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ABSTRACT

The testimony and prepared statements of witnesses, and other supplemental materials presented at the Oversight Hearing on Mathematics Achievement before the Subcommittee on Elementary, Secondary, and Vocational Education of the Committee on Education and Labor, House of Representatives, Ninty-Sixth Congress, are given. Witnesses included: Dr. Wesley Apker, Executive Director, National Association of State Boards of Education; Dr. Edward T. Esty, Senior Research Associate, Teaching and Learning Division, National Institute of Education; Dr. Roy H. Forbes, Director, National Assessment of Educational Progress; Dr. Shirley Hill, President, National Council of Teachers of Mathematics; and Kathy Schaub, Assistant Director for Program Development, Association for Supervision and Curriculum Development. (MK)

# OVERSIGHT HEARING ON MATHEMATICS ACHIEVEMENT



## HEARING

BEFORE THE

SUBCOMMITTEE ON ELEMENTARY, SECONDARY, AND VOCATIONAL EDUCATION

OF THE

COMMITTEE ON EDUCATION AND LABOR HOUSE OF REPRESENTATIVES

NINETY-SIXTH CONGRESS

FIRST SESSION

HEARING HELD IN WASHINGTON, D.C., ON OCTOBER 23, 1979

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# OVERSIGHT HEARING ON MATHEMATICS ACHIEVEMENT

TUESDAY, OCTOBER 23, 1979

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ELEMENTARY, SECONDARY,
AND VOCATIONAL EDUCATION,
COMMITTEE ON EDUCATION AND LABOR,
*Washington, D.C.*

The subcommittee met, pursuant to notice, at 9:30 a.m., in room 2175, Rayburn House Office Building, Hon. Carl D. Perkins (chairman of the subcommittee) presiding.

Members present: Representatives Perkins, Kildee, Erdahl, and Hinson.

Staff present: John F. Jennings, majority counsel; Nancy L. Kober, majority staff assistant; and Richard D. Eugenio, minority legislative associate.

Chairman PERKINS. The Subcommittee on Elementary, Secondary, and Vocational Education is conducting an oversight hearing today on the recent findings of the National Assessment of Educational Progress that the overall mathematics achievement of American students has declined between 1973 and 1978.

In September, the National Assessment released the results of its 1978 survey of math achievement. This report included, for the first time, data on the change in math achievement over a period of time. The results were not encouraging. The report showed that the math achievement of 17-year-olds dropped by 4 percentage points, 13-year-olds' achievement dropped by 2 percentage points, and 9-year-olds' by 1 point.

The report also indicated that while computational abilities were generally high, problem-solving ability generally declined during the 5-year period.

These results are not the only indication of a decline in students' math performance. SAT scores and other standardized test scores have been falling for over a decade.

I think it is time that Congress take a closer look at this situation. These findings and others like it have a great effect on how parents and the general public perceive the quality of our Nation's schools. I feel it is important for the subcommittee to consider the meaning of these findings and what can be done about them, lest they be forgotten until the next National Assessment survey comes out.

I also believe that it is very important that we debate these findings because a knowledge of advanced mathematics is essential to our continued supremacy in science and technology. And, if our country is to overcome our current economic problems, we will have to rely more and more on innovations in technology.

For all of these reasons, today's hearing is very important. Today we will be hearing from representatives of the National Assessment for Educational Progress and the National Institute of Education on the survey findings and the reasons behind the decline. We will also be hearing from representatives of mathematics teachers, curriculum specialists, and State boards of education. These witnesses will be testifying on how all levels of government might respond to these findings, keeping in mind the primary role of State and local governments in financing elementary and secondary education.

We have a panel: Dr. Roy H. Forbes, director, National Assessment of Educational Progress; Dr. Edward K. Esty, senior research associate, Teaching and Learning Division, National Institute of Education; Ms. Kathy Schaub, assistant director for program development, Association for Supervision and Curriculum Development; Dr. Shirley A. Hill, president, National Council of Teachers of Mathematics; and Dr. Wesley Apker, executive director, National Association of State Boards of Education.

Come around, the entire panel, as I call them and we will first start out with Dr. Forbes.

Identify yourself for the record, Dr. Forbes. We are delighted to welcome the panel here. Without objection, all prepared statements will be inserted in the record. Mr. Hinson, did you want to make a remark at this time?

Mr. HINSON. Mr. Chairman, I have no statement.

Chairman PERKINS. Mr. Erdahl?

Mr. ERDAHL. No thank you, Mr. Chairman. I just wish to also welcome the panel, and I am looking forward to their testimony on what you have described as a very key and important area.

Chairman PERKINS. Thank you very much, and go ahead, Dr. Forbes.

## STATEMENT OF DR. ROY H. FORBES, DIRECTOR, NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

Dr. FORBES. Thank you, Mr. Chairman. I thank the committee for inviting us to testify today.

The purpose of the National Assessment is to determine what young Americans can do and what they know. It is a unique cooperative relationship which is authorized by Congress, which is administered by the education commissions of the States, and is a project of the National Institute of Education.

The Assessment conducts yearly annual assessments in 10 different learning areas: Mathematics, reading, literature, writing, science, social studies, citizenship, art, music, and career and occupational development. We conduct the assessment by sampling students ages 9, 13, and 17 years old, out-of-school 17-year-olds, those that have dropped out of school or have graduated early. When the budget allows, we also assess groups of young adults 26 to 35.

In conducting assessments we try to gather answers to the following questions:

What is the current level of performance of the 9-, 13-, and 17-year-olds, otherwise what can they do?

Does that level of performance show a decline or an increase over a 4 to 5 year period?

How do you do various groups of young Americans, those students from economically disadvantaged areas, or from some of the remarkable ethnic groups; how do they perform in comparison with the national averages; and are those groups of students changing otherwise; are any gaps in performance closing, or are they becoming wider?

Last month, as the chairman indicated, we did release a report describing the results of an assessment which we conducted in school year 1977-78, and we compared those data with information that we collected in school year 1972-73.

What did we find? That for the most part students have a good grasp of the basic mathematic facts, otherwise being able to add 6 and 3 or subtracting 8 from 9, things of that nature. Over 90 percent of the 9-year-olds know those types of questions. When you throw division at them, it is a slightly different problem.

Most students can compute whole numbers, although those percentages drop off when you again give them more complex problems.

For example, 50 percent of the 9-year-olds, 84 percent of the 13-year-olds, and 92 percent of the 17-year-olds can add a column of four two-digit numbers. When you ask students though to multiply or to divide, those percentages drop off. Most students can work very simple word problems, but when you add additional information in a word problem that is not needed in order to work the word problem, again the students ability to solve those problems drops rather dramatically.

I think one of the most astonishing ones: When presented with an electrical bill, the 17-year-olds were asked to compute the unit cost for electricity. Only 10 percent were able to do that. Just too much information on the electric bill.

In one multiplication word problem, we gave the students strictly a computation type of exercise, then we used exactly the same numbers in a word problem, and there is a difference of 10 percentage points for the 13- and 17-year-olds' ability to be able to respond to the word problem when they know actually how to do the computation. So it is in applying the computation skill where we get into a lot of trouble.

Another illustration of difficulty with word problems: If you show the 13-year-olds and the 9-year-olds a picture of a rectangle and ask the distances around, giving the dimensions, they are able to do that, but when you give them a word problem where you ask them to determine the amount of fencing needed to close a particular area, where the picture is not drawn for them but is exactly the same dimensions of the earlier exercise; again there is a rather dramatic drop in their ability to handle that type of problem.

The assessment result also shows that teenagers did not understand the concepts of fractions, decimals, and percents. When you ask them to estimate the sum of adding two fractions, for example, twelve-thirteenths and seven-eighths, only 24 percent of the 13-year-olds and 37 percent of the 17-year-olds can correctly estimate that to be 2. That was a multiple-choice type of item.

Only 36 percent of the 13-year-olds and 58 percent of the 17-year-olds know what percent 30 is of 60. That is as simple a percent problem as we could come up with. And 8 percent of the age 13 and 27 percent of the age 17 can calculate what 4 percent of 75 is.

That provides a rather quick brief overview of what we found in the mathematical abilities for the 9-, 13-, and 17-year-olds.

What happened between the two assessments? The one in 1973 and the one in 1978? We found on the average that 17-year-olds performance declined by 4 percentage points, the 13-year-olds declined by 2 percentage points, and the 9 year olds performance was off by 1 percentage point. Again, when I break out the different types of items that we were asking these three ages, the mathematical knowledge type problems, essentially there were no changes at all in the three age groups.

When we asked skills that include computational-type skills, again 9 year performance remained unchanged, but the 13 and 17 performance did decline in mathematical understanding. Again, we were picking up a percentage of the 9's of 2, and a 4 percentage point of the 13- and 17-year-olds.

I think the one that concerned me the most, as I was reviewing the data, were the rather dramatic decline of the 9-year-olds' ability to solve word problems. There was a 6 percentage point decline for 9-year-olds; the 13-year-olds had a three percentage point drop; the 17 year olds we had a 4 percentage point drop.

When we look at the way in which different groups of students were performing in relationship to either decline or increases, we defined some encouraging information in that the gap that has existed between performance of students attending economically or attending schools that serve economically disadvantaged areas, that there was a closure of the gap in performance by 4 percentage points at both age 9 and age 13; otherwise the ability of the economically disadvantaged people at those two ages was beginning to close that gap in performance between them and the way in which the Nation performed.

When I look at these results and I compare it with data that we have collected in reading and writing, science and citizenship, and social studies, where we also have been able to report changes, there are three things that stand out very strongly to me.

First of all, the changes occurring in educational achievement of the Nation's youth are very complex. It is not a simple overall decline as some critics of American education have claimed.

For example, with the exception of the mathematical problem solving, 9 year olds have either been improving or remaining constant in their performance in reading, writing, and mathematics. In the area of reading, when we conducted our assessment with 17-year-olds, we found for the most basic type, the simpler type of reading exercise and test items, that the 17-year-olds actually showed an improvement, but for overall reading, 13- and 17-year-olds showed very little change between 1970 and 1975.

But when we asked—the 17-year-olds especially—questions which would measure their ability to infer from what they have read, we were finding a decline. So again, it is a matter of application of basic skills, more than basic skills.

The discrepancies between the performance of certain groups of students in the national average still remains a critical problem. The way in which students perform that go to schools that serve the economically disadvantaged area and those that go to schools serving more affluent communities, there is still a very large gap, although we have indicated some closure in that gap in mathematics.

We also picked up some closures in the gap in the area of reading. So it would appear to me that there is a positive effect from the combined efforts to improve the educational benefits of the economically disadvantaged. We are doing something right.

Finally, the major problem which appears to be developing is not a lack of the most basic skills, such as writing mechanics, mathematical knowledge and whole number computation, reading for literal comprehension, but rather an inability to apply these skills. The data indicate that students can handle the mechanics of writing, whole number computation and mathematical facts and definitions, and the literal reading tasks. Declines appear in the higher order skills—inferring from what is read, overall quality of writing, and mathematical problem solving—and this is the level to which we must address our concerns. Aiming our efforts at an appropriate level, for example, the most basic skills, I believe, will not help the problem. I think it might even hinder it.

Thank you, Mr. Chairman.

[Prepared statement of Dr. Roy H. Forbes follows:]

PREPARED STATEMENT OF ROY H. FORBES, DIRECTOR, NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

The purpose of the National Assessment of Educational Progress is to determine what young Americans know and can do—at a given point in time—and to measure changes (growth or decline) in their educational achievement over time. The program which represents a unique cooperative venture of the federal government and the education community, is a congressionally authorized project of the National Institute of Education and is administered by the Education Commission of the States.

National Assessment monitors ten learning areas: reading-literature, writing, mathematics, science, social studies-citizenship, art, music, and career and occupational development. Representative national samples of 9-, 13-, and 17-year-old students, and in some areas, out-of-school 17-year-olds (drop-outs and early graduates) and young adults aged 26 through 35, are assessed. Each learning area is assessed every four to eight years in order to gather data necessary to answer the following types of questions.

1. What is the current level of performance by 9-, 13-, and 17-year-olds; for example, what percent of the nation's 9-, 13-, and 17-year-olds can compute using whole numbers?

2. Does the data show growth or decline in student performance from the previous assessment(s) of the learning area; for example, has the performance of 13- and 17-year-olds in the area of mathematical problem-solving improved or declined between 1973 and 1978?

3. How do various groups of young Americans tend to perform in relation to the national average for their age group; for example, how do students from extreme rural areas or disadvantaged urban areas perform in relation to the nation?

4. Are the differences in performance by various groups staying the same or are they changing over time; for example, have females and blacks improved their performance relative to the nation in mathematics?

Last month, National Assessment released the data from the second assessment of mathematics. The data presented the level of mathematical abilities of 9-, 13-, and 17-year-old students during the 1977-78 school year; the data also presented the changes in students' mathematical abilities from the first assessment of mathematics (conducted during the 1972-73 school year) to the second. How did students do?

Assessment findings show that students appear to have a good grasp of basic mathematics facts and simple definitions. Some highlights:

Approximately 90 percent of the 9-year-olds know the sums of basic addition facts (eg., 6 + 3, 8 + 8); between 70 percent and 90 percent know simple subtraction facts. Over 90 percent of the 13- and 17-year-olds can answer basic addition, subtraction, and multiplication facts; percentages are slightly lower for division.

Sixty-five percent of the 9-year-olds, 80 percent of the 13-year-olds, and 88 percent of the 17-year-olds know that a centimeter is the metric unit most appropriate for measuring the length of one's thumb.

Fifty-seven percent, 90 percent and 94 percent of the 9-, 13- and 17-year-olds respectively can identify parallel lines.

Most students can compute with whole numbers, although percentages are lower for more complex multiplication and division problems.

Fifty percent at age 9, 84 percent at age 13, and 92 percent at age 17 can add a column of four two-digit numbers; approximately the same percentages at each age (50 percent, 85 percent, and 92 percent respectively) can subtract a three-digit number from another three-digit number using borrowing.

Sixty-six percent of the 13-year-olds and 76 percent of the 17-year-olds can multiply 671 by 402; 46 percent of the 13-year-olds and 50 percent of the 17-year-olds can divide 3,052 by 28.

Most students at all three ages can answer very simple word problems. However, many students have difficulty with more complex word problems. On a simple multiplication word problem that contains extra information not needed to solve the problem, 56 percent of the 13-year-olds answer correctly; 23 percent multiply all the numbers presented in the problem. Similarly, only 10 percent of the 17-year-olds can figure the unit cost for electricity when shown an electric bill that includes extraneous information. More students can do computation than can solve word problems that use the same numbers. On one multiplication word problem included in the assessment, 20 percent of the 9-year-olds and 77 percent of the 13-year-olds can solve the problem correctly. However, when given the same numbers as a computation problem, 34 percent of the 9-year-olds and 84 percent of the 13-year-olds multiply accurately.

The NAEP data also indicate that students may not be "thinking through" the problems. While they may possess the basic knowledge needed to solve the problem, they appear to have difficulties with the problem if it is not presented to them in a manner which calls to mind the needed algorithm or "rule". For example:

About 60 percent of the teenagers know that the sides of a square equal in length, and about half of the 13-year-olds and nearly three-quarters of the 17-year-olds can calculate the area of a rectangle given its length and width. Yet only 12 percent of the 13-year-olds and 42 percent of the 17-year-olds can successfully figure the area of a square when the length of only one side is shown.

Forty percent of the 9-year-olds and 69 percent of the 13-year-olds can calculate the "distance around" a pictured rectangle with two dimensions given. But only 9 percent at age 9 and 31 percent at age 13 can determine how much fencing is needed to go around a rectangular garden with the same dimensions that is not pictured.

Thirteen-year-olds are asked how many cars, each holding a certain number of passengers, are needed to transport a group of people. About 20 percent correctly round their answers up to the next whole number, but nearly 40 percent give the exact answer to the division, forgetting that their answer means a fraction of a car.

Assessment results also indicate that teenagers do not understand the concepts of fractions, decimals, and percents. For example:

When asked to estimate $\frac{12}{13} + \frac{7}{8}$, only 24 percent of the 13-year-olds and 37 percent of the 17-year-olds select the correct choice, 2.

In estimating 250 divided by .5, 25 percent and 39 percent of the 13 and 17-year-olds respectively answer 500; the largest percentages of students, 61 percent of the 13-year-olds and 47 percent of the 17-year-olds, ignore the decimal point, giving an answer of 50.

Only 35 percent of the 13-year-olds and 58 percent of the 17-year-olds know what percent 80 is of 60; only 8 percent at age 13 and 27 percent at age 17 can calculate what four percent of 75 is.

About one-third of the 17-year-olds do not realize that 5 percent means 5 out of 100. Forty-nine percent of the 13-year-olds and 58 percent of the 17-year-olds know that more than 100 percent of a number is greater than the number itself.

This provides a brief overview of the current level of mathematical abilities possessed by young Americans during the 1977-78 school year. But has the performance of students improved or declined since the first mathematics assessment conducted during the 1972-73 school year? To answer this question, National Assessment has included a number of items in both assessments.

The assessment data show that overall mathematics achievement has declined over the five-year time span. On the average, 17-year-olds in 1978 performed 4 percentage points lower than 17-year-olds in 1973, and 13-year-olds performed 2 percentage points lower than 13-year-olds five years before. The decrease in 9-year-olds performance was about 1 percentage point. However, valuable insights are gained when one considers the results for the various components of mathematics.

When one considers the area of mathematic knowledge which includes items stressing recall and recognition of facts and definitions, there is essentially no change in the performance of 9-, 13-, and 17-year-olds between 1973 and 1978. Within the area of mathematical knowledge, it is interesting to note that knowledge of metric terminology increased substantially while knowledge of English units appears to be declining.

When one examines the area of mathematical skills which involves the ability to manipulate mathematical symbols or use an algorithm (e.g., adding a column of numbers, reading information from a table, or solving a given equation), the performance of 9-year-olds remains unchanged between the two assessments. At age 13, there is a 2 percentage point decline; at age 17, there is a 5 percentage point. Yet the declines for teenagers appear to be tied with their difficulties in working with fractions, decimals, and percents.

The area of mathematical understanding involves the ability to grasp the principles underlying various knowledge or skills; it often requires students to translate knowledge of skills from one form to another. Thirteen-year-olds declined 2 percentage points and 17-year-olds declined 4 percentage points in this area.

The final area to be considered is that of mathematical application or problem-solving. Problem-solving requires the ability to determine which facts, algorithms, or understandings are relevant as well as the ability to apply the needed processes. It perhaps represents the ultimate goal of mathematics education. In this area, 9-year-olds decline by 6 percentage points, 13-year-olds by 3 percentage points, and 17-year-olds by 4 percentage points during the five years between assessments.

The data presented above describe the performance of the nation at each age level. How did some of the different reporting groups do?

At each age level, males and females showed virtually identical declines in performance between 1973 and 1978. Thus, differences between males' and females' achievement remained constant over the five-year period. At ages 9 and 13, there are no differences between overall average performance by males and females. By age 17, males have about a 4 percentage point advantage over females in overall mathematics achievement.

Black students at ages 9 and 13 performed closer to the national level in the 1978 assessment than they did in 1973. While black 9-year-olds were, on the average, 15 percentage points below the national level of performance in 1973, current results show them to be 10 percentage points below the nation. Blacks at age 13, whose performance averaged 21 percentage points below the national level in 1973, in 1978 narrowed the gap to 18 percentage points below the nation. In each assessment, blacks at age 17 performed, on the average, about 17 percentage points below the national level.

At ages 9 and 13, the differences between performance of students living in economically depressed urban areas and the nation also became smaller between the two mathematics assessments. Nine-year-olds living in such communities performed 13 percentage points below the nation in 1973, but only 9 points below it in 1978. Performance of 13-year-olds living in such areas averaged 18 percentage points below the nation in 1973 and 14 percentage points below it in 1978. Performance of 17-year-olds living in economically depressed urban areas averaged about 12 percentage points below the national level in each assessment.

When the results of the mathematics assessments are considered with the previously reported changes occurring in the areas of reading, writing, science, and social studies-citizenship, the following observations can be made:

1. The changes occurring in the educational achievement of the nation's youth are complex. It is not a simple, overall decline as some critics of American education have claimed. For example, in the area of science, the declines appear to have tapered off at ages 9 and 13. Indeed, when one looks at science in terms of biological and physical sciences, one finds that 9- and 13-year-olds made gains in the biological area which are offset by declines in the physical sciences. While the performance of 17-year-olds has continued to decline in science, the declines between 1977 and 1973 are smaller than those found between 1969 and 1973. With the exception of mathematical problem-solving, 9-year-olds are either improving or remaining constant in

their performance in writing, reading, and mathematics. In the area of reading, 17-year-olds have shown improvement when dealing with the most basic of reading tasks. When considering all aspects of reading, the performance of 13- and 17-year-olds showed little or no difference between 1970 and 1975; however, downward trends were found for both teenage groups when looking at inferential comprehension and reference skills. All three age groups showed declines in performance in the areas of social studies and citizenship.

2. The discrepancy between the performance of certain groups of students and the national average still remains a critical problem. However, the assessment data does provide some encouragement here. At age 17, students from disadvantaged urban areas showed approximately a 5 percentage point increase and those whose parents had no high school education showed a 4 percentage point increase in the most basic of reading skills. At age 9, students from disadvantaged urban areas showed an increase over twice that found for all 9-year-olds. When one adds the mathematics results to this, it would appear that there is a positive effect from the combined efforts to improve educational benefits for the economically disadvantaged.

3. The major problem which appears to be developing is not a lack of the most basic skills, such as writing mechanics, mathematical knowledge and whole number computation, reading for literal comprehension, but rather an inability to apply these skills. The data indicate that students can handle the mechanics of writing, whole number computation and mathematical facts and definitions, and the literal reading tasks. Declines appear in the higher order cognitive skills—inferring from what is read, overall quality of writing, and mathematical problem-solving—and this is the level to which we must address our concerns.

Chairman PERKINS. All right, our next witness is Dr. Esty.

Let me say this hearing is so interesting that I would like to be able to hear every witness, every word, but we have a caucus over on the House floor at 10 o'clock, the Democratic Caucus, so Mr. Erdahl will be in charge.

[Discussion off the record.]

## STATMENT OF DR. EDWARD T. ESTY, SENIOR RESEARCH ASSOCIATE, TEACHING AND LEARNING PROGRAM, NATIONAL INSTITUTE OF EDUCATION

Dr. ESTY. Thank you, Mr. Chairman.

My name is Edward Esty, and I am a senior associate with the teaching and learning program of the National Institute of Education (NIE), where I am leader of the mathematics studies team.

As you know, NIE is the principal Federal agency concerned with supporting research and development in education, and in the 1978 education amendments lodged responsibility for supporting the National Assessment of Educational Progress in NIE.

I am accompanied by Jeffry Schiller, who is Assistant Director for the NIE program on testing, assessment, and evaluation.

I would first like to summarize briefly a few of the highlights of the latest NAEP mathematics results: One, most children can do simple whole number computations accurately; two, there are weaknesses in more diffcult computations, with fractions, decimals, and percents; three, children have more difficulty in applying computational skills than they do with the skills themselves; and four, there are weaknesses in higher level skills.

As you know, the first mathematic assessment was done in 1973. Mr. Chairman, you have summarized the slight overall drop in the mathematics score that we have seen in those 5 years.

As Dr. Frobes mentioned, it is encouraging that we are closing some of the gaps. The scores of blacks, especially of black 9-year-olds, have improved. In 1973, black 9-year-olds scored 15 percent below the national average, while in 1978 they were 10 percent below. Black 13-year-olds went to 13 percent from 18 percent below. Black 17-year-olds were 17 percent below in both assessments.

There have been improvements in areas for all populations. For example, dramatic gains were shown in knowlege of the merit system measurement.

While it is certainly proper to be concerned about the slight overall drops in performance, I am more concerned about the tremendous disparities among groups. For example, while blacks have made improvements over the past 5 years, still they perform significantly below the national average at all age levels.

Another way of separating the population into groups is by NAEP's type of community—advantaged urban, extreme rural, and disadvantaged urban. At all three age levels, children from advantaged urban areas score better than those from either of the other two groups. But while the relative performance of the extreme rural group improves with age, the relative performance of the disadvantaged urban group actually declines with age.

Another area in which differences in blacks and whites appear is in taking courses. NAEP gathered data on what courses the 17-year-olds had taken in high school. Seventy-five percent of the white students had taken algebra I, while only 55 percent of the black students had. Similar differences are apparent in geometry and algebra II.

I think that the most startling indication of the differences among groups is that white 13-year-olds scored better than black and Hispanic 17-year-olds. The same differences occur among types of communities—13-year-olds from advantaged urban areas scored better than 17-year-olds from disadvantaged urban areas.

It is very difficult to pinpoint the causes behind the overall drops in performance in mathematics over the past 5 years. As Dr. Forbes indicated, there might be all kinds of social factors that might be contributing—possibly TV viewing time to increases in the numbers of single-parent families. As far as mathematics itself is concerned, the biggest change has been the back-to-basics movement, in concert with the increased use of minimal competency tests.

In particular, we see the following trends: There is now much more emphasis on computational algorithms, that is, rote procedures for finding answers to computational exercises, and on other mechanical procedures. For example, different kinds of percentage problems.

Word problems are now streamlined to lower reading demands. Texts are organized so that word problems at ends of chapters use whatever skill was just taught in the body of the chapter, so students do not have to think through the problem to see what must be done. These trends are encouraged not only by the back-to-basics movement, but also by the content of some minimal competency tests.

Furthermore, higher level skills, like estimation, are not sufficiently stressed. Often students are not allowed to go on to higher-level problems until earlier skills are mastered. This limits exposure to a wide range of mathematical situations that they might otherwise encounter.

I want to mention a related issue, even though it may have little to do with the declines. There has been no concentrated effort to improve the quality of mathematics teaching during the last 5 years. Indeed, many elementary teachers have taken no mathematics beyond what they had in high school.

In general, it appears that what is being taught is what is being learned. We see this in the satisfactory performance on the lower level skills, the great improvement in knowledge of the metric system, and unfortunately, in the drop in performance on the higher level problem solving skills.

My own personal view is that the back-to-basics movement has carried with it some attendant costs. People's attention has been directed toward the lowest level skills, often in connection with paper and pencil computation. This is not what we need today. We need expanded notions of basic skills, much as the National Council of Supervisors of Mathematics has proposed in their position paper on basic mathematical skills.

I didn't realize that Shirley Hill was going to be here today. She is the president of the National Council of Teachers of Mathematics. But I want to quote from something that she said very recently about the assessment results:

> The inescapable conclusion to be derived from the results of the second national assessment of mathematics is that there is a critical need for attention to higher order cognitive skills. Reasoning, analyzing, estimating, selecting appropriate information, and inferring, these are basic skills that are essential to the effective application of mathematics.

I have attached copies of the statements from the National Council of Supervisors of Mathematics and the president of the National Council of Teachers of Mathematics to my statement, and hope that they will be included in the hearing record.

[The information referred to above follows:]

# NATIONAL COUNCIL OF SUPERVISORS OF MATHEMATICS POSITION PAPER ON BASIC MATHEMATICAL SKILLS

## INTRODUCTION

The currently popular slogan "Back to the Basics" has become a rallying cry of many who perceive a need for certain changes in education. The result is a trend that has gained considerable momentum and has initiated demands for programs and evaluations which emphasize narrowly defined skills.

Mathematics educators find themselves under considerable pressure from boards of education, legislatures, and citizens' groups who are demanding instructional programs which will guarantee acquisition of computational skills. Leaders in mathematics education have expressed a need for clarifying what are the basic skills needed by students who hope to participate successfully in adult society.

The narrow definition of basic skills which equates mathematical competence with computational ability has evolved as a result of several forces:

1. Declining scores on standardized achievement tests and college entrance examinations.
2. Reactions to the results of the National Assessment of Educational Progress.
3. Rising costs of education and increasing demands for accountability.
4. Shifting emphasis in mathematics education from curriculum content to instructional methods and alternatives.
5. Increased awareness of the need to provide remedial and compensatory programs.
6. The widespread publicity given to each of the above by the media.

This widespread publicity, in particular, has generated a call for action from governmental agencies, educational organizations, and community groups. In responding to these calls, the National Institute of Education adopted the area of basic skills as a major priority. This resulted in a Conference on Basic Mathematical Skills and Learning held in Euclid, Ohio, in October, 1975.

The National Council of Supervisors of Mathematics (NCSM), during the 1976 Annual Meeting in Atlanta, Georgia, met in a special session to discuss the Euclid Conference Report. More than 100 members participating in that session expressed the need for a unified position on basic mathematical skills which would enable them to provide more effective leadership within their respective school systems, to give adequate rationale and direction in their tasks of implementing basic mathematics programs, and to appropriately expand the definition of basic skills. Hence, by an overwhelming majority, they mandated the NCSM to establish a task force to formulate a position on basic mathematical skills. This statement is the result of that effort.

## RATIONALE FOR THE EXPANDED DEFINITION

There are many reasons why basic skills must include more than computation. The present technological society requires daily use of such skills as estimating, problem solving, interpreting data, organizing data, measuring, predicting, and applying mathematics to everyday situations. The changing needs of society, the explosion of the amount of quantitative data, and the availability of computers and calculators demand a redefining of the priorities for basic mathematics skills. In recognition of the inadequacy of computation alone, NCSM is going on record as providing both a general list of basic mathematical skills and a clarification of the need for such an expanded definition of basic skills.

Any list of basic skills must include computation. However, the role of computational skills in mathematics must be seen in the light of the contributions they make to one's ability to use mathematics in everyday living. In isolation, computational skills contribute little to one's ability to participate in mainstream society. Combined effectively with the other skill areas, they provide the learner with the basic mathematical ability needed by adults.

## DEFINING BASIC SKILLS

The NCSM views basic mathematical skills as falling under ten vital areas. The ten skill areas are interrelated and many overlap with each other and with other disciplines. All are basic to pupils' development of the ability to reason effectively in varied situations.

This expanded list is presented with the conviction that mathematics education must not emphasize computational skills to the neglect of other critical areas of mathematics. The ten components of basic mathematical skills are listed below, but the order of their listing should not be interpreted as indicating either a priority of importance or a sequence for teaching and learning.

Furthermore, as society changes, our ideas about which skills are basic also change. For example, today our students should learn to measure in both the customary and metric systems, but in the future the significance of the customary system will be mostly historical. There will also be increasing emphasis on when and how to use hand-held calculators and other electronic devices in mathematics.

## TEN BASIC SKILL AREAS

### Problem Solving

Learning to solve problems is the principal reason for studying mathematics. Problem solving is the process of applying previously acquired knowledge to new and unfamiliar situations. Solving word problems in texts is one form of problem solving, but students also should be faced with non-textbook problems. Problem-solving strategies involve posing questions, analyzing situations, translating results, illustrating results, drawing diagrams, and using trial and error. In solving problems, students need to be able to apply the rules of logic necessary to arrive at valid conclusions. They must be able to determine which facts are relevant. They should be unfearful of arriving at tentative conclusions and they must be willing to subject these conclusions to scrutiny.

### Applying Mathematics to Everyday Situations

The use of mathematics is interrelated with all computation activities. Students should be encouraged to take everyday situations, translate them into mathematical expressions, solve the mathematics, and interpret the results in light of the initial situation.

### Alertness to the Reasonableness of Results

Due to arithmetic errors or other mistakes, results of mathematical work are sometimes wrong. Students should learn to inspect all results and to check for reasonableness in terms of the original problem. With the increase in the use of calculating devices in society, this skill is essential.

### Estimation and Approximation

Students should be able to carry out rapid approximate calculations by first rounding off numbers. They should acquire some simple techniques for estimating quantity, length, distance, weight, etc. It is also necessary to decide when a particular result is precise enough for the purpose at hand.

### Appropriate Computational Skills

Students should gain facility with addition, subtraction, multiplication, and division with whole numbers and decimals. Today it must be recognized that long, complicated computations will usually be done with a calculator. Knowledge of single-digit number facts is essential and mental arithmetic is a valuable skill. Moreover, there are everyday situations which demand recognition of, and simple computation with, common fractions.

Because consumers continually deal with many situations that involve percentage, the ability to recognize and use percents should be developed and maintained.

### Geometry

Students should learn the geometric concepts they will need to function effectively in the 3-dimensional world. They should have knowledge of concepts such as point, line, plane, parallel, and perpendicular. They should know basic properties of simple geometric figures, particularly those properties which relate to measurement and problem-solving skills. They also must be able to recognize similarities and differences among objects.

### Measurement

As a minimum skill, students should be able to measure distance, weight, time, capacity, and temperature. Measurement of angles and calculations of simple areas and volumes are also essential. Students should be able to perform measurement in both metric and customary systems using the appropriate tools.

### Reading, Interpreting, and Constructing Tables, Charts, and Graphs

Students should know how to read and draw conclusions from simple tables, maps, charts, and graphs. They should be able to condense numerical information into more manageable or meaningful terms by setting up simple tables, charts, and graphs.

### Using Mathematics to Predict

Students should learn how elementary notions of probability are used to determine the likelihood of future events. They should learn to identify situations where immediate past experience does not affect the likelihood of future events. They should become familiar with how mathematics is used to help make predictions such as election forecasts.

### Computer Literacy

It is important for all citizens to understand what computers can and cannot do. Students should be aware of the many uses of computers in society, such as their use in teaching/learning, financial transactions, and information storage and retrieval. The "mystique" surrounding computers is disturbing and can put persons with no understanding of computers at a disadvantage. The increasing use of computers by government, industry, and business demands an awareness of computer uses and limitations.

## BASIC SKILLS AND THE STUDENT'S FUTURE

Anyone adopting a definition of basic skills should consider the "door opening, door closing" implications of the list. The following diagram illustrates expected outcomes associated with various amounts of skill development.

**Scope of Skill Development** | **Expected Outcomes**

**EXPANDED SKILLS**
Mathematical skills beyond those described here plus a desire to learn more

→ **POTENTIAL LEADERS**
Employment and educational opportunities will continue to increase as mathematical skills continue to grow

**BASIC SKILLS**
The skills described here

→ **EMPLOYMENT VERY LIKELY**
Employment opportunities are predictable. Doors to further education opportunities are open

**MINIMAL SKILLS**
Limited skills, primarily computation. Little exposure to the other skill areas described here

→ **LIMITED OPPORTUNITIES**
Unemployment likely. Potential generally limited to low level jobs

## MINIMUM ESSENTIALS FOR HIGH SCHOOL GRADUATION

Today some school boards and state legislatures are starting to mandate mastery of minimum essential skills in reading and mathematics as a requirement for high school graduation. In the process they should consider the potential pitfalls of doing this without an appropriate definition of basic skills. If the mathematics requirements are set inordinately high, then a significant number of students may not be able to graduate. On the other hand, if the mathematics requirements are set too low and mathematical skills are too narrowly defined, the result could be a sterile mathematics program concentrating exclusively on learning of low level mathematical skills. This position paper neither recommends nor condemns minimal competencies for high school graduation. However, the ten components of basic skills stated here can serve as guidelines for state and local school systems that are considering the establishment of minimum essential graduation requirements.

## DEVELOPING THE BASIC SKILLS

One individual difference among students is style or way of learning. In offering opportunities to learn the basic skills, options must be provided to meet these varying learning styles. The present "back to basics" movement may lead to an emphasis on drill and practice as a way to learn.

Certainly drill and practice is a viable option, but it is only one of many possible ways to bring about learning and to create interest and motivation in students. Learning centers, contracts, tutorial sessions, individual and small group projects, games, simulations and community based activities are some of the other options that can provide the opportunity to learn basic skills. Furthermore, to help students fully understand basic mathematical concepts, teachers should utilize the full range of activities and materials available, including objects the students can actually handle.

The learning of basic mathematical skills is a continuing process which extends through all of the years a student is in school. In particular, a tendency to emphasize computation while neglecting the other nine skill areas at the elementary level must be avoided.

## EVALUATING AND REPORTING STUDENT PROGRESS

Any systematic attempt to develop basic skills must necessarily be concerned with evaluating and reporting pupil progress.

In evaluation, test results are used to judge the effectiveness of the instructional process and to make needed adjustments in the curriculum and instruction for the individual student. In general, both educators and the public have accepted and emphasized an overuse of and overconfidence in the results of standardized tests. Standardized tests yield comparisons between students and can provide a rank ordering of individuals, schools or districts. However, standardized tests have several limitations including the following:

a. Items are not necessarily generated to measure a specific objective or instructional aim.
b. The tests measure only a sample of the content that makes up a program; certain outcomes are not measured at all.

Because they do not supply sufficient information about how much mathematics a student knows, standardized tests are not the best instruments available for reporting individual pupil growth. Other alternatives such as criterion tests or competency tests must be considered. In criterion tests, items are generated which measure the specific objectives of the program and which establish the student's level of mastery of those objectives. Competency tests are designed to determine if the individual has mastered the skills necessary for a certain purpose such as entry into the job market. There is also need for open-ended assessments such as observations, interviews and manipulative tasks to assess skills which paper and pencil tests do not measure adequately.

Reports of pupil progress will surely be made. But, while standardized tests will probably continue to dominate the testing scene for several years, there is an urgent need to begin reporting pupil progress in other terms such as criterion tests and competency



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measures. This will also demand an immediate and extensive program of inservice education to instruct the general public on the meaning and interpretation of such data and to enable teachers to use testing as a vital part of the instructional process.

Large scale testing, whether involving all students or a random sample, can result in misinterpretations which have great influence on curriculum revision and development. Test results can indicate, for example, that a particular mathematical topic is being taught at the wrong time in the student's development and that it might better be introduced later or earlier in the curriculum. Or the results might indicate that students are confused about some topic as a result of inappropriate teaching procedures. In any case, test results should be carefully examined by educators with special skills in the area of curriculum development.

## CONCLUSION

The present paper represents a preliminary attempt by the National Council of Supervisors of Mathematics to clarify and communicate its position on basic mathematical skills. The NCSM position establishes a framework within which decisions on program planning and implementation can be made. It also sets forth the underlying rationale for identifying and developing basic skills and for evaluating pupils' acquisition of these competencies. The NCSM position underscores the fundamental belief of the National Council of Supervisors of Mathematics that any effective program of basic mathematical skills must be directed not "back" but *forward* to the essential needs of adults in the present and future.

**You are encouraged to make and distribute copies of this paper.**

The NCSM position paper was prepared pursuant to a contract with the National Institute of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official National Institute of Education position or policy.

January 1977

NATIONAL COUNCIL OF SUPERVISORS OF MATHEMATICS
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PREPARED STATEMENT BY SHIRLEY A. HILL, PRESIDENT, NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

The results of the second national assessment of mathematics reinforce the warnings that professional organizations concerned with mathematics education have been stressing in recent years. An excessive narrowing of the mathematics curricula—in the name of "Back to the Basics"—to the mechanistic learning of computational skills is detrimental to the development of problem solving.

While students displayed a fairly high level of skill in whole number computation in the assessment, their abilities to apply these skills to the solution of realistic problems were significantly lower. It is obvious that there is little benefit to be gained by concentrating extraordinary efforts on computing skills and minimal competencies if our graduates cannot effectively apply mathematics in the real world. The assessment results present convincing evidence that we cannot simply assume that if students perform well on tests of lower-order skills, then they can consequently use those skills in solving real-life problems. And surely, the latter is our primary objective.

Throughout the NAEP reports, there is evidence that students proceed mechanically and thoughtlessly through problems, seeking a familiar routine or a rigid rule to apply. In many instances, a careless reading of what is called for is apparent; in others, one finds a common failure to note that some answers are not realistic or even reasonable. Students often appear to lack a basic sense of quantitative relationships. While a reliance on drill and rote memorization of rules will produce a good showing on tests of short-term retention, this reliance also creates a mind set that is antithetical to insight into the essence of a problem.

The inescapable conclusion to be derived from the results of the second national assessment of mathematics is that there is a critical need for attention to higher-order cognitive skills. Reasoning, analyzing, estimating, selecting appropriate information and inferring—these are basic skills that are essential to the effective application of mathematics.

The NAEP mathematics report should be invaluable to teachers, mathematics educators, curriculum developers, and school policy makers in identifying areas where increased efforts are needed. Foremost among these areas are decimals, fractions and percents. All are increasingly important to the development of knowledgeable consumers. As the calculator becomes an indispensable tool, the understanding and use of decimals assumes a more prominent place in problem solving. Furthermore, the disappointing assessment results on algebraic items suggest the need to reexamine instructional methods, content and the placement of algebra courses in the curriculum for some students.

Responsible readers of the NAEP reports will recognize that simplistic judgments about the overall mathematics success or failure of students, schools, teachers or society cannot be made from such assessments. Nor was the assessment program designed to elicit such judgments. It is the identification of strengths and weaknesses that will provide guidance to mathematics teaching—not condemnation or praise.

But the challenge of the assessment results goes beyond the education community. During much of this decade, public demand and pressure—and often, resulting legislation—have placed predominant attention on minimal skills. Tests have been developed to measure the "accountability" of the education community to this mandate. Consequently, mathematics textbooks and tests consisting of computation and routine word problems have flooded the market.

Many schools and teachers have responded to public pressure by focusing mainly upon the materials to be tested or on areas most easily and quickly affected by concentrated classroom effort. Less classroom time has been devoted to the processes of problem solving than to routine processes. Indeed, the pathetic new definition of the "3-R's" is "rote, routine responses."

Public opinion should influence educational choice. But the clear message of the NAEP mathematics reports is a challenge to the public at large. The public must reexamine its present priorities and weigh the results of a mechanistic rote-skill curriculum against the need—now and in the future—or problem solvers with the flexibility to apply their knowledge in unexpected as well as routine ways.

Dr. ESTY. What is NIE doing? The National Institute of Education has two major overall goals, namely the enhancement of educational equity and the improvement of practice. We pursue these goals in mathematics through both research and development activities.

Let me give some examples of the sorts of things that we are doing. For example, one group of research grants is for projects that examine how members of various minority groups fare with mathematics, both at the school level and also in adulthood.

NIE also supports the United States participation in the Second International Study on Mathematics. The National Science Foundation is involved in this, too. Fortunately, two of the levels involved in the international study are the same as the NAEP populations: 13- and 17-year-olds. For the first time, we hope to be able to get longitudinal data on teaching techniques that are most effective in promoting mathematics learning at those critical ages.

Another project that is directly related to the NAEP findings is the Comprehensive School Mathematics Program at the CEMREL laboratory in St. Louis. CSMP is a program for children of all ability levels in kindergarten through the sixth grade. It puts most of its emphasis on the kinds of thinking and analytic skills that I have just mentioned.

The program is being extensively field tested with considerable success. Children who are in the program perform on standardized computation tests just as well as those who are not in the program, but they do significantly better on tests of higher level skills. Most encouraging is the fact that children from inner-city sections of Philadelphia and Detroit are doing very well with it.

The last major project that I want to mention is one that is just beginning. NIE is collaborating with the National Science Foundation in a program that is designed to discover the most effective uses of the new microprocessor technology in mathematics education. Clearly many of the rote skills that we have been emphasizing so much recently will be of limited value in the future, when calculators and computers will be even more in evidence than they are now. It is our belief that the new NSF-NIE joint effort has great promise for improving mathematics education for all of our children.

Thank you.

Mr. ERDAHL [now presiding]. Thank you very much, Dr. Esty.

The next person on our list here is Ms. Kathy Schaub.

## STATEMENT OF KATHY SCHAUB, ASSISTANT DIRECTOR FOR PROGRAM DEVELOPMENT, ASSOCIATION FOR SUPERVISION AND CURRICULUM DEVELOPMENT

Ms. SCHAUB. Thank you, Mr. Chairman.

Mr. Chairman, members of the subcommittee, thank you for this opportunity to speak on behalf of the Association for Supervision and Curriculum Development. I am Kathy Schaub and I am assistant director for program development and research. We are a professional association of more than 35,000 educators, mostly supervisors and administrators in elementary and secondary school systems throughout the country, and as such we are deeply concerned with this unwelcome news from the National Assessment report on mathematics.

The finding that the mathematical problem solving ability of American secondary school students has dropped over the past 5 years is no less than dismaying. In a time of increasing technical sophistication it is more important than ever that the students in our care are not only able to cope with everyday demands of ordinary computation, but are also prepared for the challenges to come in their future schooling and occupations.

We cannot be sure what all the causes of this decline may be, but the NAEP findings are consistent with a number of other studies which draw similar, if not identical, conclusions.

It is important to note, we believe, that the high school students who were tested in this assessment received their elementary school training in mathematics during the late sixties and late seventies, a time of substantial curriculum reform in American schools. Projects supported by the National Science Foundation and other agencies brought together university scholars and classroom teachers to prepare new programs that were tested, refined, and instituted on a wide scale.

In general, great emphasis was placed on what we term "inquiry teaching" aimed at developing student ability to think abstractly and solve problems more creatively rather than strictly by rote computation.

To determine the effects of this reform movement, the National Science Foundation sponsored a series of studies. The findings, published last year, indicated that most of the programs were no longer being widely used. Observers visiting classrooms reported little effort to individualize study and little teaching inquiry. Much instruction was aimed at getting students simply to remember the contents of textbooks. Many teachers told observers that they no longer believed—if indeed they ever had—that precious class time should be used trying to get students to investigate problems and think creatively about finding solutions. It was important, they argued, for students to learn the basic skills.

Anyone who does read the NSF reports could have predicted that students would probably not do well on tests requiring higher levels of thinking. American schools, sensitive as they are to public opinion, have responded to calls for back to the basics by emphasizing mechanistic skills more than creativity and understanding.

Many of the members of our association oppose this trend and continue to press for a broader definition of the aims of education. Certainly we are committed to the importance of basic skills and we know from recent research that direct instruction is effective for some purposes. But we also believe in balanced education—education that includes both computational skills and use of those skills in meaningful ways.

Most people would probably agree that students should understand mathematics so they can use it intelligently. Yet the movement known as the new math, which sought to make mathematics more understandable, failed to reach many classrooms and has largely disappeared from the rest. Some aspects of the new math may have been ill advised, but the current retreat to drill on computation is surely not the solution.

One of the main reasons for failure of the new math and teaching for inquiry was that teachers and administrators did not receive adequate training to use the new programs. The same may be said for other current Federal efforts in education. One new emphasis after another is announced in Washington, but with no solution for the basic problem, where will teachers and principals find the time to learn new approaches, or the resources to implement them?

Another national study provides some clues as to what should be done. A survey by the Rand Corp. showed that many special projects operated with Federal funds did not bring lasting changes in the school districts where they were attempted. Rand investigators recommended a different strategy for Federal efforts to improve education. Rather than sponsoring a host of categorical programs, each with its own assumptions and regulations, the Federal Government should strive to build the capacity of local school districts to manage the process of comprehensive change. In short, more Federal funds would be directed toward providing training for teachers and administrators.

The Association for Supervision and Curriculum Development supports these recommendations. Categorical funding of innumerable special emphases has contributed to fragmentation and demoralization of American education. The best way to improve education is to improve the capabilities of individual educators and the schools in which they work.

Existing services designed to help local school districts should be continued and made more accessible. For example, the National Diffusion Network's collection of education "programs that work" includes a number of nationally validated mathematics programs that have already demonstrated success in teaching problem solving skills. Before teachers can use such programs effectively, they need thorough training.

But first, they have to be aware that such programs exist. Dissemination networks have been established to provide information to educators on many specialized topics, but they are not well organized or coordinated. One of the first priorities of the new Department of Education should be to consolidate these information services.

A common concern of the consultants who reviewed the National Assessment findings was that mathematics textbooks do not provide enough practice in problem solving. We would encourage the National Institute of Education to analyze the most widely used texts to find out if that is true. In doing so, let us keep in mind that the development of text material is not a one-way street.

Publishers print what will sell, and what schools are buying these days are the basics. In other words, the quality of materials is partly dependent on the attitudes and professional skills of those who will use them.

That brings us again to consideration of what the Federal Government can do to strengthen American education. I believe the most fruitful strategies are those which make information readily available, which improve the capability of local school districts to manage the change process, and which provide for continuing professional training for teachers and other educators. Thank you.

Mr. ERDAHL. Thank you very much, Ms. Schaub, for presenting Dr. Ebersole's testimony to us this morning. Next, we will hear at this time from Dr. Shirley Hill.

## STATEMENT OF DR. SHIRLEY HILL, PRESIDENT, NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

Dr. HILL. Thank you, Mr. Chairman.

I would like to thank the subcommittee for the opportunity to appear here on behalf of my organization, the National Council of Teachers of Mathematics.

I would like to say that we in that organization in mathematical education, professionally, did welcome the NAEP publication of results, not because we were pleased with those results, but because we think it is extremely important that periodically we have benchmarks of this kind that tell us where we are, what our strengths and weaknesses are.

I was rather disappointed, in fact, with the media coverage of those results, because of the preoccupation with decline only, and I think the major message of those results was not in evidence in most of the media coverage.

These are the kinds of things that we in our profession have been trying to warn against, frankly, for sometime.

Looking at change, whether it is decline or increase, has to be analyzed very carefully I think. First of all, the items that measure change in this test constituted only a small part of the total, and it is easy for averages to be misunderstood unduly by atypical results.

But more importantly, secondly, using increases in test scores as a sole criterion for a success fails to take into account the fact that the needs of society change over time.

To us, the important message of the results of the NAEP assessment were the clear indication of a pattern of strengths and weaknesses and a clear reflection of where emphasis is currently placed in the instructional program. As you heard, the results were generally good in the computational skill area which for many people is the "third R", but the results involving the application of those skills to problems, whether routine or nonroutine, were dismal.

Evidence of higher order of ability, such as reasoning, inferring or in simple estimation skills was notable for its absence. Surely it is clear that expertise in skills such as computation is of no value unless the student can apply those skills and the knowledge learned to the solution of real problems.

I will say the results of the second assessment came as no particular surprise to those of us in the professional organization, in mathematics education. As early as 1974 and 1975 there was an NSF funded study by a National Advisory Committee on Mathematics Education that at that time noted several years of a very narrow emphasis in the schools on computation, symbol manipulation and mechanistic learning. That report warned of the danger of informing problem-solving ability and the ability to apply skills.

It also warned that excessive attention to minimal competency could result in those minimums becoming ceilings of performance, and I think there is considerable evidence today that that is indeed what has happened.

This limited focus that has been described by several people in testimony has been building over the entire decade. Dr. Esty mentioned the National Council of Supervisors of Mathematics position paper on basic skills. That is an affiliate of my organization. And in 1977, under contract with the NIE it published its position paper, which has been adopted by the National Council of Teachers of Mathematics.

It urged a broadening of the definition of basic mathematical skills to such things as problem solving, applying mathematics, estimation, computer literacy, and several others.

I do believe that such suggestions which came prior to the publication of the NAEP results have fallen largely on deaf ears. The reasons are undoubtedly complex but one of them, I believe, is the present inordinate influence on the curriculum of tests of minimal competency.

I hasten to add that neither I nor my professional organization oppose tests, but we consider them only one component of evaluation, and even the best of them are restricted in what they can measure or predict.

Article after article in our media today demonstrates that the sole public criterion for school success has become rising test scores, and I do not think this has been accompanied by a careful examination of whether we are testing those things that we think should be taught.

A goal of high test scores only makes sense if the tests measure the abilities that we are confident will be needed in the future, and I wonder how many who are pressing for higher test scores know the contents of those tests.

The NAEP data is terribly important to us because it does go beyond the kind of things that might be taught in the simplified version of mineral tests and present textbooks, and I say thank goodness and the Government for that assessment of NAEP.

I believe that we come to a situation where what is happening in the schools is that the thing that is most easily taught and most easily tested is dictating the major objectives, and this is turning the educational world on its head, because ideally, we should select our goals, then try to achieve them, then try to measure them, and then try to test our success. But I believe the means to the end have become the end in themselves.

It would be bad enough if we would simply conclude that this devotion of excessive instructional time to mechanistic skills is just not leaving enough time for those experiences that develop ability to apply those skills, but I think more devastating is the likelihood that the very methods we used that have the greatest payoff in short term testing, that is, repeated drill, extensive drill on routine techniques, mechanistic learning of formulas; are in fact counterproductive. They are counterproductive to developing flexibility and adaptability, and these are the things that characterize a good problem solver.

One of those is being familiar with the idea of mindset that an overly routinized drill engenders.

I believe that it is true that the NAEP results can be seen as a reflection of a response of the schools to perceived public mandate. Certainly many people—and this includes many of the public's representatives—interpret public opinion as calling for a return to the old 3 R's, and that translates into math, to computation, and a few routine word problems. Evidently the schools are doing well in this limited domain, but it is not enough, and I think that message is the one that needs to go to the public.

I have been asked to respond to what our organization is doing about this situation. I am pleased to be able to do so, because we have been putting considerable effort for many years into encouraging a broad comprehensive curriculum, and I can provide lots of evidence for that in programs of our meetings and conferences, replete with ideas for teachers on problem solving applications.

Many of our publications have had special issues on problem solving, minimal competency, the testing issue, calculating organization. Our 1978 yearbook was on the proper place of computational skill. Our 1979 yearbook was on applications and our 1980 yearbook will be on problem solving.

Let me mention two ways in which the NAEP data are particularly important to us: We have been funded by NSF to provide a series of interpretive reports of the data to disseminate the information widely, to audiences not only of teachers, teacher educators and researchers, but to the general public as well.

Moreover, in my view, is the use that we are making of the NAEP data, along with a good deal of other data, in the development of an extensive set of recommendations for the mathematics program of the 1980's. We are putting considerable resources into this effort and this is probably a unique effort historically in that we have never had such an extensive data base on which to base professional recommendations.

There have been a series of status studies in recent years on what is happening in the classrooms. We have a good deal of assessment data, particularly the NAEP data. Thus, these recommendations can be based on reality.

But in addition, the National Council of Teachers of Mathematics has a project funded by NSF on surveying many sectors of society on what they believe should be happening in mathematics education, and our policy recommendations will be built on that very extensive data base and released in April 1980.

This position is predicated on a couple of ideals, one of which is that everyone would have input into what happens in education, but that position is predicated on an assumption of a well informed public, and we believe our obligation is to help form public opinion about these recommendations.

I will say to you this is not easily done and I feel strongly that one of the important roles of Government is to help in facilitation of that process, to be able to get such responsible recommendations to the public where responsible decisions can be made.

I was asked also to respond to what Government might do. I would like to summarize very briefly some of the things I listed. At the Federal level I hope that we will have help in what could be perhaps an important national conference involving representatives of all major sectors of society to study critically and implement recommendations such as those I have described we will be publishing in the eighties. Certainly we have the funding structure in place to fund serious research efforts to an analysis of problem solving abilities and to a determination of the ways these abilities are best learned and taught.

I agree that we should have considerable effort in funding within service institutes for teachers and new imaginative teacher education programs to prepare teachers competency to develop problem solving abilities.

At State and local levels I think it would be appropriate at this point to have task forces made up of parents, teachers and officials, to examine the effects of mandated testing on the mathematics program. I think there should be a mathematics specialist in every State department of education and every school district.

I think districts should be encouraged to support professional leave days for teachers to attend professional meetings and seminars. They are the least expensive and most valuable form of in-service education.

I think local districts should develop teacher support systems to work with those persons now teaching mathematics without complete qualifications, and I should mention that there is a current shortage of mathematics teachers that is growing steadily worse and that many people are teaching mathematics in the secondary schools without the requisite preparation. I think society and its representatives should find ways to attract candidates into mathematics teaching and retain the current supply.

In addition to an increase in people entering mathematics teaching, there is a drain on the mathematically competent into higher paying fields.

Finally, I think we need to develop good home school cooperative programs in using the developing technological schools to teach mathematical problem solving.

In my organization, we are prepared to throw our resources and energies into such a massive cooperative effort and we believe we need the help and the facilitating effect of Government agencies to achieve a balanced sensible mathematics program. If each teacher in the country were to agree with the position I have taken, that alone would not be sufficient to change school mathematics.

Thank you, Mr. Chairman.

[Prepared statement of Dr. Shirley Hill follows:]

### PREPARED STATEMENT OF DR. SHIRLEY HILL, PRESIDENT, NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

In general, the media coverage of the results of the second mathematics assessment of the National Assessment of Educational Progress (NAEP) missed the most important message of the reported results. In their preoccupation with decline, many reporters failed to emphasize the most interesting, useful and solid data—the evidence of areas of strengths and weaknesses at the present time.

Evidence of change, whether of decline or increase, must be analyzed carefully if it is to be of any value other than to create dramatic headlines. In the case of the second NAEP assessment, this is particularly true for two reasons. First, the items that measure change over time (repeated items from the previous assessment) constituted a very small proportion of the total items and thus the results were subject to skewed averages caused by a large change in performance in just one or two items. Second, using increases in test scores as the sole criterion for success fails to take into account the fact that needs change over time. Some skills become obsolete and emphasis in the curriculum must change as the needs of society and individuals change.

Tests and textbooks rarely anticipate such change. But in an enterprise like education we must be concerned not with present essentials or basics but with those abilities needed a decade or two hence.

What, then, is the message that is important to us in mathematics education and to the public and its representatives? It is the very clear reflection of where emphasis is being placed in the instructional program. The results were generally good in the computational skill area (the third R to many who speak of "Back-to-Basics"). But the results in items involving the application of skills to problems, routine or non-routine, were dismal. Evidence of higher-order abilities such as reasoning, analyzing, inferring, or even of simple estimation skill, was notable for its absence.

One need not be an expert in mathematics nor does one need a crystal ball to see that this situation is unacceptable for preparation of our future citizens. Expertise in skills as computation is of no value unless the student can apply the skills and knowledge learned to the solution of problems.

The results of the NAEP second assessment in mathematics came as no particular surprise to those of us in professional organizations in mathematics education. The narrowing of the mathematics curriculum was noted and warned against by a National Advisory Committee on Mathematical Education in a National Science Foundation funded study in 1975. In its report, "Overview and Analysis of School Mathematics," the committee referred to several previous years of narrow emphasis on computation, symbol manipulation and rote learning and advised of the dangers of ignoring application and problem solving as important objectives. Thus it can be documented that a limited skills-oriented curriculum has been in existance throughout much of the decade.

The report also warned that the limited stress on minimal competencies might well result in the minimums becoming ceilings of performance. Evidence is accumulating that pressure for high test scores is indeed having that very result.

In 1977, the National Council of Supervisors of Mathematics, aided by a contract with the National Institute of Education, published a position paper urging a broadened definition of what is basic in mathematics. At the top of the list are the basic abilities of Problem Solving and Applying Mathematics to Everyday Situations. This position was adopted by the parent organization, the National Council of Teachers of Mathematics as its official position on Basic Mathematical Skills.

But such suggestions from professional groups have too often fallen on deaf ears. The reasons are doubtless complex but one of them, I believe, is the present inordinate influence on the curriculum of tests. Neither I nor the professional organization I represent oppose tests. But we consider them as only one component of evaluation and even the best are restricted in what they can measure or predict.

The present problem goes beyond the tests' technical limitations and their appropriate use. Today, test results are being considered synonomous with school and student success or failure. Article after article demonstrates that the sole public criterion for school "success" has become rising test scores. This has not been accompanied by a careful examination of whether we are testing what we think should be taught. The goal of high test scores only makes sense if the tests measure the abilities that we are confident will be needed. How many people pressing for higher scores even know what is being tested?

What can be most easily tested and taught is dictating the objectives of many schools. This is an educational world turned on its head. Put simply, the ideal is that we would select our goals, then try to achieve them, then try to measure and test our success. Now, the means to the end have become the ends in themselves.

It is no wonder that many schools and too many teachers have settled down to a single-minded dedication to one goal—high scores on tests of minimal skills. There has been during the past few years an intense concentration on those skills most easily and quickly affected by such a focus. Short-term retention is the goal, not long-term retention and ability to apply.

One can predict that we will see considerable reporting of increases on minimal competency test scores in the next few years (already numerous newspaper stories attest to this trend), but at the same time a test of the NAEP type will likely continue to reflect poor problem solving performance. Such data will not be inconsistent. We will need to look only at what the particular tests cover and emphasize to see what is happening.

It would be bad enough if we could conclude that devoting excessive instructional time to minimal computational skill is simply not leaving enough time for the experiences that develop ability to apply mathematical skills. More devastating is the likelihood that the very methods that have the greatest payoff in short-term retention of skills (i.e. repeated, extensive drill on routine techniques and rote learning of formulas) are counterproductive to development of the flexibility and adaptability that characterize a good problem solver. We are all familiar with the "mind-set" that overly routinized drill engenders. It blinds one to alternatives or imaginative pathways.

It may be that the NAEP results should be seen as a response to a perceived public mandate. Certainly many people, including many of the public's representatives, interpret public opinion as calling for a return to the old three Rs as the basics In mathematics, that translates to computation and a few routine word problems" Evidently the schools are doing best in this limited domain

It isn't enough and that is what the NAEP message is all about That message needs to go not ony to educators but to the public It will not be useful to seek scapegoats In fact, the application of blame must be made with such a broad brush that it is useless More productive will be everyone recognizing where we are, what we have to do, and cooperating in doing it

The National Council of Teachers of Mathematics has for some time been devoting considerable resources and efforts to combating what we see as an excessive narrowing of the school mathematics program. Since long before the NAEP results were published we have been urging attention to problem solving, as evidenced in our many conference programs and publications Our 1979 Yearbook was on Applications in School Mathematics and our 1980 Yearbook will be on Problem Solving. Our 1978 Yearbook presented a balanced view on the development of and the place of computational skills in the curriculum. We maintain they do have a place.

Two other recent publications stress applications of mathematics to real life problems Our journals have had numerous articles for teachers on development of skills and the application of skills to realistic problems Special issues have focused on problem solving, a more comprehensive curriculum, and minimal competencies

We maintain a public relations program that attempts to bring our viewpoint to the attention of not only our membership but to the public.

Our specific use of the NAEP data falls into two categories. We received a National Science Foundatoin grant to prepare interpretive reports of the data. The purpose is to disseminate the information widely, within and outside our own membership Audiences will include classroom teachers, teacher educators, researchers, administrators, and the general public Types of manuscripts will include general summaries and overviews, analyses of particular subgroups' performance (e g. women or blacks), specific notes emphasizing implications for teaching, special assessment topics (e.g. attitudes or hand-held calculators), research papers, and papers bringing assessment information to bear on specific issues. These reports are in process now.

But in addition, the results are one component of an extensive data base used in the development of a set of recommendations for the mathematics program of the 1980s. It is probably unique that a major set of policy recommendations from a professional group has been generated from such a comprehensive data background.

We have more information today on what is happening in the schools than ever before: NAEP and other test results, the NSF-funded status studies of what goes on in classrooms, etc. Thus our recommendations will recognize reality. But also, the opinions of all sectors of society should be considered in determining what we ought to be doing. Toward this end, the National Council of Teachers of Mathematics, with NSF funding, has conducted a series of surveys among educators and the lay public of preferences and priorities for mathematics instruction.

With these data as background, recommendations will be made to schools, teachers and administrators, representatives of government, parents and the public. They will be released in April 1980.

This effort is predicated on the position that everone should have input into decisions about the goals of education. But such a position is also predicated upon the assumption of a well-informed public. We believe that a major obligation of professional organizations is informing public opinion in the area of our professional expertise. This is not easily done. Our efforts are so often frustrated by our inability to present information and opinion through the communications media—the only conduit to public opinion.

If this viewpoint is to be more than an ideal, the role of government is vital. Government should facilitate this process. It seems to me that there are many areas within existing structure in which governmental agencies can help.

At the Federal level:

1. Encourage sufficient breadth in the interpretation of the legislative definition of basic skills to permit essential abilities in problem solving and general quantitative literacy to be included.

2. Fund a serious research effort into: (*a*) Analysis of problem solving abilities; (*b*) determination of ways these abilities are best learned and taught.

3. Fund a development effort to provide new materials for teaching problem solving in mathematics, application of mathematical skills and computer literacy.

4. Fund inservice institutes for teachers in teaching problem solving and applications.

5. Fund new and imaginative teacher education programs to prepare mathematics teachers competent to develop problem solving and application abilities.

6. Sponsor a major national conference involving representatives of all major sectors of society to study, disseminate and implement recommendations such as those of the National Council of Teachers of Mathematics for mathematics programs of the 1980s.

7. Include mathematics specialists (the counterpart of the reading specialists) in the Basic Skills programs of the Office of Education.

At State and local levels:

1. Form Task Forces made up of parents, teachers and officials to examine the effects of mandated testing on the mathematics program.

2. Include a mathematics specialist in every state department of education and every school district.

3. Encourage districts to support professional leave days so that teachers can attend professional meetings and seminars. (They are the least expensive and most valuable form of inservice education.)

4. Develop teacher-support systems using professional organizations and district resource personnel to work with those persons teaching mathematics without complete qualifications. (The current shortage of mathematics teachers will grow worse and many people are teaching mathematics in secondary schools without requisite mathematical preparation.)

5. Find ways to attract candidates into mathematics teaching and to retain the current supply. (In addition to a decrease in people entering mathematics teacher preparation programs, there is a drain on mathematically competent personnel into higher paying fields.)

7. Maintain a minimal level of quantitative literacy for all students but also give attention to the mathematically talented.

8. Study the adequacy of high school mathematics requirements. (In the latest Gallup poll, 97 percent of those surveyed considered mathematics essential to all. Is one year of mathematics in grades 9–12 sufficient as a requirement?)

9. Develop computer literacy programs for all secondary school students.

10. Develop home-school cooperative programs in using technological tools to teach mathematical problem solving.

The membership in those professional organizations whose single goal is the improvement of learning in a subject area represents a very small proportion of the teachers of this country. Thus our activities touch directly only a small percentage of teachers of mathematics.

Even if every teacher of mathematics were to subscribe wholeheartedly to the positions the National Council of Teachers of Mathematics is taking, this alone would not be sufficient to change school mathematics. The factors, both school and non-school, that determine curriculum are too many and too complex for our group alone to control. We believe we should be leaders in this endeavor but we need the help and cooperation of everyone.

We are prepared to throw our resources and our energies into a massive cooperative effort with parents, teachers, administrators and government agencies to achieve a balanced, sensible mathematics program that has the breadth and depth to comprehend future as well as present needs. Government at all levels should facilitate and underwrite this effort.

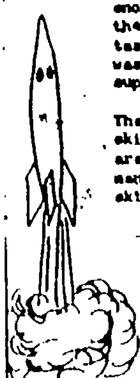
## Appendices

Appendix A.—Position Paper on Basic Skills National Council of Supervisors of Mathematics (an affiliate of the National Council of Teachers of Mathematics, NCTM).

Appendix B.—Description of NCTM leadership role.

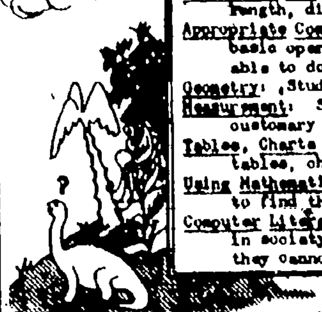
Appendix C.—Position on the Basics.

## SUMMARY OF THE NATIONAL COUNCIL OF SUPERVISORS OF MATHEMATICS POSITION PAPER ON BASIC MATHEMATICAL SKILLS



Mathematics supervisors are concerned that as a result of the "back-to-the-basics" movement, today in many schools there is too much emphasis on computation and not enough stress on other important mathematical skills. To respond to this trend, the National Council of Supervisors of Mathematics (NCSM) set up a twelve-member task force to write a position paper on basic mathematical skills. The position was first written in July, 1976, and later revised on the basis of ideas from supervisors throughout the country.

The position paper urges that we move forward, not "back" to the basics. The skills of yesterday are not the ones that today's students will need when they are adults. They will face a world of change in which they must be able to solve many different kinds of problems. The NCSM position paper lists ten important skill areas that students will need.



- Problem Solving: Students should be able to solve problems in situations which are new to them.
- Applying Mathematics to Everyday Situations: Students should be able to use mathematics to deal with situations they face daily in an ever-changing world.
- Alertness to Reasonableness of Results: Students should learn to check to see that their answers to problems are "in the ball park."
- Estimation and Approximation: Students should learn to estimate quantity, length, distance, weight, etc.
- Appropriate Computational Skills: Students should be able to use the four basic operations with whole numbers and decimals and they should be able to do computations with simple fractions and percents.
- Geometry: Students should know basic properties of simple geometric figures.
- Measurement: Students should be able to measure in both the metric and customary systems.
- Tables, Charts and Graphs: Students should be able to read and make simple tables, charts and graphs.
- Using Mathematics to Predict: Students should know how mathematics is used to find the likelihood of future events.
- Computer Literacy: Students should know about the many uses of computers in society and they should be aware of what computers can do and what they cannot do.

The role of computation is put into its proper place. Long computations will usually be done with a calculator, but computation is still important. Mental arithmetic is a valuable skill. Computational skills by themselves are of little use, but when used with other skill areas they give the learner basic mathematical ability. School systems which try to set the same requirements for all students should beware of requirements which either are too difficult or which stress only low-level skills.

Rather than using only a single method such as drill and practice for learning basic mathematical skills, many different methods should be used. Hands-on experiences with physical objects can provide a basis for learning basic mathematical skills. Standardized tests are usually not suitable for measuring individual student progress. Instead, the tests used should be made especially to measure the mathematical skills being taught.

The NCSM position paper sets forth a basis for identifying which basic mathematical skills are important and for determining if students have learned these skills.

NCTM Newsletter
Sept. 1978

# A MATTER OF IMPACT

SHIRLEY HILL
*NCTM President*

Why do you belong to NCTM? The answers to that question might be varied—and complex, perhaps sometimes deceptively simple. An organization like NCTM usually states its purposes in terms of broad professional objectives, such as the improvement of mathematics instruction. But consider here the purposes of such organizations in terms of what they should do for their members. I should like to make the case that the self-interests of teachers and the general betterment of educational processes, far from being competitive, are inextricably linked and mutually reinforcing.

In my view, the ways NCTM should serve you as teachers fall into two broad categories (I am using *teacher* as a professional designation in the way our organizational name does; you may read instead "supervisor," "researcher," "administrator," or whatever applies.) The first category is the one we most often talk about, services that help us directly in the teaching-learning process. These include our journals and other publications, meetings, and other information services. They are vital to our purposes, and we must continue to put a substantial proportion of organizational energy and resources into maintaining quality in these services. They should remain constantly responsive to changing needs, alert to creative alternatives.

The second category of purpose relates to the leadership role NCTM should serve as a collective voice for mathematics teachers in all forums and at all levels of decision making that impinge on mathematics education. Who can fail to observe, today, that decisions affecting us in the most vital ways are influenced strongly by the aggressively expressed concerns of well-organized groups?

Is this political action? Yes, but in the best and broadest sense of the word—*political*, related to policy. Educational policy is our business, and we should play our legitimate role in the determination of that policy. We can have the most impact as professionals through a *collective* position, a *consensus*, an *organization*. this can be achieved by making our positions known where it counts and by insisting that we be accorded our legitimate voice as the experts in mathematics education.

This rationale for membership in a professional organization is especially compelling today. Unlike the situation in the 1960s, the major pressures on the mathematics program now appear to be coming from *outside* the mathematics education profession. The strong momentum of such issues as back to basics and minimal competency testing is largely generated by public opinion (witness recent Gallup polls) and legislative action.

Within our profession, we have seen some highly responsible and thoughtful statements defining what is basic in mathematics. Although these position statements have been widely disseminated, often quoted, and effective *within* educational circles, I do not think they have been as influential as they deserve to be outside professional education.

At a recent high-level HEW conference I found it frustrating to discover that the vast majority of participants considered the issue of the definition of basic skills already settled. To them it meant reading, writing, and arithmetic. The prevailing attitude seemed to be, "We know what is basic; so let's get on with testing these skills."

Our communication *within* professional circles helps us hone our ideas. We may even achieve consensus. But more and more I find myself asking, "Is anybody out there listening?" I believe we should and can do a better job of informing public opinion and influencing policy. And I believe that professional organizations such as ours should pursue these goals aggressively.

Currently, NCTM is working on a number of fronts. A grass-roots governmental relations network is becoming operational. We are sought out increasingly by funding agencies for authoritative advice and resources directed toward particular problems. We are examining our several formal coalitions with other groups with the objective of maximum impact and minimum overlap in public and government relations. Especially effective is the formation of temporary, informal alliances with other professional organizations with which we find common cause on specific issues.

Particularly promising for positive impact, in my view, is the major effort of NCTM over the next several years to develop and disseminate a set of recommendations for the mathematics curriculum of the 1980s. This project is unique in that it attempts to actualize an educational philosophy that is rarely practiced. The ideal in our society is that all citizens have a voice in determining the goals of education. But once this is assumed, it is also clear that the professional—the expert—has a special role in the process.

The recommendations will proceed from, but not be strictly determined by, a data base of public opinion and an assessment of current status. Several National Science Foundation (NSF) studies provide information about what *is*. The NSF-funded NCTM Priorities in School Mathematics (PRISM) project will provide information on society's view of what *ought to be*. PRISM is surveying various segments of society, both public and professional, on specific issues. But an opinion survey itself cannot generate recommendations. Here the professional role is crucial. The recommendations will represent the authoritative knowledge and experience of professionals, but they will take into account reality and responsibility—what exists, as well as a recognition of the validity of the informed citizen's opinion.

To be successful we need communication, coordination, and cooperation—an emerging consensus. We, the members of the Board of Directors, need to hear from you. Tell us your view of the vital issues, your priorities. We need to know that when we speak out, we represent or reflect your opinion.

I have another request. If you agree on the values of NCTM membership to you, convince a colleague. The greater our membership, the greater our potential for impact. You will do yourself and your colleague a great favor. It is in organizations like NCTM that the professional's self-interest and altruism coincide.

NCTM Newsletter
March 1979

# The Basics in Mathematics: More Than the Third R

Shirley Hill
*NCTM President*

During the past year I have spoken at a number of our regional meetings about the basics in mathematics. Apparently the views that were expressed have struck a chord of concern, and I have been asked repeatedly to summarize the talks in this *Newsletter*.

The phenomenon that I shall refer to simply as the basics movement is probably the most influential issue in education today. One of its significant aspects is that it is largely a public or political movement, with pressure from outside the profession. This means that our role as professionals is vital in guiding and informing public opinion in order to achieve a responsible consensus on what is indeed basic and essential in education.

If we accept the movement as a valid and legitimate public movement (even though it is often simplistic and misinformed), then it can present an opportunity and a challenge to do something we should always be doing—examining the goals and objectives of education and trying to achieve societal consensus on the nature of these goals and the school's role in their achievement.

The danger is that if the professional voice goes unheeded, the narrow, cramped, painfully nostalgic version of what is basic will prevail. This is the back-to-basics vision of the three Rs and a hickory stick, which is the simplistic staple of the media's message as well as a political hobbyhorse for many legislators. I do not believe a *well informed* public would want such a limited program, but the key, obviously, is the qualifier, "well informed."

There are two dimensions along which much of today's dialogue about basics, as well as about the related minimal competency testing programs, is severely limited and dangerously inadequate.

One of these is the pinched and narrow view of what life is. Too often the only criteria for defining the basic "life" skills seem to be based on a view of the human being solely as a worker or consumer. The emphasis is narrowly vocational with a limited notion of what makes people truly productive in society. Even the definition of the consumer role appears to be confined to buying and selling and computing interest.

Can anyone in a world where we are constantly bombarded with persuasive statistics seriously deny that the ability to deal intelligently with quantitative information is absolutely basic to good consumerism? And I mean more than the ability to read tables and graphs. I mean the ability to interpret information and to be alert to misinterpretations, the ability to draw valid inferences from data.

I am prompted to ask, in the words of an old song, "Is that all there is?" Surely "life skills" go well beyond the bits and fragments and unrelated competencies that are standard fare in much of testing. Life skills should provide for a meaningful life as well as a productive one and therefore should surely include abilities to reason, to make responsible judgments, to predict, to solve abstract problems, and to engage in and appreciate human expression, such as the arts.

Three sentences from a recent editorial by Norman Cousins (*Saturday Review*, 16 September 1978) seem particularly apt: "Education has failed to educate about education. One of the biggest needs of the school is not to teach people to do things but to help them understand what they are doing. Nothing is easier than to create a society of people in motion; nothing is more difficult than to keep them from going nowhere."

The second dimension of limited viewpoint is shortsightedness. Education is inevitably a future-oriented enterprise. We should be talking, not about what is needed basically in today's society, but about what will be essential a decade or two hence. Society is not static, and the basics are not eternal. This, of course, is the difficult part—to look ahead, to predict. Particular skills will become obsolete. The ability most needed will be that of the flexible, adaptable problem solver.

It seems to me that we face some very difficult curricular choices in the near future. All lists of "minimal competencies" in mathematics include "appropriate computational skills." So would mine. But are we confronting the specific task of defining "appropriate"? It seems to me we should be looking at some of the computational skills from a "cost effective" standpoint—that is, comparing the time required to achieve mastery of these skills to the extent of their actual use in life outside school.

A college president said recently to his entering freshman class, "When you leave here, people will be much more interested in what you can learn than in what you know." Perhaps the most important skill the school can nurture is the ability to go on learning for a lifetime. That ability is basic.

There is a fallacy about the basics in mathematics that is particularly pernicious and widespread. It is that one must master basic computational techniques before one can go on to any other mathematics. Widely accepted in education outside mathematics education, this myth seems to die hard. Much good and challenging mathematical problem solving can proceed without awaiting complete skill mastery. The danger in the "prerequisite" fallacy is to be seen in the practice of keeping students solely in remedial work on skills until minimal-competency tests are passed. This has the potential of widening the gap between the advantaged and the disadvantaged rather than closing it, since it may limit many students to learning skills that are most subject to obsolescence while others go on to learning those problem-solving and reasoning skills likely to stand them in good stead in an uncertain future.

A nightmarish vision of that future struck me recently while I was reading about the startling developments in artificial intelligence. Computer programs are coming closer and closer to being indistinguishable from human thought. Predictably, programs will ultimately reach a stage of "reasoning." It struck me as supremely ironic that at the very time we are on the threshold of "teaching machines to reason" we are spending an inordinate amount of our educational energies teaching our children mechanistic skills.

Mr. ERDAHL. Thank you very much, Dr. Hill.

The next person on our panel is Dr. Wesley Apker, if I pronounced the name correctly. Please proceed and you may read your statement or if you feel more comfortable doing so, summarize as you see fit.

STATEMENT OF DR. WESLEY APKER, EXECUTIVE DIRECTOR, NATIONAL ASSOCIATION OF STATE BOARDS OF EDUCATION

Dr. APKER. Thank you.

There is no denying that achievement scores in math have declined. Our response to that decline, however, must be based upon a careful analysis of the specific areas of decline, the age levels of decline, and findings of recent researchers.

We should all be greatly encouraged that as a group, fourth grade disadvantaged children did not show declines. That tells me that the infusions of State and Federal compensatory education dollars in the early grades are having an impact. We need to make certain that more compensatory education dollars flow to the secondary school level, particularly the junior high school level.

That overall computational achievement was generally high and that problem solving achievement generally declined is not surprising to me. Learning to compute is both more easily learned and more easily taught. Problem solving requires higher level reasoning ability, the understanding of written concepts and the manipulation of symbols and numbers in a logical sequence. Problem solving is both more difficult to learn and to teach.

In the past several years a series of research findings, when taken together, begin to give us the clues to potential solution. I begin with the assumption that the foundations for reading, writing, computation and basic reasoning must be in place by grade 3, certainly no later than grade 4. Dr. Gene Glasser has found that as class size approaches 15, absolute learning gains become consistent and significant. Dr. David Berliner has found that students of teachers who: Maximize time spent on teaching tasks; minimize lost teaching time, called transition time; design learning tasks which ensure high rates of initial learning success; design tests which measure what has been taught; diagnose student skill deficiencies and design or provide appropriate and immediate remediating learning opportunities; and who routinely provide feedback to their students consistently and significantly learn more than do students who do not have these kinds of teachers.

This appears to be true regardless of race, income, geographic areas, or disadvantage.

The final research important to us is an emerging body of knowledge coming out of brain research. Dr. Robert Oren's work on left and right hemisphere learning and Dr. Herman Epstein's and Dr. Conrad Toepfer's research on brain maturation seem to be providing some evidence that the way children learn best and when they learn best may have a great deal to do with the developmental stages of brain maturation. Now, I happen to believe that these sets of research have potential significance as we plan our response to declining achievement scores.

That is, we should do everything we can to reduce K–3 class size to as close to 15 as possible, we should encourage much more research in matching the teaching of certain kinds of skills to brain maturation and developmental cycles, and we should conduct broad scale in-service education with teachers and principals regarding the application of the Berliner findings.

The implementation and practice of the Glassner and Berliner research, plus an increased focus on problem solving in the early grades have the potential for greatly increasing the foundational learning in reading, writing, computing and basic reasoning. Success in the early grades will mean success throughout school.

With the infusion of title I dollars at the secondary school level, coupled with a remediation effort built upon Berliner's findings, there is reason to be hopeful about successful outcomes. It would also be wise to relate much more of the secondary school curriculum to real life application. The more young adolescents can see the relationship of what they are learning to adult living, the more personal meaning that learning takes on. The more personal meaning a learned concept has, the much greater the likelihood that the concept will be remembered and utilized.

I believe our response to declining achievement scores should be as follows: Reduce K-3 class size to as close to 15 as possible; broad application by teachers of the Berliner findings in all grades; greater infusion of title I dollars in the secondary school level; revision of the secondary school curriculum so it systematically relates to adult living; more systematic effort to teach basic reasoning, logic and problem solving skills utilizing the cognitive skills approach; more systematic use of in-service training in implementing the recommendations above; redesign of teacher training programs to teach and model Berliner findings, increase subject specialization and lengthen the period supervised teaching internship from one semester to several years; and increased research in matching the teaching of certain skills to brain maturation and development.

The Federal Government can help by providing adequate levels of title I funding, by continuing their support of funded educational research, and by encouraging more effective models of dissemination and in-service training.

NASBE has believed for a long time that one of the reasons policymakers do not often utilize research and practice information prior to making policy decisions is because research is seldom made available in ways that have meaning to them.

Similarly, research findings rarely get quickly translated into usable and practical in-service training programs. NASBE is prepared to work with NAEP in translating their findings into policy relevant packages for busy policymakers. NASBE is also ready to assist in developing far more relevant in-service training models which would seek to assist teachers in applying research findings.

Finally, NASBE is more than willing to assist State boards in implementing the recommendations we have made today.

Mr. ERDAHL. Thank you very much, Dr. Apker.

I want to thank the entire panel for, I think, some very perceptive observations of things that are proper for us as Members of the Congress and certainly of this subcommittee to hear.

Mr. Perkins has some questions that will be asked by his assistant, Jack Jennings. But before that, I have a couple or three as well.

Another reason this is of special importance to me are the average ages you have picked. I happen to have a 17-year-old and a 13-year-old and a little girl 9 not so long ago. These are interesting observations from a personal way as well.

Several of you have touched on what might be the reason for the decline in mathematical perception. Do some of you who didn't comment care to give your theories or ideas why have we seen this decline? We have had some hinting that maybe young people and adults watch too much television. Maybe that epitomizes some of the impact of the values in society. It is not so new, I guess. The Romans had circuses.

People like to be [illegible]ntertained and I have often wondered from observing our ow[illegible]dren if sometimes we get into this frame and then maybe the [illegible]sion shouldn't be a scapegoat. But I think it is one of the f[illegible]nvolved, that we are so used to being entertained that wh[illegible] go to school, teachers need to compete with Johnny Carson to entertain the kids.

I have talked to clergymen. They are trying to do the same thing.

Does anybody care to elaborate on that concept and what really might be the cause of this decline we see in these technical mathematical skills?

Dr. Hill, I will start with you.

Dr. HILL. To me, one of the most balanced reports on that very question presented a few years ago was that report presented by the Blue Ribbon Panel on the "Decline of the Scholastic Aptitude Test Scores," and the reason I thought it was so balanced and excellent is that it pointed out so clearly that the factors involved in decline were obviously very many and very complex and one of the things they mentioned was television among many others, some in school and some out of school.

I would like to react particularly to the television thing because I think it does speak directly to our concern for problem solving. I think the problem with television is not only that it gets students accustomed to being entertained, but related to that is it puts the watcher in a very passive medium, that is, you don't react to a television set, you can't talk back to it, you can't get an answer back to it, and my view of problem solving is the opposite. It is a very interactive thing.

One proceeds not to read about them in books but rather to look at a situation, try to conceptualize it and say what do I need to know here, what information must I have, what do I know and where do I go to get the information I don't have.

Television certainly does not do that sort of thing, and I think maybe looking ahead optimistically, take a newer technology that may permit that kind of interactive learning of problem solving in a simulated way is the computer, microcomputer. This will permit the kind of thing where indeed you do have to look for the information you need and that is what the problem solving is all about.

I agree also with the article I read by Neil Postman that says I think something you said, the school should not be trying to compete with Johnny Carson, they should be trying to do precisely the opposite in the school setting, and I agree with that.

Mr. ERDAHL. Anybody else?

Dr. FORBES. Several years ago, we released a report where we had asked students about their homework assignments and how much homework they actually did and also the amount of television viewing which went on during the week.

We found that for those sutdents that had a lot of homework and still watched a lot of TV that they performed quite well, but those students that, just as you would imagine, those students that do no homework and watch a lot of television performed at the bottom of the heap. We don't know if school turned them off, and that is why they are watching the television, or if it is the other way around.

Mr. ERDAHL. If I could interrupt here. I marvel at our children who watch the TV and study at the same time. We used to listen to the radio and study at the same time.

Dr. FORBES. I have a couple of teenagers that claim they can do it also.

I think the decline that we pick up in problem solving for the 9-year-old is probably a direct result of the back to the basic emphasis at that earlier age. The declines that we are picking up with the 13- and 17-year-olds go along with the declines that we have picked up in other learning areas, for example, writing, being able to write an essay, or especially in the physical sciences where they are not taking the same number of chemistry and physics courses as they used to take.

So as Dr. Hill has pointed out, I think it is a combination of a lot of effects, some of it is 17-year-olds essentially not taking the classes, not being exposed to things, and it could be that we have bottomed out in the declining period and we have started back up, and some of the 13-year and 17-year-olds are still caught up with, some of the things we did wrong back in the sixties.

Mr. ERDAHL. Anyone else wish to comment?

Another observation I have refers to Dr. Ebersole's testimony. On the third page, I underscored this because I think it is so basic, "The best way to improve education is to improve the capabilities of individual educators and the schools in which they work."

Then another one of the things that struck me, I think this was in Dr. Esty's testimony, in general, it appears that what is being taught is being learned.

I suppose that underscores the importance of the teachers in the whole system, and as educators I am sure you have all heard that the best university in the world would be one where Socrates sat on one end of the log and the students sat on the other. This is the kind of fundamental concept and one that we think we should recall and remember.

Also, several of you mentioned the importance of the early training—I think Dr. Apker mentioned the importance of stressing a small class size through the K-3.

As some of you know, I succeeded Al Quie, who is now Governor of Minnesota. One of the things he tried to get through the State legislature, unsuccessfully this time, was a rather substantial reduction in class size in the early grades. I think that is important.

Just a couple of other questions. Have you any assessment comparisons going back before the early seventies? I think we had the one we talked about today.

Dr. Forbes, I think you spoke most to this comparing 1978 to 1973. Do we have some other comparisons or related ones going back into the sixties or fifties that you are aware of?

Dr. Forbes. Unfortunately, nothing at the national level. There have been some previous studies where people have attempted to pull together information from the various State testing programs, but because they all used different tests and have different curriculum, the way in which things are put together, that is extremely difficult to do.

The people that have written critical books on education have indicated that the decline going on dates back into the earlier sixties. SAT decline scores would also agree with that.

Mr. Erdahl. That brings up another question, because we have been having this series of hearings on the so-called truth in testing bills. From your perspective and from your position and background, what would the implementation of these bills do to the ongoing assessment process as you see it?

Dr. Forbes. In trying to follow the legislation rather closely I believe it would have very little effect on national assessment itself in that we are not trying to measure the performance of individual students but only the performances of groups of students. So, therefore, an individual student may only take 10 percent of the total assessment at an age level.

That distinction probably exempts national assessment from any of the legislation which is currently being discussed.

We have made it a very long-term practice of releasing approximately 50 percent of our items to the general public, so people can see exactly what the items were and the way in which students performed on those items.

For researchers, we have always been a professional organization, like the National Council of Teachers of Mathematics, or in one case the National Science Teachers Association, we let them come in and look at all of the items which were used in the assessment. So instead of maintaining security of our items the same way in which the college board needs to maintain the security of their items, we just don't fall into the same general ball park right at the present time.

Mr. Erdahl. Do any of the other panelists wish to comment on that idea, as your experience pertains to the bills that are now before this subcommittee?

I am not sure if it was Dr. Hill or who brought this up, but it struck a responsive chord with me, if this truth in testing bill would in fact lead to more teaching for the test. Frankly, I have some apprehension that as we release this test material, requiring new tests and so forth to be published and put forward, or maybe requiring that some system be used, other than testing, there is that possibility of teaching for the test. Do you see that diminishing or increasing?

Dr. Hill. I think it is a real danger. As far as truth in testing is concerned, that is one of those things I would have to say at this point has fallen into other hands. I think there really are clearcut pros and cons. I do think one of the major hazards is precisely the one you mentioned. I think we already have pretty good evidence within the schools that this is what is happening in many instances.

Teaching for the tests, I have heard a State legislator say that is exactly what we ought to be doing, but I think he meant by that that if the tests are testing what we want to be teaching then, of course, that is what we ought to be testing. It is a little circular.

On the other hand, if it means just practicing those various types of items that you know are going to be covered then the whole purpose of testing obviously is lost and I think there is a real hazard in that that needs to be protected against in whatever legislation we have.

Mr. ERDAHL. Thank you.

Another thing that several of you brought up is this whole business of the back to basics concept and what it might have done to the problem solving method of teaching. I personally can't see why those two things aren't compatible. Why can't we have the back to basics concept and have it blended in with problem solving?

Dr. APKER. One of the reasons that there has been an overreaction to back to basics is because, No. 1, it was mandated by a number of legislatures.

Mr. ERDAHL. Is that in response to the so-called new math?

Dr. APKER. No; it was a response to the feeling that we have been putting a great deal of money into education and we are not certain that we are getting our money's worth, and so what we are going to do is demand more accountability. One way we can do that is impose some kind of standard, and that began to lead back to the basics.

Also, the concern that there were increasing numbers of students who do not read, write, and compute. The difficulty was that at the same time there was a demand to go back to the basics—I am not certain we ever left it—but I think there is a whole host of other reasons why the achievement scores fell.

But in the process of demanding certain kinds of standards be met there was nothing taken away, and when you take a look at the number of minutes in the schoolday and the number of things that have to be taught, to teach a higher level of thinking, like problem solving, requires much more time in terms of teachers' time to teach, and it takes some sophisticated teaching to teach it. And I think we all said in some ways that there aren't adequate models available in terms of teaching problem solving as a higher level cognitive skill, and it takes longer to teach.

So I am not saying that it can't be done both at the same time, but in order to accomplish that, there is going to have to be a great deal more inservice teacher training for teachers to help them understand how to teach problem solving.

Dr. ESTY. When you talk about the back to basics and problem solving together, the question really is what basics are you talking about, and unfortunately, as I have said, it seems to me the current view of basics in the minds of a lot of people is that basics in mathematics consist of computation.

Consider the position that the National Council of Supervisors of Mathematics did in their position paper, that I referred to and Dr. Hill referred to. They are trying to define the basics there in a way that is agreeable to their membership of the National Council of

Supervisors of Mathematics, and you find that 1 of the 10 basic skills, according to them, is in fact computation. But there are lots of others. The first basic skill that is listed of the 10 in their little paper is problem solving.

So, if in fact you define basic skills to include problem solving, then, yes, they can and they should coexist, it seems to me.

Mr. ERDAHL. Thank you very much.

During the several weeks we have had testimony on the truth in testing bill, we have heard about various drawbacks that exist in standardized tests. I think all of us would agree that they are there and certainly standardized tests are used to provide an assessment of how that person might do in other educational opportunities or in the job skill. There seems to be a valid reason for tests. We have heard about this morning, that assess the performance of our educational system. We should not use our kids as guinea pigs, but I don't know how else we are going to assess the educational process if we don't use some standardized tests.

Some people, I think, would have us do away with them. Any comments on that from this panel?

Dr. FORBES. Just some information for clarification purposes. The assessment, although we conducted the assessment in a standardized way, it is not a normal reference type that is being mentioned in the truth in testing legislation. And if those tests are developed in order to be able to rank students, say which student is better than the others, since we aren't interested in developing a score for a student, but for groups of students, we aren't limited in the same way in which a normal reference test is when we product the output to the asssessment.

We can ask a question like the one I have referred to where we asked students to calculate the unit cost of electricity. In a normal reference test the chances are that item would never be included because it would not have ranked very many students at all. So, therefore, the assessment is able to do a broader brush, to be more indepth, and more comprehensive than a normal reference test.

I think that education needs both. They need the standardized normal reference tests to rank order students to give school people that information. They also need something like the assessment that we conducted at the national level and a number of States replicated what we do at the State level, and together all of these data coming together which gives a true picture.

I agree with you, without both types we would be in kind of bad shape, we would not know what is going on.

Mr. ERDAHL. I appreciate that clarification and explanation.

Jack, do you have some questions?

Mr. Jennings is an assistant to Chairman Perkins. Maybe he has some questions for the panel.

Mr. JENNINGS. Thank you.

I would like to ask several questions. It seems that the gist of the findings on mathematics of the national assessment is that there is heavy concentration in the schools on purely computational skills and there seems to be a lack of concentration on problem solving ability. Is that how you would summarize your findings, Dr. Forbes?

Dr. FORBES. Certainly the assessment contains a number of items from all of those areas, and the fact that students tend to be able to do a lot better on computational skills we would assume that that is where the emphasis is being placed. And then talking about math educators who helped us with the data and present some interpretive remarks in our report, that was exactly what they were saying, that the emphasis is currently being placed on the more basic skills at the expense of some of the higher order skills.

They also pointed out that the textbooks tend to be downplaying problem solving also, and so if you have teachers that are not very well trained to teach mathematics, which is the case for some elementary teachers, and they have to follow the textbook, and the textbook is downplaying problem solving skills, I make the assumption that is exactly what is going on, that they stick with more of the rote memory, drill work, at the expense of doing some problem solving.

That is why we have the rather drastic decline. The thing that disturbs me the most about the whole result is the drastic decline of 9 year olds in problem solving.

Dr. Hill would probably be able to respond in more depth than I would.

Mr. JENNINGS. Would you care to add to that?

Dr. HILL. I think that the major message of the results is this distinction between the concentration on computation and problem solving. But I would like to repeat something that I said earlier, because I think it is very important.

I think it is not just a matter of giving attention and time to one area rather than the other that is crucial, because, instructional time is critical. We know that as time on task, as we often call it.

I think it is also a matter of the fact that if you are really preparing students primarily to pass a test, do well on a test at the end of that year, you are preparing for short term retention, and the best methods to influence test results on lower order skills are well known. They consist of a lot of drill and practice routines and mechanistic kinds of learning.

I would like to maintain it is not just a matter of being at the expense in the time but also that that very process leads me into what I was calling a mindset that makes students unable to cope with nonroutine unfamiliar kinds of problems.

We have students who come in and think you cannot do a mathematical problem unless you memorized a formula to do that problem. It completely misses the point of what mathematical problem solving is about. So I think that method of teaching which is encouraged by our pressure for test scores is in fact antithetical to developing problem solving ability.

Mr. JENNINGS. Then the implication of both your testimony, Dr. Hill, and Dr. Forbes 'testimony, seems to be a criticism of the back to basics movement with the narrow concentration on computational skills?

Dr. HILL. In the narrow sense.

Mr. JENNINGS. In light of that, I would like to ask Dr. Apker, a question. I have read your recommendations and your recommendations really don't talk about any informational program or any educational program being undertaken by the Association of State

Boards of Education, to broaden an understanding on the part of State legislators that possibly basic skills are too narrowly focused on computational skills and possibly they should be broadened to include problem solving skills as well.

Does your organization have any plans to broaden that type of view?

Mr. ERDAHL. I think we can refer properly to you as Dr. Apker, is that correct?

Dr. APKER. That is correct.

Yes, we published about June of this year a publication called "Minimum Competency Testing, The State of The Art," in which we counseled state board members to proceed with caution. We tried to help them understand the difficulty of designing tests that would adequately measure minimum competency without (*a*) violating due process, and (*b*), without running the risk of measuring that had not, in fact, been taught.

You might be interested in knowing that at our convention just completed 1½ weeks ago, our association backed entirely away from a stand on minimum competency testing and said rather that indeed if States did establish standards that they should make certain that their most proper remediation applied at early grade levels, so that the remediation could be eliminated.

I spoke in my testimony about the fact that often policymakers could not utilize research in practice when they make policy decisions because the research is not available in ways that have meaning to them. That is very much the case with State board members and it is very much the case with legislators.

One of the things that we proposed to do, and Roy and I have talked about this, is, and there is an information release from NAEP, and we have also talked to Mike Timpane at NIE—everytime there is an information release in terms of research that is significant somehow retranslates that information, that research into a policy package that has meaning for State board members and, for legislators. We are doing that in areas where we have ongoing projects and we are doing that in areas where there are emerging major issues.

We are prepared to share with State board members and indeed we did this in Williamsburg, about some of the results of NAEP testing, particularly mathematics, in the last that have just come out.

Mr. JENNINGS. Thank you.

Dr. Forbes, could I ask you two more or less technical questions about your findings.

First of all, Dr. Hill criticized your findings on the grounds of a lack of equating that there were not a sufficient number of comparable questions between the tests of 1973 and the tests of 1978 so you couldn't have proper equating of the result. How would you respond to that concern?

Dr. FORBES. The number of items that we developed for the 1972-1973 assessment was significantly smaller than the number of items we had in the 1977-78 assessment because we released part of the items and that leaves a certain number of items to use in the reassessment. Those are the items that we actually measure change on. We keep those items secure for that period of time.

The assessment attempts to share those items, item by item, the results for each item with organizations like the National Council of Teachers of Mathematics, so that they can come in and look to see if they feel like the items were sufficient or not.

It is my understanding that their organization has taken a position that it would be a lot better to have had a lot more items in the change than what we had, but I don't believe they have said that the items and the number of items is so highly questionable that they are disagreeing that a decline or they would suggest that maybe a decline did not occur. I haven't heard Dr. Hill or anyone from the organization suggest that.

So, I accept their criticism that we have been in a lot better shape to be able to have a lot more items when we reassess mathematics the next time around. We will have a larger number of items and there hopefully we will remove that criticism. A constructive criticism that we readily accept.

Mr. JENNINGS. Dr. Hill.

Dr. HILL. Only that I agree, we certainly are not saying we question the decline that was indicated there. I think it is fairly clear. But we are very glad to hear there will be more items in the next change.

Mr. JENNINGS. Dr. Forbes, if I could also ask you another question. I read some of your questions on your tests and one of the things I was wondering was, possibly one of the problems with the results could be that the children did not have reading skills, in order to understand questions, and is there any way that you can distinguish between a decline in math skills and a decline in reading skills within your math examination, because the questions asked, the problem solving questions, really are more complex in the English language. Can you comment on that?

Dr. FORBES. Yes sir. Up to this time we have been able to administer the assessment with what we refer to as a pace tape, which essentially is reading the item that is in assessment with all of the foils associated with an item. So there is a tape recording that is going in the room during the administration, so there is an announcer who reads the item, so the student that has limited reading ability would be able to listen to what is being said at the same time they may be reading it.

Mr. JENNINGS. You do that item by item, then you allow a time for an answer?

Dr. FORBES. Item by item. Some time is left for them to be able to respond to that.

For students that do not need that crutch, they tend to move along speedily. There has been some research that would suggest that having two modes like that, where the student could read for themselves or listen to the item being read to them, that that doesn't interfere. It is like television and radio, they tend to block out the one which they consider to be the one that would be redundant.

We have been doing some research to try to determine if that is helpful and we are making at the present time, we are looking at the possibility maybe of even dropping that particular aspect of the assessment where we would no longer be reading the item to the student.

When you are solving problems, especially the more difficult problems, and it starts becoming a comprehension problem, I don't know how one separates the mathematical problem comprehension parts out from the reading comprehension part.

Mr. JENNINGS. Mr. Perkins wanted me to mention something in particular to you, Dr. Forbes, about your results between 1973 and 1978. As I understand your testimony, and understand Dr. Apker's testimony, you were saying that it seems that Federal efforts such as title I were having an effect on the schools because you could see a significant increase in the scores for disadvantaged students. Is that understanding of your testimony correct?

Dr. FORBES. I was trying to be extremely careful in the way I said it to keep my fellow researchers off my back. But since we are not evaluating title I, the combined effects of all of the things which are going on in the compensatory education must be having a positive effect because we are seeing some closures in those gaps. So it is not only the Federal title I program but the State compensatory programs, and all of these things together, so the best we can do is monitor changes, what is happening to that group of students that those programs are trying to serve. That is kind of the official response.

My only intuitive reaction, yes, title I is paying off.

Dr. APKER. I share Dr. Esty's concern the gap is not closing as rapidly as we would like it to. I certainly do believe the infusion of title I compensatory education programs at both the state and Federal level is of help.

Mr. JENNINGS. We so rarely have good news it is nice to draw out some good news when you can.

If I could just ask a couple more things.

Dr. Hill, you said in your testimony that your organization had a grant from the NSF to disseminate the results of this test, and also to come up with some recommendations for a curriculum for the eighties for mathematics.

Do you think that it is important that while you do this, while you do talk among yourselves, in order to make recommendations for the eighties that you are also talking about other groups representing teachers in general, administrators in general, because if you make your recommendations, teachers of mathematics aren't necessarily the ones who are going to make decisions on curriculum, so do you have any plans to reach out to the other groups while you are doing this type of study?

Dr. HILL. I can't tell you how glad I am you asked that question. I do want to say the NASF grant is just for the purpose of interpretive reports of these data. The other effort is out of our own resources, except that we have been funded in addition to looking at all of the other data and using all our own resources and personnel that we can in this, we have also been funded to do a survey called "Priorities in School Mathematics."

That is a survey that asks people in various sectors of society, not only professionals in education—that includes administrators and school board members and so forth—but also we have a sample from the lay public.

We are very serious about looking at what people believe should be happening in mathematics education. We are taking that and all the other data we possibly can get our hands on, taking that and saying, now, given this, and responsibly and honestly looking at it, what do we as the professionals in mathematics education believe ought to be happening during the next decade.

I feel very excited about this prospect because what I think it does is build on a data base but also does responsibly what any professional organization ought to do, ask people what they think and that is exactly what we have done.

Mr. JENNINGS. Dr. Hill, if I could ask you another question regarding testing in general. During the subcommittee's hearings on the Weiss bill, the truth in testing bill, testimony revealed that ETS is scoring women and men differently in verbal skills and in computation skills on the graduate record examination and possibly on the SAT examination.

So that in effect what they are saying is that women do better with verbal skills than men, and it would be unfair to compare or to put women and men's scores together because men would generally be lower than women, but the opposite occurred in computation skills, and, therefore, men would do better than women and women would be disadvantaged. So ETS has made a decision that they would report these scores separately. So in effect, men's scores in verbal skills would only be compared with men's and women's only with women.

Do you believe that is discriminatory against women because women are being separated from men in something that should show common knowledge and ability?

Dr. HILL. I think it is not directly discriminatory because I do think it reflects a state of affairs that is in itself discriminatory, and that is the deeper issue of association attitude about females with respect to mathematical ability. Research has shown that in achievement when you get up to junior high and high school age it does tend to separate and that males do better in achievement at the high school level.

It does not show this at the lower levels and so I think we would say that something is happening there that is discouraging girls and young women with respect to their both interest in and abilities to go on in mathematics courses, and that is the key to it all.

I think this situation is improving. I believe even the NAEP data indicated that course enrollments, the data they had, are changing, as a matter of fact, to where women are now being represented to a greater extent in mathematics courses, but there has been a real differential in mathematic course taking, male and female, and that is the kind of result I think they are reacting to. I think the root causes of that situation have to be changed and that is where the discrimination lies.

Mr. JENNINGS. It is only a personal opinion, if you don't combine men's and women's scores, all you are doing is perpetuating the separation.

Dr. HILL. Yes, sir.

Mr. JENNINGS. If I could ask a question that Mr. Corrada sent over in a letter to Mr. Perkins. Mr. Corrada is concerned that the number of Hispanics who were tested in the national assessment was such a small number that you couldn't really draw a proper conclusion about the achievement of Hispanics from the data, and

Mr. Corrada wanted to know for the record, Dr. Forbes, if you could tell us why you have not broadened your sample of Hispanic students in order to be able to reach proper conclusions on their achievement and whether you have any plans in the future to broaden that sample?

[The above referred to letter follows:]

CONGRESS OF THE UNITED STATES,
HOUSE OF REPRESENTATIVES,
*Washington, D.C., October 22, 1979.*

Hon. CARL D. PERKINS,
*Chairman, Subcommittee on Elementary, Secondary and Vocational Education, Committee on Education and Labor, U.S. House of Representatives, Washington, D.C.*

DEAR CARL: I am glad that our subcommittee is looking into the declining achievement in the area of mathematics. In the recent study entitled "Changes in Mathematical Achievement, 1973-78, Result from the Second Assessment of Mathematics", which was published in August of this year, and carried out under an NIE contract, there is a section dealing with results by race (Chapter 2, pp. 21-22). On page 22, a section reads: "The Hispanic Group was relatively small, thus changes in their performance in either direction on the different cognitive process levels are generally not statistically significant." When one considers that Hispanics constitute a significant segment of our national population, and in the coming decade may very well become the largest minority group, this admission is a simplistic way of writing off the duty to adequately measure the achievement levels of Hispanics. I wouild appreciate receiving Dr. Forbes' and Dr. Etty's views on why so little was done to ascertain what I believe is a critical deficiency in the educational achievement of Hispanics, and what can be done to improve their track record in this respect in the future.

Thanking you for your assistance in this endeavor, I remain.

Cordially,

BALTASAR CORRADA.

Dr. FORBES. Some of the summary data at the national level where we do report Hispanic data, the standard errors associated with the sample are small enough, I believe the data are reliable.

The Congressman is correct; the number of Hispanics in the total sample is quite small; it reflects the total number of Hispanics in the total population. We go after the national sample, and therefore, that is why we end up with a very small number of Hispanics in the country. We would have to offer sample areas where the Hispanics tend to be, in the Southwestern part of the United States, and Northern part of the United States, and some of the metropolitan areas and central part of the country.

There have been discussions when we refunded with NCS and now with NIE exploring some way maybe of improving the sample for Hispanics but right at the present time, there is nothing on the drawing board to increase the samples.

Mr. JENNINGS. Thank you.

Thank you all for your testimony.

I would like to thank our acting Republican chairman for his courtesy in permitting me to ask so many questions.

Mr. ERDAHL. Thank you very much, Mr. Jennings.

I also want to thank the members of the panel for their very excellent testimony and for their responses and observations and all these things become part of the official committee record and they are available for my colleagues and their staffs.

Thank you very much for being with us today.

[Whereupon, at 11 a.m., the subcommittee was adjourned, subject to the call of the Chair.]

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