



THE BROWN CENTER ON EDUCATION POLICY THE BROOKINGS INSTITUTION

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New Study Finds That Math Items on the Nation’s Benchmark Exam Are Too Easy, Don’t Adequately Assess Skills—Eighth Graders Asked to Solve Problems Using First Grade Arithmetic

Report from Brown Center on Education Policy Also Finds Too Many Middle School Math Teachers Lack Sufficient Formal Training in Mathematics

Report Also Includes a Follow-Up Study That Finds Far Fewer Failing Schools Receive Blue Ribbon Schools Award

Washington, D.C., November 18, 2004 – A new report from the Brown Center on Education Policy at the Brookings Institution finds that math items on the National Assessment of Educational Progress (NAEP) math assessment lack challenging arithmetic, often requiring skills that are several years below grade level. The findings cast a disturbing light on recent highly-publicized math gains as measured by the NAEP assessment.

Despite sharply rising test scores on both the NAEP Math and most state math tests, the Brown Center’s analysis of the difficulty of the math items at fourth and eighth grade demonstrates that the NAEP test fails to assess essential arithmetic skills that are required for success in algebra and higher mathematics.

“The good news is that NAEP scores have risen dramatically in mathematics over the past decade,” noted Tom Loveless, director of the Brown Center on Education Policy and author of the *2004 Brown Center Report on American Education*. “But, given our findings, it is unclear whether this is a significant accomplishment in terms of substantial gains in mathematics skills and knowledge.”

The National Assessment of Educational Progress, or NAEP as it is commonly known, assesses fourth, eighth, and twelfth grade students in math and reading. Scores on the math assessments have risen dramatically over the last 10 years, indicating that U.S. students are becoming more adept at mathematics.

But the Brown Center analysis shows that the NAEP math assessments rely on arithmetic skills that are far below the grade levels of the students being assessed. The analysis finds that almost all problem solving items use whole numbers and avoid fractions, decimals, and percentages – forms of numbers that students must know how to use to tackle higher order mathematics like algebra.

Equally problematic is the fact that, given the low arithmetic rigor of many of these items, many students still fail to answer the questions correctly.

For example, the analysis finds that the level of arithmetic required on more than four out of ten (43.6%) problem solving items on NAEP is at least two years below grade level for fourth graders. Even so, fourth graders fail to do well on them. Items often demand nothing more than being able to add and subtract whole numbers and basic multiplication, yet a majority of the nation's fourth graders miss the average item assessed at this level.

The failures are even more alarming at the eighth grade. Almost four out of ten items (39.6%) address arithmetic skills taught at the *first and second grade* – six years below the grade level of eighth graders taking the test. More than three-fourths of the items are at least four years below grade level – taught in the fourth grade or lower. Yet, the percentage of eighth graders answering items correctly is an unimpressive 41.4%.

Algebra items lack rigor at both the fourth and eighth grades. On the eighth grade assessment, the arithmetic demands of algebra items are pitched at only the mid-second grade level.

Comparison of algebra and number sense items

Table

1-5*4th Grade*

Content Strand	N	Items with Whole Numbers Only	Average Grade Level of Items	Students Answering Correctly (%)
Algebra	15	15 (100%)	2.3	40.5
Number sense	66	47 (71.2%)	3.4	48.1

8th Grade

Content Strand	N	Items with Whole Numbers Only	Average Grade Level of Items	Students Answering Correctly (%)
Algebra	25	23 (92.0%)	2.6	45.6
Number sense	54	31 (57.4%)	4.1	55.3

Source: Analysis of NAEP items in public release.

Data on items available at <http://nces.ed.gov/nationsreportcard/ITMRLS>

“Really knowing algebra means being able to solve equations that contain more sophisticated forms of numbers than whole numbers. Calling these items algebra is conveying a false sense of rigor, making very simple math seem more sophisticated than it actually is,” noted Loveless.

“If students do not possess the tools to solve problems involving fractions, decimals, and percents – if students do not grasp forms of numbers other than whole numbers – then the only problems they will ever be able to solve will be mathematically trivial,” the report warns.

Too Many Middle School Math Teachers Lack Sufficient Formal Training in Mathematics—Unfocused Professional Development Also Raises Serious Concerns for Educators

The report also includes a national survey of middle school mathematics teachers and finds that most middle school mathematics teachers did not major in mathematics, do not hold a teaching certificate in the subject, and are not getting the kinds of professional development that will help them gain essential content knowledge.

For this analysis, the Brown Center on Education Policy surveyed a random sample of 252 middle school math teachers nationwide. The survey found that fewer than one-fourth (22%) of the teachers majored in math while in college. Additionally, less than one-half of middle school math teachers – only 41% – hold a teaching certificate in mathematics.

**Middle school math
teacher backgrounds****Table
2-1**

Background	Percent
Undergraduate major in mathematics	22%
Undergraduate minor in mathematics	19%
Teaching credential or certificate in mathematics	41%

This lack of content knowledge among middle school math teachers is unique to the United States. According to the Third International Mathematics and Science Study (TIMSS), 71% of teachers of eighth grade mathematics in the countries that participated in the study hold bachelor's degrees in mathematics.

The Brown Center survey findings are particularly disturbing given the need to ensure that all classroom teachers be deemed "highly qualified" by the end of the 2005-2006 school year, as required by the No Child Left Behind Act (NCLB). Content mastery is a key component of this requirement. The Brown Center study makes evident the need to focus professional development efforts squarely on those teachers lacking sufficient content knowledge.

The survey reveals that current professional development efforts fail to focus on core mathematics principals and leave teachers lacking the deep content knowledge necessary to teach students to high levels.

**Number of topics on
which teachers
received professional
development****Table
2-7**

Number of Topics	Percent of Teachers
None	3%
1-3 topics	16%
4-7 topics	44%
8 or more topics	36%

For example, 80% of the teachers surveyed said they have received professional development on 4 or more topics (44% of them received instruction in four to seven topics; 36% in eight or more topics).

"This kind of unfocused professional development is particularly worrisome among teachers lacking serious content knowledge in mathematics," noted Loveless. "Professional development for middle school mathematics needs to be focused on the core knowledge and skills teachers must master in order to teach their students effectively."

Loveless recommends targeting professional development on the teachers in need – those lacking sufficient content training in mathematics. According to the survey, about one-fourth of middle school math teachers have completed fewer than four undergraduate math courses offered by a mathematics department, and they are less likely than their peers to hold math teaching credentials. “Numbering approximately 16,000 teachers, this should be the target group for intensive, content-oriented professional development,” Loveless said.

Follow-Up Study Finds Far Fewer Failing Schools Receive Blue Ribbon Schools Award— Despite Progress, Additional Reforms Are Necessary

For the final study in the report, the Brown Center analyzed the achievement levels of schools receiving the prestigious Blue Ribbon Award from the U.S Department of Education and found that far fewer failing schools received the award last year than five years ago. But too many schools with mediocre records of academic achievement still win the award, raising the need for additional reforms to further improve the program’s focus on academic achievement.

The *2000 Brown Center Report on American Education* found a disturbing percentage of Blue Ribbon schools selected in 1999 – about one-fourth of them – had scored below the 50th percentile in their state’s assessment of academic achievement - hardly a blue ribbon-worthy performance. In 2003, the federal government revamped the Blue Ribbon Schools Program, raising the relative weight in the evaluation criteria of academic achievement measures and lowering the weight of process measures. The first schools to win the award under the new rules were selected in 2003.

This year’s follow-up study finds that the 2003 batch of winners is indeed higher achieving than the 1999 group. About one-third of the 2003 Blue Ribbon schools (31%) score in the top 10% of schools in their respective states, four percentage points more than in 1999. The percentage of undeserving schools – those with achievement levels below the 50th percentile – has been reduced from 24% in 1999 to only 9% in 2003. And all but one of the low-achieving schools designated as Blue Ribbon are from California.

Achievement of 1999 Blue Ribbon Schools
 (1999 test scores)

Table
3-1

Percentile

State	Number	99th-90th	89th-50th	49th-1st
California	39	12 (31%)	18 (46%)	9 (23%)
Illinois	3	1 (33%)	1 (33%)	1 (33%)
Indiana	4	0 (0%)	2 (50%)	2 (50%)
Michigan	9	1 (11%)	5 (56%)	3 (33%)
Pennsylvania	10	4 (40%)	6 (60%)	0 (0%)
New Mexico	1	0 (0%)	0 (0%)	1 (100%)
Washington	4	1 (25%)	2 (50%)	1 (25%)
Total	70	19 (27%)	34 (49%)	17 (24%)

Note: Test scores from 1998-1999 school year, adjusted for socioeconomic status (SES). Public schools only. Blue Ribbon awards given in 1999.

Source: Tom Loveless. *The Brown Center Report on American Education: How Well Are American Students Learning?* (2000)

Achievement of 2003 Blue Ribbon Schools
 (2003 test scores)

Table
3-3

Percentile

State	Number	99th-90th	89th-50th	49th-1st
California	24	2 (8%)	18 (75%)	4 (17%)
Illinois	6	1 (17%)	4 (66%)	1 (17%)
Indiana	3	2 (67%)	1 (33%)	0 (0%)
Missouri	8	5 (63%)	3 (37%)	0 (0%)
Pennsylvania	3	1 (33%)	2 (67%)	0 (0%)
Ohio	10	7 (70%)	3 (30%)	0 (0%)
Washington	3	0 (0%)	3 (100%)	0 (0%)
Total	57	18 (31%)	34 (60%)	5 (9%)

Note: Test scores from 2002-2003 school year, adjusted for socioeconomic status (SES). Public schools only. Blue Ribbon awards given in 2003.

Source: Data compiled from respective state department of education websites.

The study finds that the recent reforms of the Blue Ribbon program have succeeded in sharply diminishing the number of glaringly undeserving winners. That said, the study finds that the reforms have not gone far enough, warranting additional changes to the program. For example, some states still rely on schools to *nominate themselves* for state award programs, which often serve as the initial screen for the Blue Ribbon program. This means that schools are self-selecting and schools that know how to navigate the application process have a distinct advantage over other schools. The report recommends revising the Blue Ribbon program so that self-selection is not the basis for Blue Ribbon consideration. Instead, program officials should seek out and identify schools

worthy of recognition. While cost and time prohibitive in earlier years, advances in technology make this a viable option today. As Loveless notes in the report, “Achievement data are routinely collected that can be used to identify outstanding schools.”

According to Loveless, “The Blue Ribbon Schools Program is an opportunity for the nation to celebrate educational excellence, to honor the teachers and principals who believe in academic excellence. The program is doing a better job of recognizing exemplary schools today than it did five years ago, but its focus on academic achievements could be even sharper.”

About the Brown Center on Education Policy & The Brookings Institution

Established in 1992, the Brown Center on Education Policy conducts research on topics in American education, with a special focus on efforts to improve academic achievement in elementary and secondary schools. The Brown Center is part of The Brookings Institution, a private nonprofit organization devoted to research, education, and publication on important issues of domestic and foreign policy. The Institution maintains a position of neutrality on issues of public policy. Interpretations or conclusions in Brookings publications should be understood to be solely those of the authors.

For a full copy of the report as well as information about other Brown Center events and publications, please visit the Brown Center’s Web site at www.brookings.edu/browncenter, or call Alice Henriques at 202-797-6469.

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