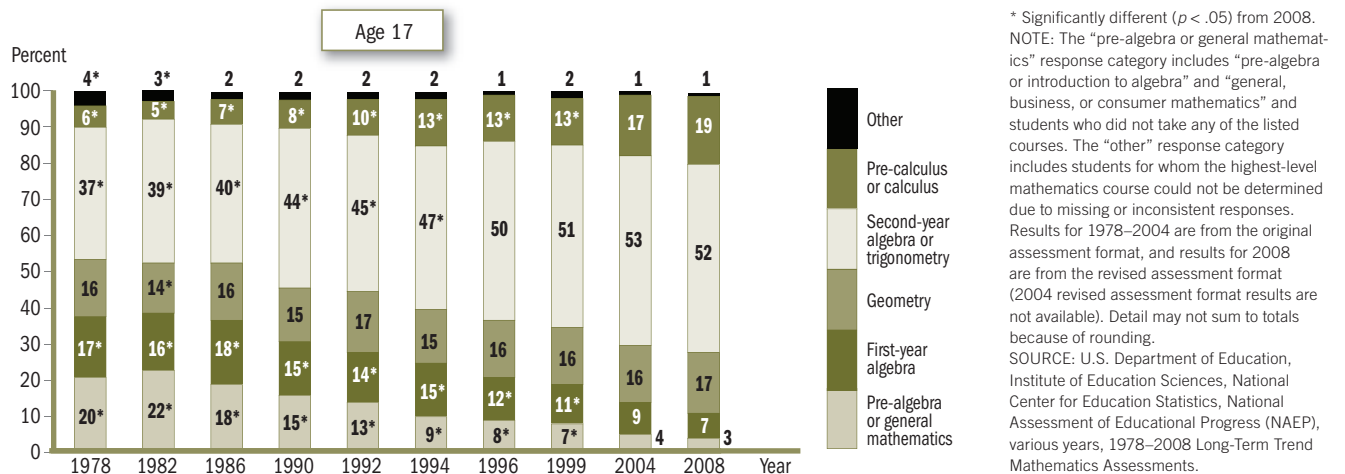
FIGURE 16. Trend in percentage of 13-year-old students in NAEP mathematics, by type of mathematics course they have taken during the school year



Similar to the pattern for 13-year-olds, the percentages of 17-year-olds taking higher-level courses increased (figure 17). A comparison of 2008 to 1978 shows that a greater percentage of 17-year-olds indicated that they had taken pre-calculus or calculus. The percentage of 17-year-olds who had taken second-year algebra or

trigonometry increased from 37 percent in 1978 to 52 percent in 2008. The percentage of students who indicated that the highest level of mathematics they had taken was pre-algebra or general mathematics, or first-year algebra, decreased over the same time period.

FIGURE 17. Trend in percentage of 17-year-old students in NAEP mathematics, by highest-level mathematics course they have ever taken



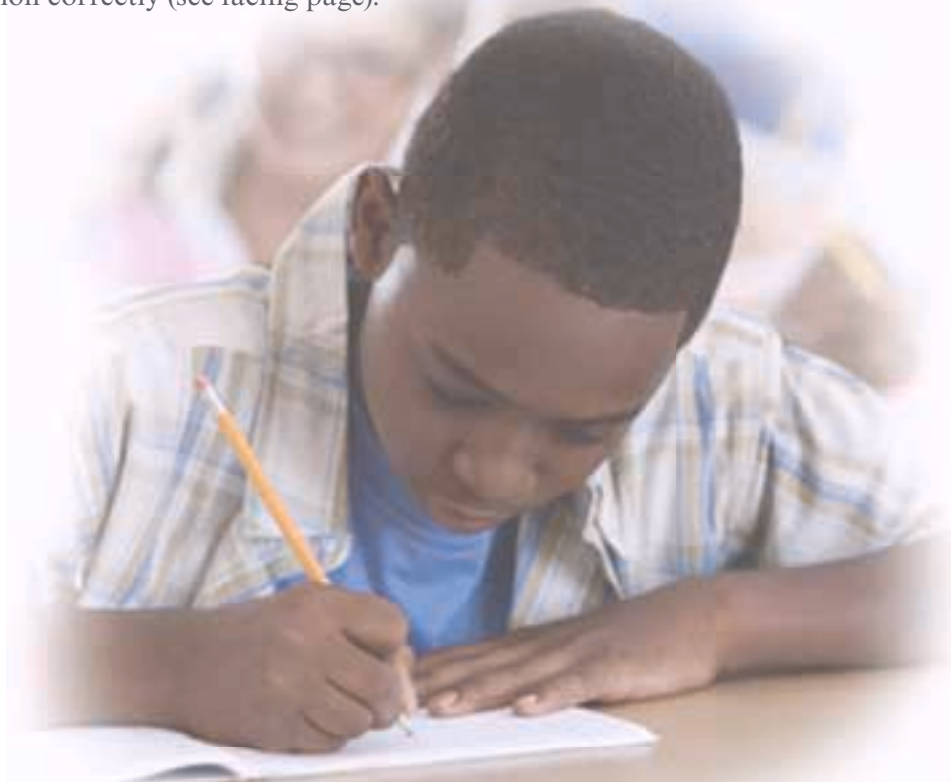
Sample Questions

Beginning in 2004, as a result of modifications to the long-term trend mathematics assessment, it became possible to share questions with the public. Once again, some of the questions that have been administered to students since the early 1970s are being released. These released questions will not be administered in future NAEP long-term trend assessments.

Topics in the NAEP long-term trend mathematics assessment include numbers and numeration; variables and relationships; shape, size, and position; measurement; and probability and statistics. The distribution of assessment items from these topics differs across the age levels, with more emphasis placed on topics relating to numbers at ages 9 and 13 than at age 17, and more emphasis placed on topics relating to variables at age 17 than at ages 9 and 13.

Three sample mathematics questions for each age group are presented in this section. The response options for multiple-choice questions are provided as the students saw them, and the oval for the correct answer is filled in. All constructed-response questions in the long-term trend mathematics assessment were scored as correct or incorrect, and the correct response is shown on the answer line.

In the sample questions that follow, the percentages of students who answered correctly overall and within each performance level are shown in the tables below each sample. For example, 44 percent of age 9 students answered the first mathematics sample question correctly, while 16 percent of age 9 students at performance level 150 answered the question correctly (see facing page).



For More Information

Additional sample questions from the 2008 long-term trend assessments can be found at <http://nces.ed.gov/nationsreportcard/itmrls>.

Sample Mathematics Questions

AGE 9

Sample question 1 required students to demonstrate a conceptual understanding of the relationship between parts and a whole using fraction vocabulary.

How many fifths are equal to one whole?

- A $\frac{1}{5}$
- B 1
- C 4
- D 5

Percentage of correct responses for 9-year-old students at each performance level: 2008

Overall	Below level 150	Level 150	Level 200	Level 250
44	‡	16	29	65

‡ Reporting standards not met.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

Sample question 2 assessed students' knowledge of operations with whole numbers.

$$\begin{array}{r}
 \text{Add} \quad 38 \\
 \quad 74 \\
 \quad 66 \\
 + 75 \\
 \hline
 \end{array}$$

ANSWER: 253

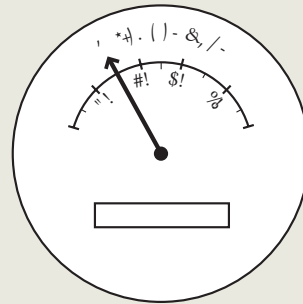
Percentage of correct responses for 9-year-old students at each performance level: 2008

Overall	Below level 150	Level 150	Level 200	Level 250
58	‡	19	52	74

‡ Reporting standards not met.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

Sample question 3 asked students to read a scale on a number line presented in the context of a bicycle speedometer. To answer the question, the student had to determine the value corresponding to a point halfway between the points marked at 10 and 20 miles per hour.



The bicycle speedometer above shows about what speed?

- A 10 miles per hour
- B 15 miles per hour
- C 20 miles per hour
- D 45 miles per hour

Percentage of correct responses for 9-year-old students at each performance level: 2008

Overall	Below level 150	Level 150	Level 200	Level 250
85	‡	42	84	96

‡ Reporting standards not met.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

Sample Mathematics Questions

AGE 13

Sample question 4 required students to apply multistep arithmetic operations with decimals to a real-world situation.

Sally bought two tickets to a movie. Each ticket cost \$4.25. She paid for the tickets with a \$10 bill. How much change did she get?

- (A) \$5.75
- (B) \$5.25
- (C) \$4.25
- (D) \$1.75
- (E) \$1.50

Percentage of correct responses for 13-year-old students at each performance level: 2008

Overall	Below level 200	Level 200	Level 250	Level 300
66	13	31	67	87

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

Sample question 5 asked students to demonstrate the ability to find a decimal representation of a number equivalent to a given fractional representation.

Write as a decimal.

$$\frac{136}{100} = \underline{\quad 1.36 \quad}$$

Percentage of correct responses for 13-year-old students at each performance level: 2008

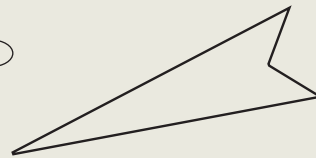
Overall	Below level 200	Level 200	Level 250	Level 300
47	7	14	38	81

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

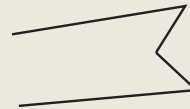
Sample question 6 required students to demonstrate knowledge and understanding of the definition of a polygon. A polygon is a “closed” plane figure consisting of line segments.

Which figure is NOT a POLYGON?

(A)



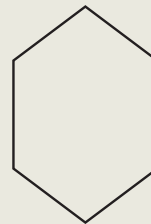
(B)



(C)



(D)



Percentage of correct responses for 13-year-old students at each performance level: 2008

Overall	Below level 200	Level 200	Level 250	Level 300
85	50	76	83	94

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

Sample Mathematics Questions

AGE 17

Sample question 7 required students to demonstrate the ability to order and compare real numbers.

Which number is between 1.8 and 1.9?

- (A) 0.189
- (B) 0.198
- (C) 1.83
- (D) 1.93

Percentage of correct responses for 17-year-old students at each performance level: 2008

Overall	Below level 250	Level 250	Level 300	Level 350
83	52	75	90	93

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

Sample question 8 asked students to demonstrate procedural knowledge by evaluating a function for a given value.

If $f(z) = z + 8$, what is the value of $f(6)$?

ANSWER: 14

Percentage of correct responses for 17-year-old students at each performance level: 2008

Overall	Below level 250	Level 250	Level 300	Level 350
65	16	41	78	98

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.

Sample question 9 asked students to solve a multistep problem involving the perimeter and area of a square.

The perimeter of a square is 36 centimeters. What is the area of the square?

- (A) 6 square cm
- (B) 9 square cm
- (C) 18 square cm
- (D) 81 square cm

Percentage of correct responses for 17-year-old students at each performance level: 2008

Overall	Below level 250	Level 250	Level 300	Level 350
59	11	29	79	98

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Mathematics Assessment.



Technical Notes

Sampling and Weighting

The target population for the 2008 NAEP long-term trend assessments consisted of 9-, 13-, and 17-year-old students enrolled in public and private schools nationwide. Eligibility for the age 9 and age 13 samples was based on the calendar year: students in the age 9 sample were 9 years old on January 1, 2008, with birth months January 1998 through December 1998, and students in the age 13 sample were 13 years old on January 1, 2008, with birth months January 1994 through December 1994. Students eligible for the age 17 sample had to be 17 years old on October 1, 2008, with birth months October 1990 through September 1991.

The national samples for students at ages 9, 13, and 17 were chosen using a multistage design that involved drawing students from the sampled public and private schools across the country. Within each age, the results from the assessed students were combined to provide accurate estimates of the overall performance of students in the nation.

Each school that participated in the assessment, and each student assessed, represents a portion of the population of interest. Results are weighted to make appropriate inferences between the student samples and the respective populations from which they are drawn. Sampling weights account for the disproportionate representation of some groups in the selected sample. This includes the oversampling of schools with high concentrations of students from certain minority groups and the lower sampling rates of students who attend very small private schools.

Scaling Interpretation

Although the reading and mathematics long-term trend assessments were initially scaled across the three ages the first time each subject was reported on a 0–500 scale, the results for subsequent years were scaled within each age group. Over the years, as the current assessment data are further removed from the base year, cross-age comparisons become weaker because the number of test questions initially used to link the three ages are relatively small and some have been

released to the public, and the performance patterns among racial/ethnic and other student groups upon which the original scale was based may have changed over time. Therefore, even though comparing results between the three ages may be appropriate for the overall results, comparisons for subgroups are not as strongly supported by the data and are discouraged.

School and Student Participation Rates

To ensure unbiased samples and to meet reporting requirements established by the National Center for Education Statistics (NCES) and the National Assessment Governing Board, school participation rates need to be at least 85 percent before substitute schools are added. The weighted national school participation rates for ages 9, 13, and 17 were 96, 95, and 90 percent, respectively. Student participation rates were 95, 94, and 88 percent, respectively, for each of the three age samples in both reading and mathematics.

Initial participation rates needed to be 70 percent or higher to report results separately for private schools. While the school participation rate for private schools met the standards in 2008 for reporting at ages 9 and 13 (72 and 79 percent, respectively), it fell below the standard at age 17 (61 percent). Participation rates were high enough for reporting results in 2008 for Catholic school students at all three ages (88, 94, and 76 percent at ages 9, 13, and 17, respectively); therefore, separate results for Catholic schools are included in this report.

The 1973 Mathematics Results

The mathematics trend scale was developed in 1986 and included previous mathematics trend assessments. However, because the 1973 mathematics assessment had too few questions in common with the assessments that followed, results from the 1973 assessment were placed on the same 0 to 500 mathematics scale using mean proportion correct extrapolation. Estimates were extrapolated from the data so that average mathematics scores could be reported for the nation and by race/ethnicity and gender at all three ages in 1973.

The extrapolated estimates were obtained by assuming that, within a given age level, the relationship between the logit transformation of a student group's average percentage of correct responses for common questions and its scale score average was linear, and that the same linear relationship held for all assessment years and for all student groups within that age level. Because of the need to extrapolate the average scale scores, caution should be used in interpreting the pattern of trends across those assessment years. For more information, see Appendix A of *NAEP 2004 Trends in Academic Progress: Three Decades of Student Performance in Reading and Mathematics*, available at <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2005464>.

Accommodations and Exclusions

Prior to 2004, no testing accommodations were allowed for students with disabilities (SD) and English language learners (ELL) selected to participate in the long-term trend assessments. One of the changes introduced as part of the 2004 assessments was the use of accommodations, such as extra testing time or individual rather than group administration for students who needed such accommodations to participate in the assessments. The results for the 2008 long-term trend assessments are based on administration procedures that also allowed accommodations. Appropriate accommodations were determined by having the school official most knowledgeable about the student identified as requiring an accommodation complete a questionnaire guided by a decision tree. This procedure has been used in NAEP since 2005. Some accommodations allowed in the mathematics assessment were not allowed for reading, such as bilingual booklets and reading the test aloud to students.

Exclusion rates were generally lower when accommodations were permitted. In 2004, between 7 and 8 percent of students selected to take the original format of the long-term trend assessments were excluded when accommodations were not permitted, and between 3 and 5 percent selected to take the revised format were excluded when accommodations were permitted (see appendix table A-3). In 2008, when accommodations were also

available, the percentages of SD and/or ELL students excluded were 4 percent in reading and 3 to 4 percent in mathematics (see appendix table A-4).

Race/Ethnicity

Results are presented for students in different racial/ethnic groups according to the following mutually exclusive categories: White, Black, and Hispanic. (Note that reading results for Hispanic students were not available prior to 1975.) Because results for Asian/Pacific Islander students were not reportable for some of the previous assessment years, they have not been included in the long-term trend reports. Results for those years in which they could be reported are available in the NAEP Data Explorer at <http://www.nces.ed.gov/nationsreportcard/naepdata/>. Results for American Indian (including Alaska Native) students are not reported separately because there were too few students sampled in this group for the results to be statistically reliable. Data for all students, regardless of whether their racial/ethnic group was reported separately, were included in computing the overall national results.

Results by students' race/ethnicity are presented in this report based on information collected from two different sources:

Observed Race/Ethnicity. Prior to 2004, students participating in the long-term trend assessment were assigned to a racial/ethnic category based on the assessment administrator's observation. The results for the 2004 original assessment format and all previous assessment years are based on observed race/ethnicity.

School-Reported Race/Ethnicity. Data about students' race/ethnicity from school records were collected in 2004 but were not collected for any of the previous NAEP long-term trend assessments. The results presented in this report for the 2004 revised assessment format and for 2008 are based on school-reported race/ethnicity.

Parents' Education Level

Students were asked to indicate the extent of schooling for each of their parents, choosing among the following options:

- Did not finish high school
- Graduated from high school
- Had some education after high school
- Graduated from college
- I don't know

The response indicating the highest level of education for either parent was selected for reporting. The questions were presented only to the students in the age 13 and age 17 samples.

While students in previous long-term trend assessments were asked about their parents' education level, the wording of the question in the revised format of the reading assessments administered in 2004 and 2008 was different from previous years. Consequently, trend results are reported only for the mathematics assessment.

Interpreting Statistical Significance

Comparisons over time or between groups are based on statistical tests that consider both the size of the differences and associated variability (i.e., standard errors). Standard errors are margins of error, and estimates based on smaller groups are likely to have larger margins of error. The size of the standard errors may also be influenced by other factors such as how representative the students assessed are of the entire population. When an estimate has a large standard error, a numerical difference that seems large may not be statistically significant. Differences of the same magnitude may or may not be statistically significant depending upon the size of the standard errors of the statistics. Standard errors for the NAEP scores and percentages presented in this report are available at <http://nces.ed.gov/nationsreportcard/lttdata/>.

The usual test for the statistical significance of a difference assumes that only one comparison is being made. A small chance necessarily exists that the test mistakenly identifies a difference as real. When several comparisons

are made concurrently, the likelihood of finding results that are mistakenly considered significant increases. The Benjamini-Hochberg False Discovery Rate procedure controls the rate of false discoveries and reduces the chance that a set of statistical tests indicates a difference while no actual difference exists.

The reader is cautioned against making simple causal inferences between student performance and the other educational variables discussed in this report. A statistically significant relationship between a variable and measures of student performance does not imply that the variable causes differences in how well students perform. The relationship may be influenced by a number of other variables not accounted for in this report, such as family income, parental involvement, or students' attitudes.

Setting the Performance Levels

To aid the interpretation of the NAEP long-term trend results, the reading and mathematics scales were divided into five successive levels of performance, and a "scale anchoring" process was used to define what it meant to score at each of these levels. The levels for each scale were set at 150, 200, 250, 300, and 350. For each of these five levels, questions were identified that were likely to be answered correctly by students performing at that level on the scale and much less likely to be answered correctly by students performing at the next lower level. The guidelines used to select these questions were as follows: students at a given level must have at least a specified probability of success with the questions (usually 65 to 80 percent), while students at the next lower level must have a much lower probability of success (that is, the difference in probabilities between adjacent levels must exceed 30 percent). Content specialists for each subject examined these empirically selected question sets and used their professional judgment to characterize each level. The reading scale anchoring was conducted on the basis of the 1984 assessment, and the scale anchoring for mathematics trend reporting was based on the 1986 assessment.

More information on the long-term trend assessment can be found at http://nationsreportcard.gov/ltt_2008/.

Appendix Tables

TABLE A-1. Percentage of students assessed in NAEP reading, by age group and selected student and school characteristics: Various years, 1971–2008

Age group and characteristics	1971	1975	1980	1984	1988	1990	1992	1994	1996	1999	2004 ¹	2004 ²	2008
Age 9													
Race/ethnicity													
White	84*	80*	79*	75*	75*	74*	74*	76*	71*	69*	59	59	56
Black	14	13	14	16	16	16	16	15	17	18	17	16	16
Hispanic	—	5*	6*	7*	6*	6*	7*	6*	8*	9*	17	17	20
Other	2*	2*	1*	2*	3*	4*	3*	4*	4*	4*	7	7	7
Gender													
Male	50	50	50	50	50	51	51	50	49	49	50	51	50
Female	50	50	50	50	50	49	49	50	51	51	50	49	50
Type of school													
Public	—	—	89	88	88	92	88	89	86*	88	89	89	90
Private	—	—	11	12	12	8	12	11	14*	12	‡	‡	10
Catholic	—	—	9*	9*	8	5	9*	6	7	6	6	6	5
Age 13													
Race/ethnicity													
White	84*	81*	80*	77*	76*	73*	73*	74*	71*	70*	64*	63*	57
Black	15	13	13	14	15	15	16	15	15	16	15	16	16
Hispanic	—	5*	6*	7*	6*	8*	7*	8*	9*	10*	16*	16*	21
Other	1*	2*	1*	2*	2*	3*	3*	3*	5	3*	5*	5	7
Gender													
Male	50	50	49*	51	50	50	49	51	49*	49	49	51	51
Female	50	50	51*	49	50	50	51	49	51*	51	51	49	49
Type of school													
Public	—	—	88	89	89	88	86	89	89	87	92	90	90
Private	—	—	12	11	11	12	14	11	11	13	‡	‡	10
Catholic	—	—	9*	9*	9	7	7	9*	6	7	5	5	5
Age 17³													
Race/ethnicity													
White	87*	84*	83*	77*	77*	74*	75*	73*	72*	72*	68*	70*	59
Black	11	11*	12	14	15	16	15	15	15	14	12	12*	15
Hispanic	—	3*	4*	7*	6*	7*	8*	8*	9*	9*	14*	13*	18
Other	1*	1*	1*	2*	2*	4*	3*	3*	4*	4*	5*	6*	7
Gender													
Male	49	49	51	51	48	50	52	50	51	52	49	50	50
Female	51	51	49	49	52	50	48	50	49	48	51	50	50
Type of school													
Public	—	—	93	90	88	93	92	89	92	90	91	90	92
Catholic	—	—	6	6	11	3	6	7	5	7	‡	‡	4

— Not available.

‡ Reporting standards not met.

* Significantly different ($p < .05$) from 2008.

¹ Original assessment format. Results prior to 2004 are also from the original assessment format.

² Revised assessment format. Results after 2004 are also from the revised assessment format.

³ For students at age 17, results are not shown for private schools under the type of school category because the minimum participation guidelines for reporting were not met.

NOTE: Black includes African American, Hispanic includes Latino, and "other" includes Asian, Native Hawaiian or other Pacific Islander, American Indian/Alaska Native, and unclassified. Race categories exclude Hispanic origin. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1971–2008 Long-Term Trend Reading Assessments.

TABLE A-2. Percentage of students assessed in NAEP mathematics, by age group and selected student and school characteristics: Various years, 1978–2008

Age group and characteristics	1978	1982	1986	1990	1992	1994	1996	1999	2004 ¹	2004 ²	2008
Age 9³											
Race/ethnicity											
White	79*	79*	77*	74*	75*	75*	72*	70*	60	59*	54
Black	14	14	15	16	16	15	16	18	15	16	16
Hispanic	5*	5*	6*	5*	6*	6*	8*	8*	18	18*	23
Other	1*	2*	2*	4*	3*	4*	5	4*	7	7	7
Gender											
Male	50	49	50	49	49*	49	50	49	49	50	50
Female	50	51	50	51	51*	51	50	51	51	50	50
Type of school											
Public	89	86	85	89	87*	88	87*	88	88	90	90
Private	11	14	15	11	13*	12	13*	12	‡	‡	10
Catholic	10*	9*	12*	7	9*	7	9*	8	6	5	5
Age 13											
Race/ethnicity											
White	80*	79*	77*	73*	74*	73*	71*	71*	66*	62	58
Black	13	14	14	16	16	15	15	15	15	16	15
Hispanic	6*	5*	7*	7*	7*	8*	9*	10*	15*	17	21
Other	1*	2*	2*	4*	3*	4*	4	4*	4*	5	6
Gender											
Male	50	50	50	50	50	49	48	50	48	49	50
Female	50	50	50	50	50	51	52	50	52	51	50
Parents' highest education level											
Did not finish high school	12*	11*	8	8	6	6	6*	6	7	7	7
Graduated from high school	33*	34*	31*	27*	23*	23*	23*	21*	19*	18	17
Some education after high school	14	14	16	17*	18*	17*	17*	17*	15	15	14
Graduated from college	26*	32*	38*	41*	44	46	45	48	47	47	48
Unknown	15	9*	8*	8*	8*	8*	10*	9*	12*	13	14
Type of school											
Public	91	89	96*	90	88	88	89	88	91	92	90
Private	9	11	4*	10	12	12	11	12	‡	‡	10
Catholic	9	8	3	7	8	9*	7	7	6	4	5
Age 17⁴											
Race/ethnicity											
White	83*	81*	78*	73*	75*	73*	71*	72*	69*	69*	59
Black	12	13	14	16	15	15	15	15	13	12	14
Hispanic	4*	5*	5*	7*	7*	9*	9*	10*	14*	14*	19
Other	1*	2*	3*	4*	3*	3*	4*	4*	5*	5*	7
Gender											
Male	49*	49*	49	49	51	49	50	48	48	50	50
Female	51*	51*	51	51	49	51	50	52	52	50	50
Parents' highest education level											
Did not finish high school	13*	14*	8	8	8	7*	6*	7*	9	8	9
Graduated from high school	33*	33*	28*	26*	21*	22*	21	20	19	19	19
Some education after high school	16*	18*	24	24	25*	24	24	23	22	22	22
Graduated from college	32*	32*	37*	39*	43	44	46	48	47	47	46
Unknown	5	4	3*	3*	2*	3*	2*	3*	3*	4*	5
Type of school											
Public	94	92	96*	93	91	88	91	89	91	91	92
Catholic	4	6	2*	3	6	8	5	6	‡	‡	4

‡ Reporting standards not met.

* Significantly different ($p < .05$) from 2008.

¹ Original assessment format. Results prior to 2004 are also from the original assessment format.

² Revised assessment format. Results after 2004 are also from the revised assessment format.

³ For students at age 9, results are not shown for the parental education level category because research indicates that these students are less likely to report this information accurately.

⁴ For students at age 17, results are not shown for private schools under the type of school category because the minimum participation guidelines for reporting were not met.

NOTE: Black includes African American, Hispanic includes Latino, and "other" includes Asian, Native Hawaiian or other Pacific Islander, American Indian/Alaska Native, and unclassified. Race categories exclude Hispanic origin. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1978–2008 Long-Term Trend Mathematics Assessments.

TABLE A-3. Percentage of students identified as students with disabilities and/or English language learners excluded in NAEP reading and mathematics, as a percentage of all students, by subject and age group: Various years, 1990–2004

Subject and age group	1990	1992	1994	1996	1999	2004 ¹	2004 ²
Reading							
Age 9	5.5	6.6	7.4	8.1	7.9	8.1	5.2
Age 13	5.3	5.7	6.1	6.9	6.5	8.3	4.9
Age 17	4.5	5.3	5.2	7.3	6.0	6.7	3.7
Mathematics							
Age 9	5.3	6.7	7.8	7.8	7.4	7.0	2.9
Age 13	5.3	6.0	6.2	6.5	6.1	7.9	3.2
Age 17	4.5	5.4	5.3	7.4	6.1	7.3	3.2

¹ Original assessment format. Results prior to 2004 are also from the original assessment format.

² Revised assessment format.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1990–2004 Long-Term Trend Reading and Mathematics Assessments.

TABLE A-4. Percentage of 9-, 13-, and 17-year-old students with disabilities (SD) and/or English language learners (ELL) identified, excluded, and assessed in NAEP reading and mathematics, as a percentage of all students, by SD/ELL category: 2008

SD/ELL category	Reading			Mathematics		
	Age 9	Age 13	Age 17	Age 9	Age 13	Age 17
SD and/or ELL						
Identified	21	18	16	20	18	15
Excluded	4	4	4	3	3	4
Assessed	16	14	12	18	15	12
Without accommodations	9	6	5	8	5	4
With accommodations	8	8	8	10	9	8
SD						
Identified	11	13	12	11	13	11
Excluded	3	3	3	2	3	3
Assessed	8	10	9	9	10	8
Without accommodations	2	3	2	2	2	2
With accommodations	6	7	7	7	8	7
ELL						
Identified	10	6	5	10	6	5
Excluded	2	1	1	1	#	1
Assessed	9	5	4	10	5	4
Without accommodations	6	4	3	6	4	2
With accommodations	2	2	1	4	2	2

Rounds to zero.

NOTE: Students identified as both SD and ELL were counted only once under the combined SD and/or ELL category, but were counted separately under the SD and ELL categories. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2008 Long-Term Trend Reading and Mathematics Assessments.

U.S. DEPARTMENT OF EDUCATION

The National Assessment of Educational Progress (NAEP) is a congressionally authorized project sponsored by the U.S. Department of Education. The National Center for Education Statistics, a department within the Institute of Education Sciences, administers NAEP. The Commissioner of Education Statistics is responsible by law for carrying out the NAEP project.

Arne Duncan
Secretary
U.S. Department
of Education

Sue Betka
Acting Director
Institute of
Education Sciences

Stuart Kerachsky
Acting Commissioner
National Center for
Education Statistics

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Museum Development and Science
Communication
New York, New York

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County Superintendent of Schools
Sacramento County Office of Education
Sacramento, California

Robin C. Hall
Principal
Beecher Hills Elementary School
Atlanta, Georgia

Kathi M. King
Twelfth-Grade Teacher
Messalonskee High School
Oakland, Maine

Kim Kozbial-Hess
Fourth-Grade Teacher
Hawkins Elementary School
Toledo, Ohio

Henry Kranendonk
Mathematics Curriculum Specialist
Milwaukee Public Schools
Milwaukee, Wisconsin

James S. Lanich
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CONTENT CONTACT

Jonathan Beard
202-502-7323
Jonathan.Beard@ed.gov



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