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By Herbert Ginsburg, Ph.D.,
Professor of Psychology and Education at Teachers College, Columbia University

Mr. Chairman and members of the Panel, I thank you for the opportunity to speak today. I have spent 30 years researching the development of mathematical thinking and cognitive function. I have written curriculum for early elementary learners, and developed instruments for measuring early math skills. I am currently developing mCLASS:Math, a handheld computer-based assessment that guides teachers through diagnostic interviews that reveal K-3 students' mathematical thinking and learning needs. Where this research-based formative assessment and diagnosis has been done in the past, it has led to significant learning gains (Black & Wiliam, 1998a & 1998b; Fuchs and Fuchs, 1986; Fuchs et al,1994; Fuchs et al, 1992; Fuchs, Fuchs, & Hamlett, 1989a & 1989b); we believe the implementation of these proven techniques on a technology platform that enables classroom teachers to use them can be a breakthrough for early math teaching and learning.

Why Early Math Matters

While many have pointed to poor algebra performance as the most conspicuous instance of students not being prepared to do advanced math, many teachers and researchers recognize that the problem begins much earlier. In the United States, low-income and minority students perform relatively poorly in math as early as kindergarten and first grade (Denton & West, 2002). By the third grade, many American students show signs of math learning difficulties (Ostad, 1998, 1997; Geary, et. al., 2004).

Research shows that an early start can be a major contributor to preventing later failures in math learning. Efforts must begin in early childhood, with a particular focus on the foundational skills learned from kindergarten through third grade. Effective early math education can help young students to:

- Acquire a sound foundation — the basic skills and concepts — for learning such advanced subjects as algebra (National Association for the Education of Young Children and National Council of Teachers of Mathematics, 2002);
- Avoid retention in the early years by increasing math and reading skills (Magnuson, Myers, Ruhm, & Waldfogel, 2003); and
- Develop positive attitudes toward learning math to prevent early difficulties from becoming a self-fulfilling prophecy (Ma, X., & Xu, J., 2000).

In response to these mounting challenges, we must intensify efforts to introduce new programs and strengthen current programs that address the sources of young students' math difficulties, so as to prevent later failure.

The Importance of Formative Assessment in the Early Grades

Ongoing assessment of early math learning is a vital step toward reversing the dramatic failures of math education in the United States. A rigorous, developmentally appropriate formative assessment program for kindergarten to third grade reveals what children understand about math, and where they require intervention in order to stay on track to master basic skills. The formative assessment is used throughout the year to help teachers improve student performance *before* the summative assessment at the end. The formative assessment directly impacts teachers' day-to-day instruction in real time, rather than when it is too late.

Such an assessment program would help *teachers* to:

- Efficiently measure individual student performance in crucial areas of early math;
- Acquire insight into students' math thinking;
- Help students overcome math learning difficulties;
- Think more deeply about math teaching and learning.

Such a program would help *administrators* to:

- Review classroom, school, and district data useful for evaluating success in student achievement;
- Efficiently provide teachers with professional development around early math and diagnostic interviewing;
- Recognize early the patterns of a student, classroom, or school that is not making progress toward high math achievement.

There are emerging research-based, reliable, and valid methods to help teachers assess the math learning of individual students for purposes of instruction and intervention. These instruments can also give administrators a picture of student progress toward learning standards. Such an assessment and instruction system will help teachers and administrators learn *what* students know and *how* they know it with immediate and obvious consequences for instruction.

The research suggests that such a system must have three important features:

1. *Screening* assessments to examine proficiency and identify risk factors;
2. *Flexible Diagnostic* interviews of the sort originally developed by Piaget (1976) and used by various cognitive researchers, to further probe the thinking and strategies that underlie the student's performance, and to match instruction to students' needs.
3. And *Progress monitoring* to determine whether instruction is effective in promoting a particular child's achievement.

Such a system should also capitalize on technology, which is having a transformative effect on assessment. Technology makes the process of assessment and data collection far more efficient, so that it's feasible for teachers to monitor student progress frequently and drive instructional decision-making. In addition, the information collected is more accurate, and delivered instantly with analysis and recommendations that have an immediate impact on instruction.

Benefits Beyond Assessment

Such formative assessment provides a form of professional development in which teachers learn to "think to the test" rather than merely "teach to the test." In the process of administering the assessment, teachers learn to think more deeply about what is involved in math learning and teaching. They discover that math learning involves various kinds of mental processes, that students assimilate what is taught into what they already know, and that teaching involves far more than drill.

Another indirect benefit is that teachers learn to incorporate sound forms of testing and interviewing into their everyday classroom practices. They learn that these methods can help monitor their students' learning during the process of instruction and thereby improve it.

Students also learn a great deal from a good assessment, particularly if there is a flexible interview component. Research has shown that the process of eliciting student explanations and justifications of their thinking in itself promotes understanding of math concepts (Chi, Leeuw, Chiu, & LaVancher, 1994). When students are asked to describe how they solved a problem and to justify their solutions, they learn, as does the teacher, that thinking about math is an integral part of learning the subject.

As you develop recommendations, please give serious consideration to the importance of math education in grades K-3, and to how a formative assessment system can help to improve learning outcomes in these critical, foundational early years. Where formative assessment has been used in the past, it has led to improved teaching and significant learning gains (Black & Wiliam, 1998a & 1998b; Fuchs and Fuchs, 1986; Fuchs et al,1994; Fuchs et al, 1992; Fuchs, Fuchs, & Hamlett, 1989a & 1989b); studies also suggest that a technology platform enables classroom teachers to conduct formative assessment often and analyze data easily, resulting in better instruction and student outcomes (Landry, Swank, Assel, Anthony, and Gunnewig, 2005; Mandinach, et al., 2005; Hupert, et al., 2004; Sharp, 2004; TEA 2003). We believe a special focus on giving children the right start in the early grades can have a powerful impact on math teaching and learning. Thank you again for your time.

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