Eisenhower Southwest Consortium for the Improvement of Mathematics and Science Teaching

Classroom Compass

Spring 1996 • Volume 2, Number 2

HIGHLIGHTS

Assessment: A Window to Learning

Betty Culver never felt comfortable with traditional report cards for her students. In fact, she was not satisfied with any form of impersonal reporting. Describing the complexity of the children's learning throughout the year was difficult. Even parent conferences, which did provide face-to-face explanations of the students' achievements, could not adequately describe their growth and development. How could one gather all the details from the past six weeks and communicate them in one short session to a listening parent? Betty's solution was to capture on-going classroom work and teacher-student interviews on video. She showed clips to the parents as an introduction to their conference discussion. The videos helped her effectively communicate student progress and analyze her own instruction. Assessment became a tool of learning, not a weapon of control.

Defining Our Goals

What should instruction accomplish? Should students be memorizing multiplication facts or solving problems? Or both? Should they be conducting inquiries or studying codified scientific understanding? Or both? The answers to such questions should be the basis for assessment strategies. When expectations for a core of knowledge, skills, and practices are defined, teachers and students can identify what is required for success. Rigorous standards, which articulate expectations or benchmarks for students at various grade levels, can provide a foundation for teachers, schools, and communities to build an assessment structure.

continued on page 2

Assessment, *continued*

Assessment results can be guideposts that help both teacher and student identify what has been learned and what areas need further work. They can be used as part of a cycle that includes instruction and assessment, then evaluation and redesign of instruction. Such assessments are an integral part of the teaching day, not a report that appears every six weeks. As much a reflection of the instruction's success as of the student's progress, assessment can help teachers redirect their efforts to match students' strengths or weaknesses. Assessment should also help students think about their own learning.

Fitting Assessment with Instruction

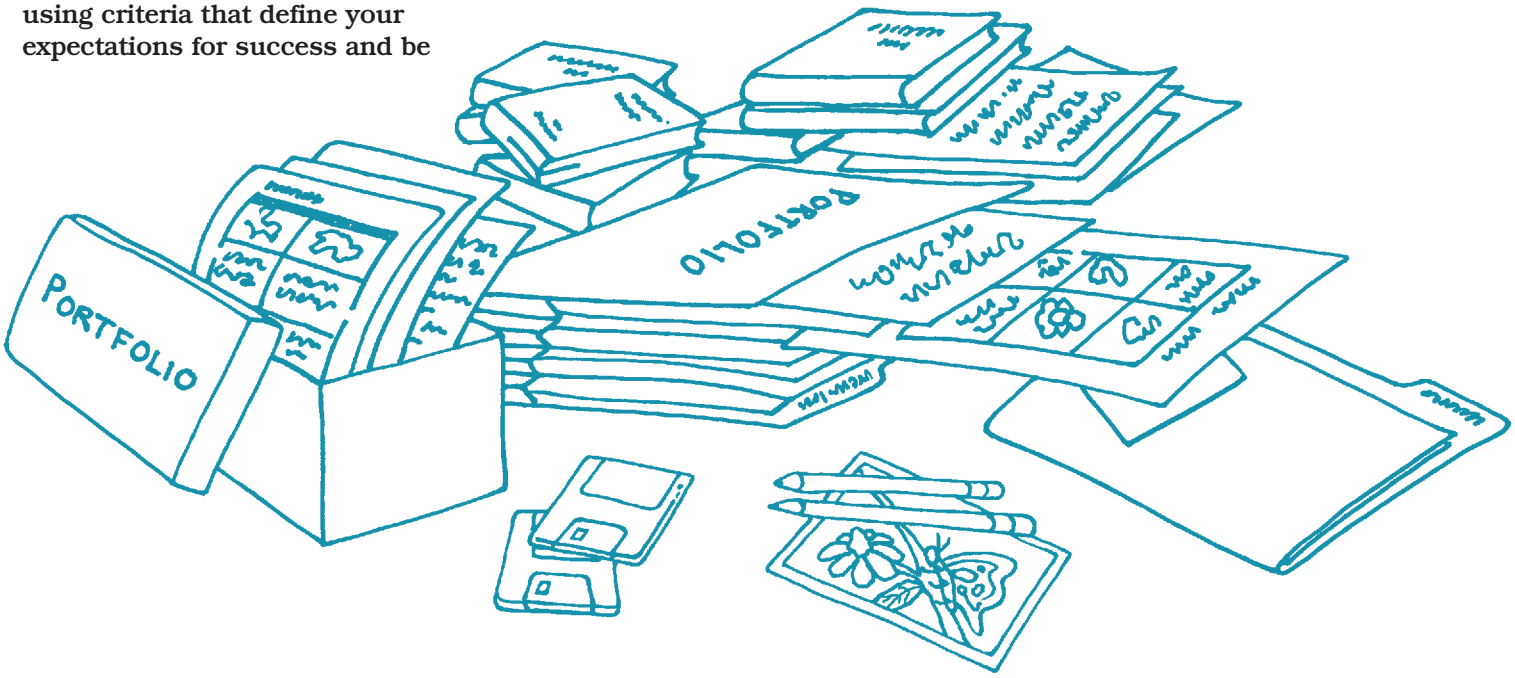
To be sure assessment supports learning, match it with classroom experience. While textbook-based tests measure what the textbook has presented, they will not provide information about students' contributions to a lively class discussion. If students spend their time working in groups, they should be assessed in a similar setting. Observe them as they interact, using criteria that define your expectations for success and be sure they know your expectations before assessment occurs. If they use calculators to solve problems, give them the same tools to complete their assessment.

If the goal of instruction is to assist all students in developing their understanding of mathematics and science, use assessment to help them expand their understanding. While a single assessment indicates understanding at a particular moment, a collection of student work and the teacher's perceptions provides a reflection of the fluid, dynamic nature of learning. Assessment that occurs as teachers listen, observe, interact, and reflect provides a picture of student development over time.

Tools for Record-keeping

Each day students provide evidence of their understanding in many ways—through explanations, discussions, projects, and questions. This evidence of student learning can be lost if there is no conscious effort to keep track. Traditional report card grades and paper-and-pencil tests reflect only a part of the classroom experience; teachers need a variety of record-keeping and reporting strategies to capture other evidence of growth in understanding. These can include videos as well as checklists, rubrics, student portfolios, and project evaluations—tools that can convey the complexity of student learning.

Teachers are researchers in their classrooms. They are engaged in observing students who are engaged in learning. Walking around the classroom with a clipboard and an observation sheet can be an effective way to keep track of student progress. Some teachers have found that personal digital assistants (PDAs) are invaluable portable aids to data collection. These hand-held electronic record-keepers can be programmed with learner profiles and defined characteristics the teacher will be looking for. The information can later be downloaded to a computer. Another tool—the camera—can be used to take photographs that record activities and projects providing excellent reminders of events, student participation, and products.



Putting Numbers on Performance

Single-answer questions are easy to score. Part of the power of standardized, single-answer tests is the solid, quantifiable numbers they produce. But how does a teacher quantify an open-ended class discussion? What can be reported about the processes used in a science investigation? Teachers need ways to organize and report what occurs in the classroom. One way to do this is through the use of rubrics. Rubrics are scoring guides that assign numerical values to achievement outcomes.

Many rubrics include examples that illustrate and differentiate between the different categories. For instance, one of the rubrics below addresses observation—an essential skill in scientific investigation. The example provides a continuum of designations of observational skill: Novice ("Sees only obvious things"), Proficient ("Can quantify observations"), or Advanced ("Uses patterns and relationships to focus further observations"). Content knowledge is categorized in a similar way in the Food for Animals rubric.

Food for Animals

N
- Anything an animal takes in is food.

N+
- Shows some ideas from Novice level and some from Proficient level.

P
- Animals need food, water, and air to live.
- Animals get food from eating plants or other animals.
- Animals get both nutrients and energy from food.

A
- Shows some ideas from Proficient level, and some from Advanced level.
- Unlike plants, animals take in food and break it into small particles in their guts.
- Some food energy is stored inside animals, and some is released as heat when animals use the food to grow and function.

Observing and Measuring

N
- Sees only obvious things
- Notices few details or changes; poor discrimination ability
- Doesn't use all senses

N+
- Makes somewhat focused and active observations, but their quality, depth, breadth, and accuracy is inconsistent

P
- Uses all senses to notice details, patterns, similarities, and differences
- Can quantify observations using appropriate measurements

A
- Follows a regular program of observation and measurement
- Makes objective and accurate observations and measurements consistently

A
- Judges how frequent and accurate observations and measurements need to be for an experiment, and makes them accordingly
- Uses discerned patterns and relationships to focus further observations

Getting Others' Views

Even with the aid of good instruments and tools, a teacher may want to involve others in the assessment process. Expanding the audience for student performance helps guard against personal biases and adds the value of additional perceptions to the assessment process. A team of teachers can cooperatively grade a collection of portfolios or projects. Groups of teachers who regularly discuss assessment practices and issues will uncover alternative views of students' achievements. Teams from within the school or the community can examine collections of students' work or be the audience for student presentations. Students can contribute by suggesting evaluation criteria and voicing their views of what constitutes acceptable and quality work.

Assessment is an essential part of the teaching process; some say it actually drives instruction. If this is true, then introducing alternative ways of assessing students will result in different ways of teaching. Instruction that helps students perform confidently on a performance test is very different from instruction that prepares students for a paper-and-pencil test. The resultant learning will reflect those differences.

See ***Classroom Assessment: A List of Readings*** on page 10

Developing Self-Directed Learners

an excerpt from the *National Science Education Standards*

Students need the opportunity to evaluate and reflect on their own scientific understanding and ability. Before students can do this, they need to understand the goals for learning science. The ability to self-assess understanding is an essential tool for self-directed learning. Through self-reflection, students clarify ideas of what they are supposed to learn. They begin to internalize the expectation that they can learn science. Developing self-assessment skills is an ongoing process throughout a student's school career, becoming increasingly more sophisticated and self-initiated as a student progresses.

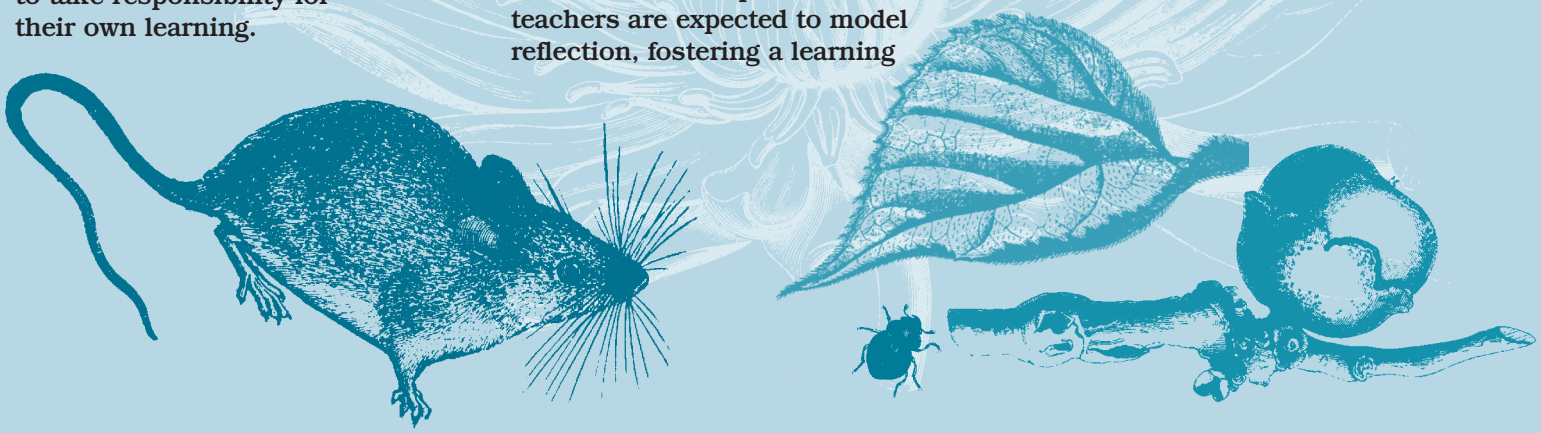
Conversations among a teacher and students about assessment tasks and the teachers' evaluation of performance provide students with necessary information to assess their own work. In concert with opportunities to apply it to individual work and to the work of peers, that information contributes to the development of students' self-assessment skills. By developing these skills, students become able to take responsibility for their own learning.

Teachers have communicated their assessment practices, their standards for performance, and criteria for evaluation to students when students are able to

- Select a piece of their own work to provide evidence of understanding of a scientific concept, principle, or law—or their ability to conduct scientific inquiry.
- Explain orally, in writing, or through illustration how a work sample provides evidence of understanding.
- Critique a sample of their own work using the teacher's standards and criteria for quality.
- Critique the work of other students in constructive ways.

Involving students in the assessment process increases the responsibilities of the teacher. Teachers of science are the representatives of the scientific community in their classrooms; they represent a culture and a way of thinking that might be quite unfamiliar to students. As representatives, teachers are expected to model reflection, fostering a learning environment where students review each others' work, offer suggestions, and challenge mistakes in investigative processes, faulty reasoning, or poorly supported conclusions.

A teacher's formal and informal evaluations of student work should exemplify scientific practice in making judgments. The standards for judging the significance, soundness, and creativity of work in professional scientific work are complex, but they are not arbitrary. In the work of classroom learning and investigation, teachers represent the standards of practice of the scientific community. When teachers treat students as serious learners and serve as coaches rather than judges, students come to understand and apply standards of good scientific practice.



A WRITTEN ASSESSMENT FOR ELEMENTARY STUDENTS

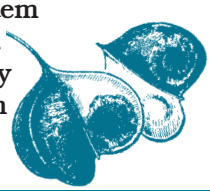
Environmental Impact Statements

Students predict the effects of a cleanup effort on their outdoor study site

This Environmental Impact Statement assignment is part of Who Eats What?—a 4-week unit on the ecology of food webs for upper elementary students. During the unit, students work to determine the food web of a chosen outdoor study site—possibly the schoolyard or a nearby park. The unit includes classroom and field-based studies, games, presentations, and background readings that support reflection, discussion, and exploration.

Assessment data is collected throughout Who Eats What? Students contribute to journals or e-mail, save materials for portfolios, and complete self-evaluations and group evaluations. They also complete two erformance events: the development of an interpretive outdoor study station for the field study site and an exhibition about "Who Eats What?" for an invited audience. Students who have completed several weeks' work on the unit would be ready for the Environmental Impact Statement assignment.

In the introduction to this activity, let the class members discuss their ideas of what constitutes good work. The list at right gives an idea of possible criteria that might be suggested. You may want to assign a point system to help your analysis. For example, correctly tracing the food chain might get a higher score than mentioning an organism that would die from the cleanup. Let the rubric reflect what you and your class think is important.



The students can discuss ideas for the statement in pairs, then individually write an Environmental Impact Statement addressed to the landowner. After a class discussion about the statements, the students can evaluate their work and choose samples for a portfolio.

By the end of this activity, students should have demonstrated:

- Their understanding of how changes in a landscape could ripple through a food web.
- Their understanding of the importance of considering the food web of a piece of land before altering it.

The Scenario

A new business called the Clean Up Crew Two has made a special offer to the owner of your study site. After its parent company, the Clean Up Crew, picks up any trash on the site, Clean Up Crew Two will clear away all the dead leaves, branches, logs, and all other dead material on the ground. Clean Up Crew Two will also remove dead branches from living plants, and dead plants that are still standing. They say that their work will make the site a neater, cleaner, and safer place for people to enjoy. Their first visit will be free, then the landowner will pay a discount price for a cleanup every six months.

Student Challenge:
Write an Environmental Impact Statement in the form of a letter to the study site landowners. Say what you predict would happen to the things that live on the site if the owners accept the cleanup offer. Give examples of how each thing affected could cause other changes in the food web. You may use food chains, food webs, and resource books to help figure out how Clean Up Crew Two's work could affect the site.

Environmental Impact Statement: *Essential Points*

Content

- Mentions organisms that would die or lose their food source
- Mentions organisms that could increase
- Uses food chain vocabulary

Scope

- Describes how one change could affect more than one food chain in a food web
- Correctly traces a food chain through at least two steps

Communication

- Overall, presents a clear, detailed, and convincing argument for why to accept or not accept the cleanup offer

SCORED DISCUSSIONS FOR UPPER LEVEL STUDENTS

Thinking Aloud About Mathematics

This assessment actively involves an entire mathematics class in a problem-solving discussion. Eilene Leach explained this method of challenging her Colorado high school students in "An Alternative Form of Evaluation" in the November 1992 issue of The Mathematics Teacher.

Several days a week Eilene Leach begins class with the following scenario: a challenging homework problem is presented to a group of four students who sit in front of their classmates. The group is given five minutes to discuss and solve the problem while the rest of the class observes.

"When I first tried scored discussion, I was afraid the students would hate it. I was wrong. Those students in front of the class were trying their best, since they were working in front of their peers. The students in the audience listened intently. I learned more about how students reasoned than I had by watching them in cooperative groups....[After the timer bell rang] the audience could contribute to the suggestions.... Sometimes the students in the audience were so excited they could hardly keep quiet until the five-minute timer rang."

Leach has developed a rubric that she uses to score group members as they puzzle through the problem. Problem-solving skills and the successful use of appropriate mathematical strategies are valued, as are indications of skillful group interaction.

"By seeing the scored discussions the students learned how to discuss mathematics....When a group has a particularly difficult time with their problem, I pull my chair into the group and continue the discussion for several more minutes, modeling how to develop a strategy and how to involve all members in the solution process."

Discussion Scoring Guide

Positive Points	
• Determining a possible strategy to use	+3 points
• Successfully communicating a strategy	+3 points
• Correctly applying a property	+2 points
• Recognizing misused properties or arithmetic errors	+2 points
• Drawing another person into discussion	+2 points
• Asking a clarifying question	+3 points
• Moving the discussion along	+1 point
Negative Points	
• Not paying attention or distracting others	–2 points
• Interrupting	–2 points
• Making an incorrect assumption	–2 points
• Making a personal attack	–3 points

This activity provides the students an arena for public discourse about mathematics. It accommodates several NCTM curriculum standards including:

- Learning to reason mathematically
- Learning to communicate mathematically
- Becoming mathematical problem solvers

The discourse sessions give every participant the possibility of success.

The sessions provide an alternative to paper-and-pencil assessments and let students explain their thinking and demonstrate their ideas.

Once or twice a semester, Leach devotes the entire period to scored discussions.

At the beginning of the semester, Leach explains the activity and enlists several students in a "trial run." She emphasizes problem-solving strategies and successful group techniques as well as ways students can lose points through interrupting or monopolizing the discussion. She gives the students copies of the score sheet so they will know expectations for a successful session. An added bonus: if the students solve the problem, it is not on that night's homework.

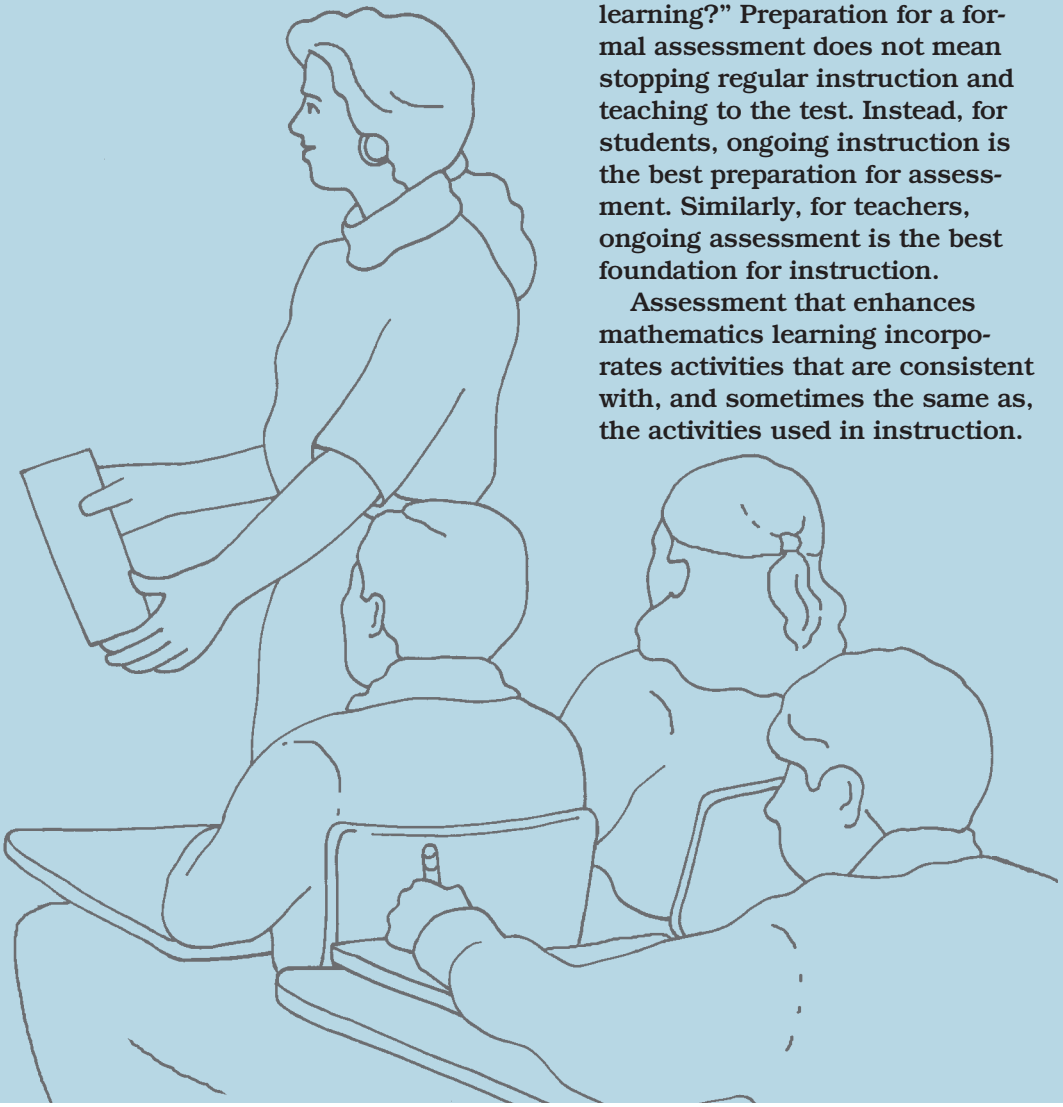
The Learning Standard: Assessment in Mathematics Classrooms

an excerpt from *Assessment Standards for School Mathematics*

Assessment that enhances mathematics learning becomes a routine part of ongoing classroom activity rather than an interruption. Assessment does not simply mark the end of a learning cycle. Rather, it is an integral part of instruction that encourages and supports further learning. Opportunities for informal assessment occur naturally in every lesson. They include listening to students, observing them, and making sense of what they say and do. Especially with very young children, the observation of students' work can reveal qualities of thinking not tapped by written or oral activities. In planning lessons and making instructional decisions, teachers identify opportunities for a variety of assessments. Questions like the following become a regular part of the teacher's planning: "What questions will I ask?" "What will I observe?" "What activities are likely to provide me with information about students' learning?" Preparation for a formal assessment does not mean stopping regular instruction and teaching to the test. Instead, for students, ongoing instruction is the best preparation for assessment. Similarly, for teachers, ongoing assessment is the best foundation for instruction.

Assessment that enhances mathematics learning incorporates activities that are consistent with, and sometimes the same as, the activities used in instruction. For example, if students are learning by communicating their mathematical ideas in writing, their knowledge of mathematics is assessed, in part, by having them write about their mathematical ideas. If they are learning in groups, they may be assessed in groups. If graphing calculators are used in instruction, they are to be available for use in assessment.

Students' classroom work, along with projects and other out-of-class work, is a rich source of assessment data for making inferences about students' learning. Many products of classroom activity are indicators of mathematics learning: oral comments, written papers, journal entries, drawings, computer-generated models, and other means of representing knowledge. Students and teachers use this evidence, along with information from more formal assessment activities, to determine next steps in learning. Evidence of mathematics learning can be found in activities that range from draft work, through work that reflects students' use of feedback and helpful criticism, to a polished end product. Continuous assessment of students' work not only facilitates their learning of mathematics but also enhances their confidence in what they understand and can communicate. Moreover, external assessments support instruction most strongly when classroom work is included. When classroom work, the teacher's judgments, and students' reflections are valued parts of an external assessment, they enhance students' mathematics learning by increasing the fit between instructional goals and assessment.



Resources and Opportunities

A Personal Digital Assistant

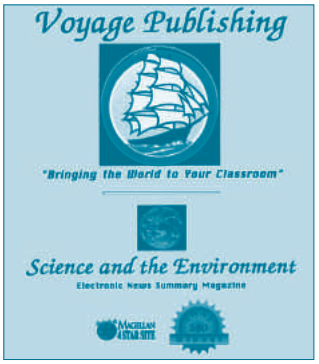
The Newton MessagePad, made by Apple Computer, is an electronic device that converts written notes into typed documents, which can then (with an additional connection kit) be transferred to a Macintosh computer or a PC that uses Windows software. Load these hand-held devices with appropriate software and student assessment profiles can be designed to fit your specifications. This gadget serves as an electronic clipboard that lets the user gather, organize, and interpret data more efficiently than with paper-and-pencil records. For further information about the educator's advantage price, call Apple at 1-800-959-2775. The Newtons cost around $500 with the educator's advantage.

Learner Profile

Sunburst educational software company offers assessment software that can be loaded on the Apple Newton or used with a bar code scanner to provide a mobile data collection tool. The software allows the user to create descriptions of desired student learning on the computer, then transfer the data to the hand-held device. After the data are collected (at the end of the day, at the end of the week), transfer the observations back to the computer for analysis, grouping, and report generation. A 1.4 MB disk for Macintosh or Windows is priced at $99. Call Sunburst at 1-800-321-7511.

Eco-Inquiry

A hefty volume of 392 pages, *Eco-Inquiry* provides three ecology modules for upper elementary or middle grades. The four-to-seven week modules examine food webs, decomposition, and nutrient cycling and include suggestions for hands-on investigations, discussions, games, writing assignments, and presentations. Assessment is encouraged throughout the modules with ideas for journal topics, collection of portfolio materials, suggestions for written and performance activities, and student self-evaluations. *Eco-Inquiry* by Kathleen Hogan. Dubuque, Iowa: Kendall-Hunt Publishing Company. 1994. $36.95

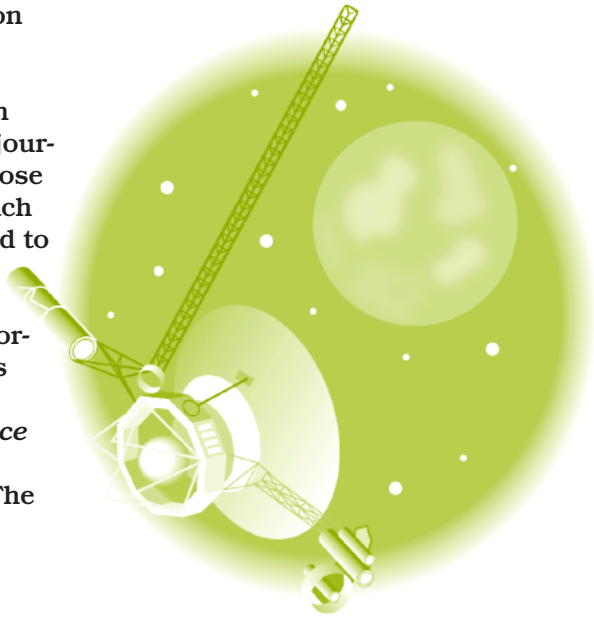


Voyage Web Site

This bimonthly internet magazine provides summaries of news stories on environmental issues. Editors review more than 500 magazines, journals, and newspapers and choose 80 articles to summarize in each issue. Students are encouraged to copy the summaries and use them for classroom research sources. Full bibliographic information on the original sources (an eclectic list that includes *ZooNooz, The Christian Science Monitor, Newsweek,* and *The Jerusalem Post*) is provided. The Web address is: <http://www.voyagepub.com/publish>.

Mars Modules

The TERC corporation (formerly Technical Education Research Center), located in Cambridge, Massachusetts, continues to develop exciting products and programs for mathematics and science educators. In anticipation of upcoming orbiter and lander missions, TERC, in collaboration with NASA, is developing hands-on, discovery-oriented investigations focusing on the planet Mars. Developers are looking for middle-school teachers to field test pilot materials during the 1996-1997 school year. Units currently available are Planetary Exploration, Volcanoes, and Valley Formation. The activities enable students to confront preconceptions, refine questions for investigation, construct meaning from images and data, develop hypotheses, collect evidence in support of hypotheses, and synthesize understanding. The modules vary in length from two to three weeks and include materials for teachers and students as well as assessment tools. The pilot activities have no technology requirements. For more information, call (617)-547-0430 or e-mail Chris Randall <chris_randall@terc.edu>.



Professional Development Awards

Congratulations to recipients of Eisenhower SCIMAST Professional Development Awards. Over 100 schools, university programs, nonprofit organizations, and community groups applied for the five-year awards offered to educators in SCIMAST's five-state region. The successful proposals emerged from a series of reviews including several SCIMAST staff reviews, scrutiny by a 10-member expert panel and final approval by a 15-member Consortium Advisory Board. The programs will receive up to $20,000 per year to carry out their professional development activities in science or mathematics education. The successful recipients are

Albuquerque Public Schools
Annalee Maestas and
Dolores Varela-Phillips,
Project Co-Directors
Albuquerque, New Mexico

College of Santa Fe
Manon Charbonneau,
Project Director
Santa Fe, New Mexico

Deer Park Educational Foundation
Nancy Hodges, Project Director
Deer Park, Texas

Ector County ISD
Rita Latimer, Project Director
Odessa, Texas

Konawa Public Schools
C.J. Vires, Project Director
Konawa, Oklahoma

New Mexico State University
Elaine Hampton, Project Director
Las Cruces, New Mexico

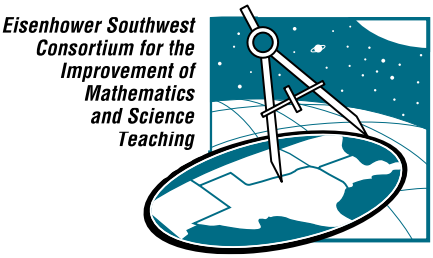
Northeast Louisiana University
Rhonda Adams, Project Director
Monroe, Louisiana

University of Texas Marine Science Institute
Rick Tinnin, Project Director
Port Aransas, Texas

University of Texas Science and Technology Center
John White, Project Director
Austin, Texas

S C I M A S T

Eisenhower Southwest Consortium for the Improvement of Mathematics and Science Teaching



The Eisenhower SCIMAST project supports science and mathematics education in five states with a combination of training, technical assistance, networking, and information resources. Eisenhower SCIMAST is funded by the U.S. Department of Education's National Eisenhower Program to serve educators in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. Eisenhower SCIMAST works in partnership with the Eisenhower National Clearinghouse, a national resource center dedicated to increasing the availability and the quality of information about instructional resources for science and mathematics educators. As part of that effort, Eisenhower SCIMAST has a resource/demonstration center open to visitors Monday through Friday, 8:00 A.M. to 5:00 P.M. The center houses a multimedia collection of science and mathematics instructional materials for grades K–12. It is located on the fourth floor of the Southwest Educational Development Laboratory, 211 East Seventh Street, Austin, Texas 78701. The center also has a toll-free number, **1-800-201-7435**, that provides callers in the five-state region information on multimedia and print instructional materials, assessment tools, and successful strategies for mathematics and science instruction.

Eisenhower SCIMAST Staff:

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Maria Torres, senior training associate
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Veronica Lopez, administrative secretary
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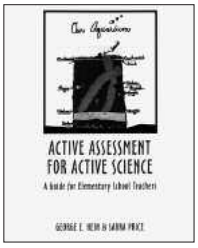
Classroom Assessment

A LIST OF READINGS

Hein, George E., and Sabra Price
Active Assessment for Active Science: A Guide for Elementary School Teachers
Portsmouth, NH: Heinemann, 1994

Heinemann Publishing
361 Hanover Street
Portsmouth, NH 03801-3912
$10.00



Hein and Price present ideas for assessment that accompanies active learning. With a focus on the elementary science classroom, the authors devote much of the book to practical suggestions for managing assessment of active learning. They also discuss ways to interpret and score children's science work. Illustrations and explanations of assessment tools include questionnaires, drawings, student self-evaluations, folders, notebooks, and embedded products and activities.

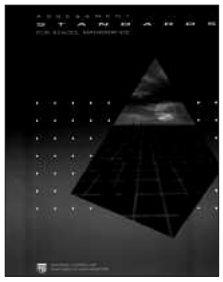
Mathematical Science Education Board
Measuring What Counts: A Conceptual Guide for Mathematics Assessment
Washington, DC: National Academy Press

National Academy Press
2101 Constitution Ave. N.W.
Washington, DC 20418
1-800-624-6242
$17.95

Cited as the scholarly base for NCTM's *Assessment Standards*, this report provides a research-based argument for mathematics assessment that not only measures results, but also contributes to the educational process itself. The report focuses on three fundamental principles: the content principle ("Assessment should reflect the mathematics that is most important to learn"), the learning principle ("Assessment should enhance mathematics learning and support good instructional practice"), and the equity principle ("Assessment should support every student's opportunity to learn important mathematics").

National Council of Teachers of Mathematics
Assessment Standards for School Mathematics
Reston, VA: Author, 1993

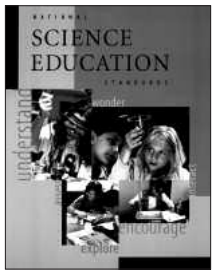
NCTM, 1900 Association Drive
Reston, VA 22091
1-800-235-7566
$25.00



Published in 1995, the *Assessment Standards* complements the earlier *Curriculum Standards* (1989), and the *Professional Standards* (1991), all written by groups of mathematics educators supported by NCTM. The *Assessment Standards* presents strategies and practices to help teachers assess students in a manner that reflects the reformed mathematics classroom. *Assessment Standards* addresses six major themes: mathematics, learning, equity, openness, inferences, and coherence.

National Research Council
National Science Education Standards
Washington, DC: National Academy Press, 1996

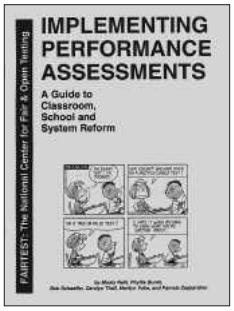
National Academy Press,
2101 Constitution Ave. N.W.
Washington, DC 20418
1-800-624-6242
$16.50



In the recently published *National Science Education Standards*, a chapter on assessment presents five standards that emphasize consistency, probing for student understanding, authenticity, fairness, and sound inference from assessment data. For teachers, the authors suggest using assessment data to plan curricula, improve classroom practice, develop self-directed learners, report student progress, and inquire into their own teaching.

Neill, Monty, et al
Implementing Performance Assessments: A Guide to Classroom, School and System Reform
Cambridge, MA: FairTest, n.d.

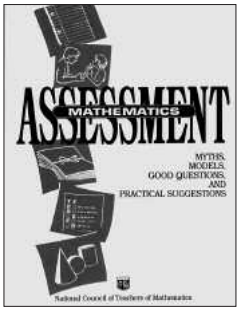
The National Center for Fair and Open Testing
342 Broadway
Cambridge, MA 02139
(617) 864-4810
$6, discounts for multiple copies



The National Center for Fair and Open Testing presents this guide for teachers, administrators, parents, community members, anyone "interested in using performance assessments in their classrooms and school systems." The 56-page booklet argues in support of performance-based testing and suggests ways various players (i.e. teachers, parents, etc.) can work to change traditional assessment practices. It also includes practical suggestions for scoring, developing rubrics, record-keeping, performance exams and projects.

Stenmark, Jean K., ed.
Mathematics Assessment: Myths, Models, Good Questions, and Practical Suggestions
Reston, VA: National Council of Teachers of Mathematics, 1991

NCTM, 1900 Association Drive
Reston, VA 22091
1-800-235-7566
$8.50



This book offers mathematics teachers an introduction to assessment techniques that focus on student thinking. The first segments of the book discuss such myths of teaching and testing as "in the classroom, only the teacher can adequately evaluate a student's progress" or "the purpose of assessment is to determine which students 'have it' and which do not." Later chapters provide suggestions and examples for introducing a variety of assessment methods in K–12 mathematics lessons. One chapter is devoted to mathematics portfolios.