

The Research Basis for the Assessing Math Concepts Series by Kathy Richardson and published by Math Perspectives

Standardized tests will never answer the question of what our children need to learn to be leaders and informed citizens in a multicultural, ever-changing world.

-from the introduction to *Failing Our Kids*

The current vogue for back to basics and extended school days is unfortunately moving education away from the recognition of individual differences and towards a one-size-fits-all approach. Simply doing more of what has not been working will not prove helpful, nor can you teach a child simply by testing him. Similarly, greater accountability without teaching innovations will also be unlikely to produce results, any more than (as the old saying states) weighing a cow over and over will fatten it. Assessment can be a very valuable part of learning if it lets teachers know how well their methods are working and lets students and parents know what is being mastered and not mastered. In the best types of assessments, the child is constantly learning and assessing, as a demonstration to himself and others of his mastery of the material.

-T. Berry Brazelton, M. D.

Types of Assessments:

Assessments for student learning fall into two categories: external and internal. External assessments come from outside, from projects gathering comparative research data or mandated by state or local districts as part of their evaluation program. Internal assessments are those used by teachers in monitoring and evaluating their student's progress and in making instructional decisions.

Adding It Up, p. 39-40

External Assessments

Standardized Testing: Any set of predetermined questions given to large numbers of students under the same conditions (such as a time limit) and scored in the same way. Usually refers to multiple-choice tests given statewide or nationwide. Standardized tests tend to be "norm-referenced," with the main purpose to compare and rank students. Standardized tests are often "high-stakes." Tests are "high-stakes" when an education decision is based on a single test score – whether a student will advance to the next grade level, be able to enter a preferred program or school, or even get a high school diploma. High stakes are also applied to schools and teachers, with judgment, rewards or punishments, based wholly or primarily on standardized test scores.

Internal Assessments

Formative Assessments: Tests designed to diagnose student strengths and weaknesses in order to adjust instruction accordingly. Usually administered periodically throughout the school year to gain individualized student information.

Performance Assessments: Assessments other than multiple choice or short-answer tests that are used to determine a student's progress toward an academic goal. The tasks are designed to evaluate performance in a real-world activity. Performance assessments include writing an essay, conducting a science experiment, giving an oral presentation, explaining in words how the student arrived at the answer to a math problem, and so forth. Sometimes referred to as authentic assessments.

Summative Assessments: Tests designed to determine student success or failure at the end of instruction. Summative Assessments are usually administered at the end of teaching units and at the end of the year.

The *Assessing Math Concepts* series of assessments are internal assessments that can be used as formative assessments, performance assessments, and summative assessments. The Student Interviews are used first to determine what students know and what they need to learn. After an appropriate amount of instruction, teachers can use the *Assessing Students at Work* Assessment Task to determine what students have learned thus far. The Student Interview can be used again at the end of the instructional period or at the end of the year as evidence of student achievement.

Research Findings

The Need For Formative Assessments

In pre-kindergarten through Grade 2, mathematical concepts develop at different times and rates for each child.

NCTM Standards, p. 76

A variety of alternative assessments in mathematics must be used to generate the information a mathematics teacher needs to determine what his/her students are thinking, how his/her students are reasoning, and what the next instructional steps should be. (Thompson and Senk, 1993; Gay and Thomas, 1993).

Standardized tests do not provide the information needed for daily classroom decision making and can narrow instruction rather than improve it. Research shows that teachers in states with high stakes tests use test results to adapt, modify, and narrow their instructional materials, methods, and focus. (Bracey, 1994; Jones, 1999; Olson, 2003; Paris, 2000) These teachers shift instructional time from non-tested content areas to subject areas that are reflected in state exams and even teach in ways which contradict their own ideas of best practices in order to raise achievement scores as measured by the test. As teachers gain familiarity with tests, they often narrow their classroom teaching to focus on content covered by the test.

Formative Assessments Provide Data For Instructional Decisions

The document, *Principals and Standards for School Mathematics*, published by the National Council of Teachers of Mathematics (NCTM) in 2000, states that to ensure deep high-quality learning for all students, assessment and instruction must be integrated so assessment becomes a routine part of the ongoing classroom activity rather than an interruption. These assessments also must provide the information teachers need to make appropriate instructional decisions. Assessment should reflect the mathematics all students need to know and be able to do, and it should focus on students' understanding as well as their procedural skills. By providing information about students' individual and collective progress toward the goals, assessment can help ensure everyone moves productively in the right direction.

Assessment can support learning as well as measure it. Several researchers have demonstrated the practice of using individual assessment information to guide instruction (Black, 1998; Guskey, 2003; Stecker, 2000). Formative assessments provide information throughout the teaching year to guide teachers.

To maximize the instructional value of assessment, teachers need to move beyond a superficial "right or wrong" analysis of tasks to a focus on how students are thinking about the tasks.

NCTM Standards p. 24

Assessments should be appropriate and adapted to meet the needs of young children

Interviews and observations are more appropriate assessment techniques than group

tests, which often do not yield complete data. Early assessments should be used to gain information for teaching and for potential early interventions rather than for sorting children.

NCTM Standards p. 75

Assessments must include important mathematics and be aligned with local, state, and national standards

Commercially published standardized tests are quite variable in the topics they cover and in the proportion of these topics emphasized at each grade level. (Romberg and Wilson). The tests frequently are not aligned with the teaching materials used in a district or even with the goals of the district.

Adding It Up, p.42

Historically, number has been the cornerstone of the entire mathematics curriculum internationally as well as in the United States and Canada.

(Reys and Nohda 1994).

All the mathematics proposed for pre-kindergarten through grade 12 is strongly grounded in number. NCTM Standards p. 32 By the end of grade 2, students should know the basic addition and subtraction combinations, should be fluent in adding two-digit numbers, and should have methods for subtracting two-digit numbers.

The more precise and detailed the information, and the better it is coordinated with curricular goals, the better the resource it is for instruction.

Adding It Up, p. 350

Formative Assessments Raises Achievement

Black and Wiliam (1998a) provide firm evidence that formative assessment is an essential component of classroom work and that its development can raise standards of achievement.

Formative assessment for learning, rather than summative assessment of learning, can dramatically affect learners' achievement. An increased quality of formative assessments has the potential to raise standards of achievement. However, in order for the assessments to serve the purpose, teachers must incorporate ideas set forth in the assessments into their own patterns of classroom work.

(Black, 2003; Guskey, 2003)

Assessments can assist learning, provide a direction, provide a goal, and function as a coach by providing milestones. Assessments often predict future performance of the students and keep students from continuing to more complex concepts when they are not yet ready to do so (Foster, 2004; Fuchs, 2004; McGlinchey, 2004).

Previous and current research clearly supports the use of formative assessments to improve academic achievement. Black and Wiliam (1998a) provided extensive and detailed research to support the use of formative assessment to ensure student learning.

Studies show that when teachers learn to see and hear students' work during a lesson and to use that information to shape their instruction, their instruction becomes clearer, more focused, and more effective. *Adding It Up*, p. 350 (46)

Description of the Assessing Math Concepts Series

This is a series of nine formative assessments for Pre-K to 3rd grade mathematics that focuses on core concepts that must be in place if children are to understand and be

successful in mathematics. The series is based on the premise that teachers will be able to provide more effective instruction when they are aware of the essential Critical Learning Phases for mathematics and of the students' progress within these phases.

Research has shown that learning about number and operations is a complex process for children (e.g., Fuson [1992]).p. NCTM Standards

The nine assessments and books are:

Book/Assessment	Goal
Counting Objects	To determine if a child can count and keep track of an unorganized pile of up to 32 counters and can make a pile of up to 18 counters.
Changing Numbers	To determine if a child knows if a number is larger or smaller than another number and can change one quantity into another.
More/Less Trains	To determine if a child can use one train of counters to figure out another, and can compare trains and /or piles to find out how many more or less one quantity is than the other.
Number Arrangements	To determine if a child can recognize parts of a number and combine those parts without having to count all.
Combination Trains	To determine what number combination the child knows. To find out if the child can use related combinations as a strategy for getting answers.
Hiding Assessment	To find out which number combinations a child knows by determining if he/she can tell the missing part of a number without having to figure it out.
Ten Frames	To determine if a child can combine numbers by making a ten and leftovers and to determine if the child can subtract using known combinations and relationships.
Grouping Tens	To determine if the child can tell "how many" in a quantity if the number of tens and ones is known, and to determine if the child can add ten and take away ten without counting. To also determine if the child knows that the total number does not change when counted in a different way, what it means to count by 2's and 5's, how well the child can do this.
Two-Digit Addition & Subtraction	To determine if a child can add and subtract from two-digit numbers by mentally breaking numbers apart and reorganizing them into tens and leftovers, and to determine how the child solves problems presented symbolically.

Assessing Math Concepts Research Application

Assessing Math Concepts incorporates ideas and strategies supported by all of the research outlined above. Teachers can assess students' learning as they develop particular concepts. The assessments identify a range of instructional needs and can be

repeated over time to document student growth. The assessments are designed to take a short amount of time while giving the teacher a great deal of information about each child, which can be used to guide instruction.

Kathy Richardson has defined the Critical Learning Phases for students of grades K-3 mathematics. A phase is a particular moment or stage in a process, especially one at which a significant change or development occurs or a particular condition is reached. The Critical Learning Phase that a child has reached determines the way he or she is able to think with numbers and to use numbers to solve problems. Classroom teachers can use the Assessing Math Concepts assessments to determine the level of thinking a child has reached. Knowing this level will guide the teacher's instruction and ensure that children will be working at a level that is most appropriate, therefore ensuring maximum growth and understanding.

Teachers benefit greatly from the data gathered from the individual Assessment Math Concepts interviews. The assessments help them know what to look for when they watch their students at work. The information and insights gained enable teachers to focus right away on how the children approach a task and to easily interpret what they see. Teachers are then able to respond immediately with appropriate support and challenges. What they observe then adds to the information gained from the interview, making their classroom observations much more productive than they would otherwise be.

The power inherent in these assessments is that they are simple to administer, but what can be learned from them is complex.

Field Test

Clark County School District, Las Vegas, NV
MASE Project Teachers
MAPS (Math Assessment for Primary Schools) Selected Schools involved in the field test of the assessment forms
Sue Plummer and Lori Squires, Project Leaders

Visalia Unified School District, Visalia, CA
STEPS: Math coaches, teacher leaders and classroom teachers

Larabee Elementary School, Bellingham, WA
Cathy Young, Math Coach

Childs Elementary School, Bloomington, IN
Chris Oster, teacher

Edmonds School District, Edmonds, WA
Edmonds Math Project: Teacher Leaders

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