Testimony of
John Hoven
On Behalf of
The Center for Education Reform
At the National Public Forum on the
Draft 2004 Mathematics Framework
September 24, 2001

Good morning. My name is John Hoven, a member of, and speaking on behalf of, the Center for Education Reform. The Center is a national, independent, non-profit advocacy organization founded in 1993 to provide support and guidance to parents and teachers, community and civic groups, policymakers and grassroots leaders, and all who are working to bring fundamental reforms to their schools.

By way of credentials, I am a Ph.D economist, with a bachelor's degree in math and physics and a master's degree in physics. Currently, I serve as co-president of the Gifted and Talented Association of Montgomery County, Maryland.

The Center for Education Reform appreciates your invitation to offer recommendations on the Draft 2004 Mathematics Framework for the National Assessment of Educational Progress (NAEP).

My remarks focus on the question of whether the mathematics objectives in the draft framework are appropriate expectations for students in grades 4, 8, and 12. We believe they are not, for they do not depart substantially from current trends in the exam.

My remarks are based on an examination of the publicly released NAEP Test Questions (http://nces.ed.gov/nationsreportcard/itmrls/). I compared these with a published set of exam problems based on the math curriculum of Singapore.[1] I chose Singapore because its TIMSS scores (Third International Math and Science Study) make it the acknowledged world leader in mathematics.

My point is simple: **There is a chasm of difference in expectations between NAEP and the problems used by world-class mathematics leaders**. We expect too little from our children, and by lowering our expectations we lower their incentive to achieve.

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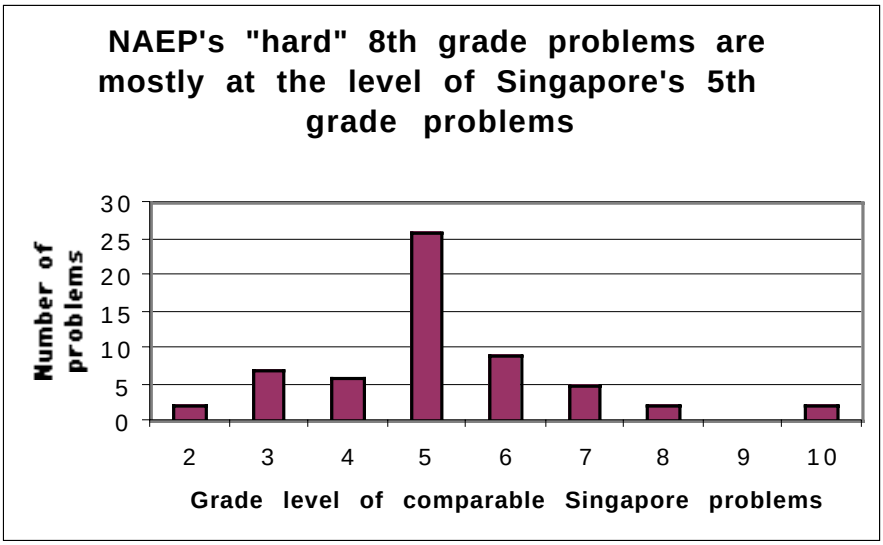
[1] Federal Test Papers Mathematics for Primary 1 to 6. Singapore: Federal Publications (2000); New Elementary Mathematics Syllabus D1 [grade 7] and D2 [grade 8] (1996); Federal Mathematics: A Problem-Solving Approach 4 [grade 10] (1994). The first two are available for purchase at http://www.singaporemath.com; the 10th grade textbook is not part of the current curriculum.

As an example, my own school district – Montgomery County, Maryland – is one of the most affluent, highly educated counties in America, yet our **gifted** students scored at the level of Singapore's **average** student.

NAEP classifies its problems as "easy," "medium," or "hard." I benchmarked the "hard" 8th grade problems, examining NAEP's highest level of expectation for 8th grade math. Most of these "hard" 8th grade problems are at the level of Singapore's grade 5 – or lower.



Now, I don't expect to convince you of that with a chart. Instead, I want you to see for yourself some of these "hard" 8th grade problems.

Consider: In one problem, for example, the student is shown a "Lunch Menu" with items like Onion Soup for $.80 and Ice Cream for $1.10. The question asks: "What is the total cost of Soup of the Day, Beefburger with Fries, and Cola?"

This is considered a "hard" eighth grade problem. But Singapore has harder problems than this in grade 3. Here are two examples:

1) 5 oranges cost $2.25. What is the cost of 12 oranges? _____

2) I want to buy a calculator for $29.70 and a watch for $32.00. I have $28.50. How much more money do I need?

(1) $26.20
(2) $30.80
(3) $33.20
(4) $32.70

Both of these are two-step math problems. They illustrate Singapore's expectation that all children should acquire mastery of the math skills needed for algebra and beyond. NAEP's expectation is that children need to be able to order take-out from McDonald's.

Algebra

In 8th grade, mathematically advanced American students take Algebra 1. NAEP ignores all of these children. *Not a single question is at an Algebra I level*. Here is NAEP's most difficult algebra question:

3) The length of a rectangle is 3 more than its width. If L represents the length, what is an expression for the width?

A) 3 ÷ L
B) L ÷ 3
C) L x 3
D) L + 3
E) L - 3

Frankly, this kind of problem is for a child who started learning algebra yesterday. By comparison, here is a Singapore problem for grade 6:

4) Ahmad scored x marks for his English in an examination. He scored 90, 80, 80 for 3 of his other 4 subjects, and did half as well in English as he did in Maths. If he had an overall average of 80 marks, how many marks did he score for Maths?
Answer: _____

Why does NAEP expect so little, and Singapore expect so much? Because Singapore students have been solving progressively more complex problems since third grade.

The two Singapore algebra problems below further illustrate the process of building math skills step by step. The first problem is the distributive law. Singapore students master this in 6th grade, so they can use it automatically in 8th grade Algebra.

5) 6p(3 + 5p) is the same as _____.

(1) $18p + 30p^2$
(2) 18p + 3
(3) $11p^2 + 30p$
(4) $11p + 3p^2$

The second problem begins the process of "chunking" – learning to see algebraic expressions as a single "chunk." That skill makes it easy to see that you just divide \$20 by p^2 kg to get $\$20/p^2$.

6) If p^2 kg of rambutans cost \$20, what is the cost of 1 kg of rambutans?

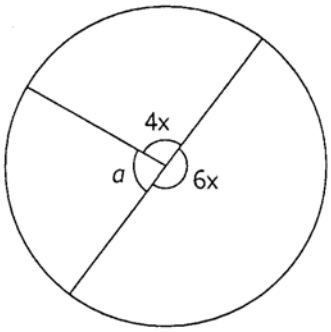
(1) \$20 - p
(2) \$20 + p
(3) \$20/p
(4) $\$20/p^2$

Finally, here are two more problems demonstrating that by 6th grade, algebra is a useful tool for Singapore children. Here they apply it to geometry and percents:

7) Given that the angles of a pie chart are as shown in the diagram, and the perimeter subtended by the angle a is 4 cm, find

(a) the perimeter and
(b) the area of the circle.

(Leave your answer in 2 decimal places.)

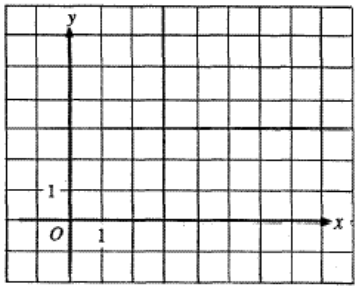


8) Rama bought n sets of toys and 6 pairs of shirts for $65. Each shirt costs $5.

(a) Find the cost of each set of toys in terms of n.
(b) If Rama received a 20% discount for all the items, how many more sets of toys could she buy if n = 5 for part (a).

In comparison, NAEP doesn't test algebra; it tests "algebraic concepts." That's a weasel word that allows for problems like this:

9) Plot the point (5,2) on the grid.



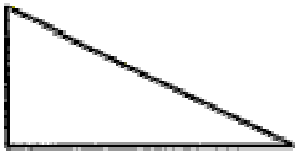
NAEP calls this a "hard" eighth grade problem. To the contrary: It's a trivial problem.

Geometry

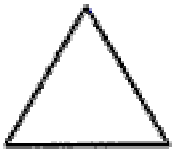
In geometry, the contrast between NAEP and Singapore is even more striking. Here's a "hard" 8th grade NAEP problem in geometry:

10) Which of the following figures contains line segments that are perpendicular?

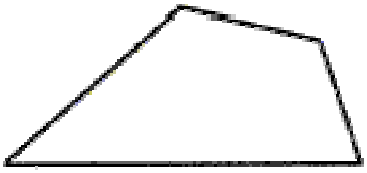
(A)



(B)



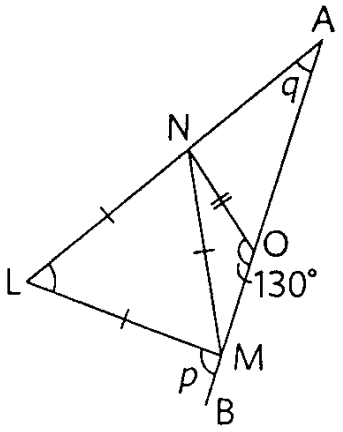
(C)



(D)

But in Singapore, "perpendicular" is a 4th grade concept. Fifth graders do multi-step geometry problems like this one:

11) LMN is an equilateral triangle and MNO is an isosceles triangle. AB is a straight line.
Find
(a) Angle p
(b) Angle q



Let's walk through this problem to underscore why it matters. The basic concept is that the sum of the angles of a triangle is 180°. LMN is an equilateral triangle, so all angles are equal to 60°. MNO is an isosceles triangle, so the two base angles are equal to each other, and they each have to be 25° in order to make the triangle add up to 180°. So

now we know Angle LMN is 60º and Angle NMO is 25º, and we can add them to find that Angle LMA is 85º. AB is a straight line, so Angle LMA plus Angle p must add up to 180º, and that makes Angle p equal to 95º. Finally, looking at triangle ALM, we know that Angle ALM is 60º and Angle LMA is 85º, so Angle q must equal 35º.

There may be many steps, but every step is simple.

Our children can do this. But only if we teach them, and ask them.

Problems like this are important because they teach children how to trace a logical argument step by step from basic facts to a final conclusion. If the student supplies a reason for each step, it's a formal mathematical proof. If the student applies this same skill to a controversy in science or politics, he or she has learned how to think logically.

Nothing remotely similar to the 5th grade Singapore problem I just gave you appears on the 8th grade NAEP.

Percentages and Proportionality

Proportionality and rate of change are topics of major concern for American education. Here's an example of a "hard" 8th grade NAEP problem in that category:

12) If the price of a can of beans is raised from 50 cents to 60 cents, what is the percent increase in the price?

A) 83.3%
B) 20%
C) 18.2%
D) 16.7%
E) 10%

Did you use the calculator on this question? ____ Yes ____ No

Note the use of a calculator. I suppose choosing between those multiple choices is what the NAEP framework means by "opportunities for them to show the mathematical thinking that can occur when a calculator is at hand," but for many Americans it is a representation of our "dumbed down" math curriculum.

Singapore students learn the concept of percentages in 5th grade, and they work much harder problems without a calculator – like these:

13) A blouse and a skirt were sold at a discount of 25% if they were bought together. If bought separately, the blouse would cost $25 and the skirt would cost 30% more than the blouse. How much would the blouse and skirt cost after the discount if they were bought together? Give your answer to the nearest cent.

14) A bank pays interest at a rate of 4% every year. If Christine has $5000 in the bank, how much money will she have altogether after 2 years?

15) 30% of the marbles in a box were blue. 45% of them were green and the rest orange. If there were 200 more blue marbles than orange ones, how many marbles were in the box?

Here is a 6th grade Singapore problem on proportionality:

16) A basket of clothes, when half full, weighed 2.4 kg. The basket became 5/8 full when another 0.5 kg of clothes were added in. What was the weight of the empty basket?

And here is one on rate of change:

17) A rectangular tank 3.6 m long, 2 m wide and 1.8 m high was 5/8 filled with water. The water dripped from the container at a rate of 0.06 m^3 per second. What was the volume of water left at the end of 1 minute?

Nothing approaching these levels of complexity appears on the 8th grade NAEP.

But if our students struggle with this aim-low NAEP, how can we pile on even more?

Singapore doesn't do more. They do less – less, that is, of the time-wasters that clutter the American "mile wide, inch deep" math curriculum. A world-class curriculum like Singapore's focuses on math skills that prepare children for algebra and beyond. It builds mastery of those skills step by step, and incorporates these skills into more and more complex problems.

In contrast, NAEP has a major focus on fluff. My favorite example is the scale drawing of a room, where the student is given the measurements of a bed, a desk, and a chest and asked to arrange them so they don't block the doors and windows. This is what NAEP calls "problem-solving." Here's another example:

18) Dave will choose one sandwich and one drink for lunch. The menu shows the choices. List below all the possible combinations of a sandwich and a drink that Dave might choose.

MENU

Sandwiches
Beef
Tuna
Ham

Drinks
Milk
Juice

This is not an assessment of a student's mastery of combinations and permutations. This is fluff. It doesn't require any math skills, and doesn't develop any.

Let me take you back to the first graph. Do you *want* this trend to continue?

Conclusion

The tragic events of two weeks ago reinforce more than ever the need for our children to hold 21st century skills.

Whereas 60 years ago, good-paying jobs existed for those without math skills and the ability to compute (and read), the world-class competitiveness of tomorrow demands that the next generation of children be prepared to meet more extensive challenges than we have ever witnessed before.

To do less is to fail them, and fail our nation.

We believe that the 2004 NAEP be required to meet world-class standards. This means that NAEP's easy problems must be similar to easy problems on exams in Singapore, Japan, or some similar world-class math power, and NAEP's hard problems must be similar to their hard problems. Sample problems should be posted on the internet with the international comparisons, as I have done in the attachment to this testimony.

Thank you for the opportunity to offer our thoughts on these issues, and I welcome the opportunity to respond to any questions you might have.

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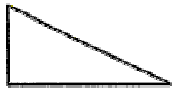
Answers to problems:

1) $5.40 for 12 oranges
2) I need $33.20 more
3) E) width = L-3
4) 100 on Maths
5) $5p(3 + 5p) = 18p + 30p^2$
6) (a) perimeter = 24 cm, (b) area = 45.84 cm^2
7) (a) $35/n, (b) 2 more sets of toys
8) intersection of the grid lines $x = 5$ and $y = 2$
9)

(A) 

10)
11) $p = 95^o$, $q = 35^o$
12) B) 20%
13) $43.13
14) $5408
15) 4000 marbles
16) 0.4 kg
17) 4.5 cm^3
18) *(Beef, Milk), (Tuna, Milk), (Ham, Milk), (Beef, Juice), (Tuna, Juice), (Ham, Juice)*