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ABSTRACT

This issue of ENC Focus is organized around the theme of educational change. It intends to provide teachers with practical resources and suggestions for implementing reform ideas in the classrooms. Featured articles include: (1) "There Can Be No Improvement Without the Teacher" (Michael Fullan and Andy Hargreaves); (2) "Changing Habits of a Lifetime" (Marsha Paulus Nicol); (3) "Playing to Learn: Systems Change Game Challenges and Teaches" (Carol Bershad and Susan Mundry); (4) "Help in Making Change: SummerMath for Teachers Serves as a Model" (Virginia Bastable); (5) "Teachers Transformed" (Annette Thorson); (6) "Evolving with the Internet: Taking Technology for Granted--Finally" (Kristine Mueh); (7) "Twelve Small Steps toward Change" (Lynda Titterington); (8) "First in the World Consortium: Superintendents Lead the Way to Systemic Change" (Leah Poynter); and (9) "Student Discourse in an Inquiry-Based Elementary Science Class" (Kathleen M. Collins, Fe MacLean, Annemarie Palincsar, and Shirley Magnusson). (WRM)

enc focus
vol. 7, no. 1, 2000
A Magazine for Classroom Innovators

The Reality of CHANGE

GUIDELINES FOR CHANGING SCHOOL CULTURE

12 NEW STRATEGIES YOU CAN USE TOMORROW

FACING THE CHALLENGE OF CHANGE—CLASSROOM TEACHERS TELL HOW

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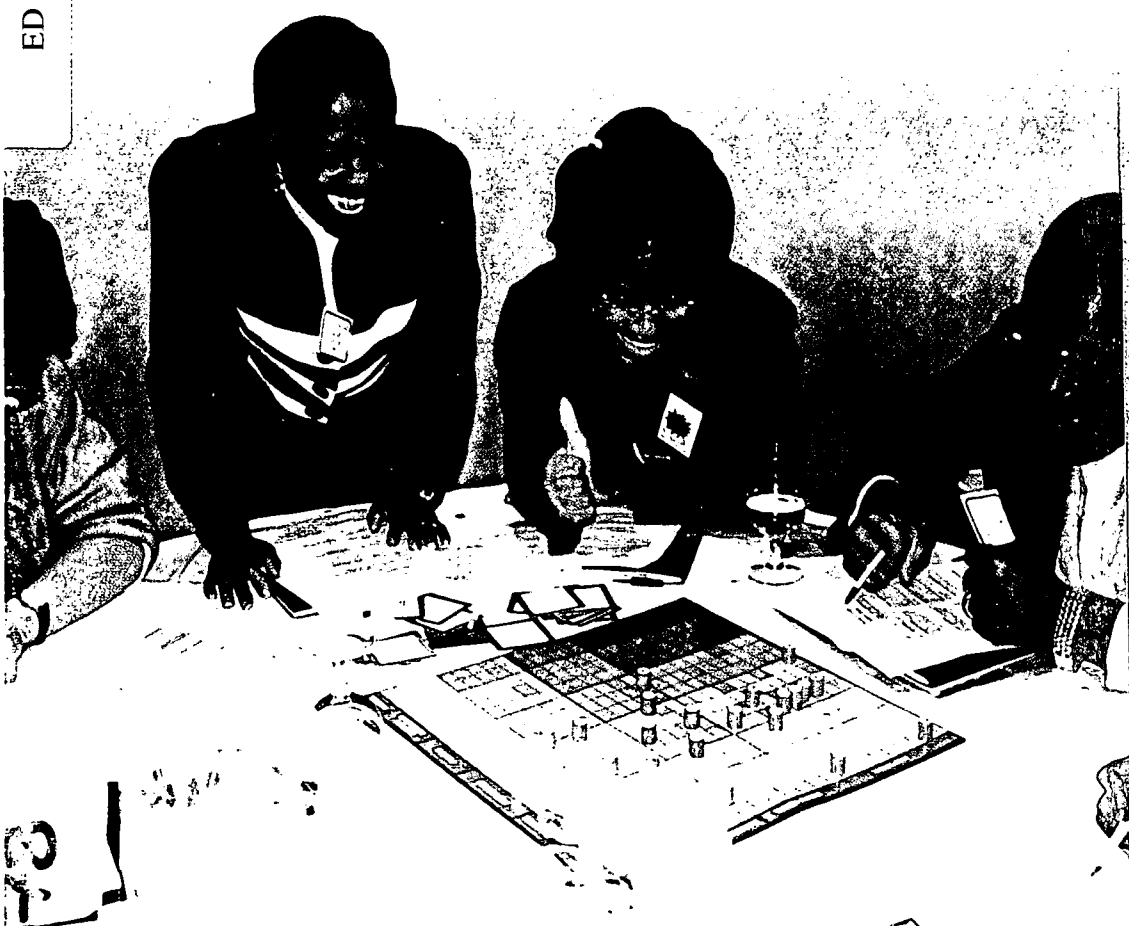

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Playing to Learn...See page 24.

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- ◯ science education
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is to identify effective curriculum resources, create high-quality professional development materials, and disseminate useful information and products to improve K–12 mathematics and science teaching and learning.

Serves all K–12 educators, parents, and students with free products and services.

Acquires and catalogs mathematics and science curriculum resources, creating the most comprehensive collection in the nation.

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Supports teachers' professional development in math, science, and the effective use of technology.

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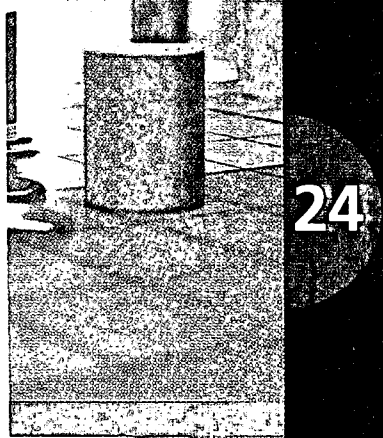

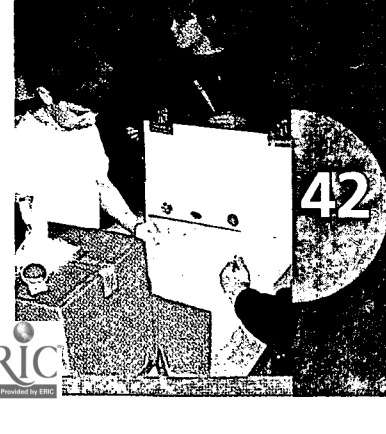

ENC Focus: A Magazine for Classroom Innovators, Volume 7, Number 1
Theme for this Issue: The Reality of Change

This icon invites you to visit the Internet for more information, more resources, more ideas for your own classroom innovations. The online version of this publication will help you get started. Visit http://www.enc.org/focus/change/

Update: Around the Clearinghouse and the Nation

This section features educational news, editorials, essays, classroom stories, columns on topics of interest to classroom innovators, and other information of the sort formerly published in our newsletter ENC Update.

ɔcus On: The Reality of Change

This section presents articles on the theme of this issue.

Focus On: The Collection

This section presents abstracts of materials from the ENC Collection chosen to illustrate this issue's theme, The Reality of Change.

JUMP ONLINE

For the full text of excellent journal articles for educators exploring change, go to ENC Online's Teacher Change: Improving K-12 Mathematics http://change.enc.org/. Click on Resources for Change and then Suggested Readings.

ENC Focus is published by the Eisenhower National Clearinghouse for Mathematics and Science Education. ENC is funded at least in part through Contract No. RJ97071001 with the U.S. Department of Education, Office of Educational Research and Improvement (OERI). The contents of this publication do not necessarily reflect the views or policies of the U.S. Department of Education nor does the mention of tradenames, commercial products, or organizations imply endorsement by the U.S. Government. ENC welcomes readers' comments and questions. Please address them to:

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editorial

No Pain, No Gain

by Annette Thorson, ENC Publishing

When I taught expository writing, I always kept one particular item on the bulletin board of my classroom. It was a magazine advertisement for an exercise machine featuring a black and white photo of an extremely fit young man using the equipment. Superimposed on the photo were large black letters: **No Pain, No Gain.** My hope, of course, was that my students would realize that learning to write well would be worth as much sweat as toning their abs.

As teachers, we recognize that learning is hard, at times painful. We help our students with the struggle every single day. Harder, more painful, still is taking the next step, applying that learning by changing one's behavior.

That sounds obvious, doesn't it? But many of the people who make the loudest demands for the reform of our educational system seem to overlook the difficulty of making the kind of change necessary. In fact, some people seem to think if we just require our students to take more standardized tests or if we fill our classrooms with enough computers, somehow education will improve.

Classroom teachers know better. In their article on page 16, international change authorities Fullan and Hargreaves remind us, "There Can Be No Improvement Without the Teacher." Recognizing that this is so, we at ENC wanted to help teachers face the future by exploring the Reality of Change—the fact that it is hard, even painful.

Let us know how ENC can serve you by calling or sending a message via email or US mail to the following departments:

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For the most up-to-date information on our latest projects, visit ENC's web site: **http://www.enc.org/**

To be sure, we would like to suggest ways to make change easier. This issue includes "Playing to Learn" in which game developers Carol Bershad and Susan Mundry describe how an engaging simulation can help districts face change (page 24). Science teacher and ENC staffer Lynda Titterington provides some low-risk techniques in "Twelve Small Steps Toward Change" (page 38). On page 28, Virginia Bastable describes a professional development program that has found some answers. Teachers Mike Smith (page 20), Valerie Penniman (page 31), and Kristine Meuh (page 35) tell inspiring stories of successful classroom change.

Nevertheless, at the foundation of every article is the recognition that successes do not come easily. Looking back on their own experiences with change, our writers admit:

> "It takes a long time and great deal of care...." (See page 18.)
> "Quite frankly, I'm afraid [using a new technique] is going to reveal too much about what I don't know." (See page 20.)
> "[You need to] have the courage to listen to resisters." (See page 27.)
> "[I had to realize] it is okay not to succeed." (See page 31.)
> "It was really earthshaking." (See page 32.)
> "I was anxious." (See page 32.)
> "I was frustrated." (See page 32.)
> "Questions were churning around and around in my head like a tornado about to touch down." (See page 34.)
> "I was not ready for the questions the students were asking." (See page 44.)

As always, we hope you will make use of this issue of *ENC Focus* to find practical ideas and resources (see page 45) that help you improve your classroom. But we also hope that the honest voices of educators presented here will give you emotional support so you can concentrate on the gain rather than the pain—so you can embrace the Reality of Change. ◉

Email the editor at athorson@enc.org

Several of the articles in this issue were originally published in ENC's professional development project, Teacher Change: Improving K-12 Mathematics. In addition, articles from other educational journals are featured on the site. Access the entire contents online at http://change.enc.org/

As noted throughout this issue, it is also easy to access specific content on ENC's Teacher Change site by linking to it through the electronic version of this magazine at http://www.enc.org/focus/change/

Calling All Classroom Innovators:

WRITE FOR ENC!

ENC invites readers to contribute articles for upcoming issues of *ENC Focus: A Magazine for Classroom Innovators.*

Topics and Deadlines:

Educational Equity
Submissions due March 1, 2000

School-Business Partnerships
Submissions due June 1, 2000

Literacy in Math & Science
Submissions due September 1, 2000

Topics and deadlines subject to change without notice.

Submission Guidelines:

Articles should be of interest to teachers of K-12 mathematics and science. Content should be grounded in the new educational standards while being short (500 to 2000 words) and compelling.

We particularly invite teachers to write about their classroom experiences, using first person and a conversational tone. Please note that library research papers written in academic language for graduate school courses are unlikely to be selected for publication. We do, however, encourage you to include a few, carefully selected references. All content must be original, and all quotations must be properly cited.

We also publish essays by K-12 students about their successes in mathematics and science. Teachers are encouraged to assist students in writing and submitting materials for publication.

Photos or other illustrations add interest, and good illustrations increase your chances for publication. However, we can use photos of students only if we receive written parental permission for those under 18 years of age.

Those considering submission of unsolicited manuscripts are encouraged to send a proposal via email:

athorson@enc.org

Or by letter:

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The Ohio State University
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Questions? Email athorson@enc.org or call (800) 621-5785 and ask for Annette Thorson.

ENC's Partners:

NASA Educational Workshops (NEW)

In each issue, *ENC Focus* features one of the many organizations that collaborate with ENC to promote educational improvement. This time, we take a look at NASA Educational Workshops (NEW).

by Leah Poynter, ENC Publishing

How would you like to spend two weeks of your summer building rockets and hot air balloons? Imagine getting an insider's view at a NASA field center—seeing experimental aircraft, testing space shuttle tires, or performing flight simulations! Teachers who participate in NASA Educational Workshops (NEW) experience these types of activities each year at the 10 National Aeronautics and Space Administration field centers around the country. (See page 7 for locations.)

Approximately 250 educators are selected to participate each year. During the intensive two-week program, workshop participants meet with NASA scientists and engineers, observe research and development, and perform related activities in the classroom with everyday materials. Sometimes putting in 14-hour workdays that can start in the early morning hours, teachers gain invaluable exposure to math, science, and technology at work.

NEW provides the opportunity for teachers to improve their knowledge and skills while working on team projects they can bring back home to their schools. For every activity they do, participants apply national standards for math and science education and plan how to use these hands-on, minds-on activities with their own students. NASA Educational Workshop program manager Deborah Daniels says the comment she hears most from participating teachers is "I can't wait to go back to school!"

In regular visits to the field centers, NEW participants have access to areas where the general public is not allowed. Each center offers its own unique projects based on the facilities available. For example, participants at the Glenn Research Center in Cleveland, Ohio, visit a "Zero-G" Drop Tower facility, where they perform an Egg Drop experiment. They test aerodynamic packaging they have designed in teams to see if their eggs can survive the fall. At the Goddard Space Flight Center in Greenbelt, Maryland, educators take a look at the Hubble Control Room and simulate the launch of a Pegasus rocket at the rocket facility. While learning about rocketry, they also perform a launch activity with a water rocket made from a two-liter plastic bottle.

Every center offers a K-6, 7-12, or K-12 program each summer. NEW participants develop lasting relationships with the scientists they meet. Some past participants have called on NASA scientists for materials for their classrooms or have arranged classroom activities with input from NASA engineers.

In the summer of 1999, six of the NASA field centers also began offering NEW workshops for invited teams of educators involved with urban and rural systemic initiative programs. These workshops provide educational opportunities for in-service program staff and professional development providers of regional or state-based initiatives. Informal educator workshops were offered at two of the Field Centers.

Teachers who have participated in NEW are encouraged to conduct outreach programs in their communities. Alumni of the program can also look forward to sharing their ideas, classroom projects, and other experiences in follow-up Share-A-Thons that occur at various national conferences and meetings including the National Science Teachers Association (NSTA) National Convention, the National Council of Teachers of Mathematics (NCTM) Annual Meeting, and the International Technology Education Association (ITEA) Annual Conference. Educators who are considering applying for NEW are invited to attend these informal sessions. Workshop alumni also receive *Orbit*, a newsletter that keeps them up-to-date on NASA educational opportunities and special events and encourages them to network with other alumni.

NEW is sponsored by NASA and is implemented through a contract with NSTA, which serves as the lead educational partner to the program and provides administrative support. ITEA, NCTM, ENC, and others provide educational guidance to the program.

NASA distributes educational materials, including CD-ROMs and videos, to NEW participants. As a Program Review Committee member, ENC shares its materials with all program participants and speaks to many of them about ENC resources. ENC also serves as a NASA Educator Resource Center, providing NASA materials to educators who visit ENC's offices at The Ohio State University.

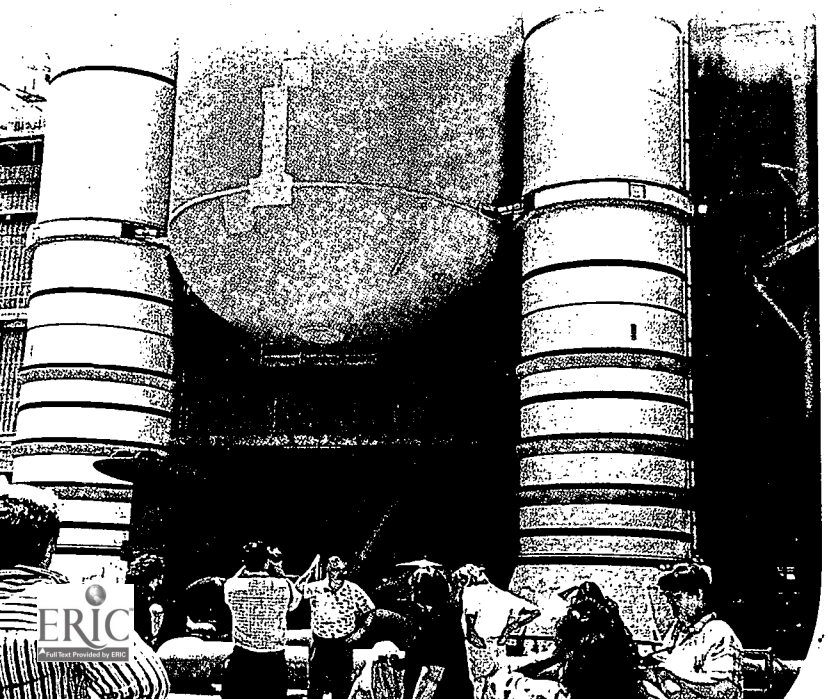
Educators who would like to apply for NEW must serve K-12 students in the areas of math, science, or technology. Expenses such as travel, housing, and meals are covered by NASA. Visit the web site listed below or call NASA Educational Workshops for more information. ◎

National Science Teachers Association
NASA Educational Workshops
1840 Wilson Blvd.
Arlington, VA 22201-3000
(703) 243-7100 / Fax: (703) 522-5413
Email: new@nsta.org

NASA Educational Workshops:
http://www.nsta.org/programs/new.htm

The NASA Education Home Page:
http://education.nasa.gov/

NASA is now providing all of its educational materials online: http://spacelink.nasa.gov/products/



NEW Locations: NASA Field Centers

Ames Research Center, Moffett Field, California, has been designated the NASA Center of Excellence for Information Technology.

Glenn Research Center, Cleveland, Ohio, concentrates on new propulsion, power, and communications technologies for application to aeronautics and space.

Dryden Flight Research Center, Edwards, California, is NASA's primary center for flight research.

Goddard Space Flight Center, Greenbelt, Maryland, expands knowledge of the Earth and its environment, the solar system, and the universe through observations from space.

Jet Propulsion Laboratory, Pasadena, California, is the lead center for robotic exploration of the solar system.

Johnson Space Center, Houston, Texas, focuses on design and development of spacecraft; selection and training of astronauts; planning and conducting human space flight missions; and participation in the experiments carried aboard space flights.

Kennedy Space Center, Florida, is the NASA Center of Excellence for launch and payload processing. It is the starting point for all US human space flights.

Langley Research Center, Hampton, Virginia, was the first national civil aeronautics laboratory and has become a world-class center for aeronautics, earth science, space technology, and structures and materials research.

Marshall Space Flight Center, Huntsville, Alabama, is the lead center for Space Transportation Development.

Stennis Space Center, Mississippi, is a Center of Excellence for rocket propulsion testing and NASA's lead for enabling companies to commercialize Remote Sensing.

ENC Partners: Eisenhower Consortia & ENC Demo Sites

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Eisenhower Regional Math/Science Consortium at AEL
Pam Buckley, Director
1700 North Moore Street, Suite 1275
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Toll-free: (800) 624-9120
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aelinfo@ael.org
URL: http://www.ael.org/eisen/

demo site

George Watson
Marshall University
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Mid-continent Region

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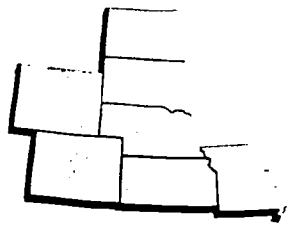

consortium

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Toll-free: (800) 949-6387

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Arizona, California, Nevada, Utah

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WestEd Eisenhower Regional Consortium for Science and Mathematics Education
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Fax: (415) 241-2746
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program: werc@wested.org
URL: http://www.wested.org/werc/

demo site

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California Academy of Sciences
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Email: amalley@cas.calacademy.org

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Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, Wisconsin

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demo site

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mathsci@rbs.org
URL: http://www.rbs.org/

demo site

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demo site

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Contact the Eisenhower Consortium or ENC Demonstration Site that serves your state for assistance in improving mathematics and science education.

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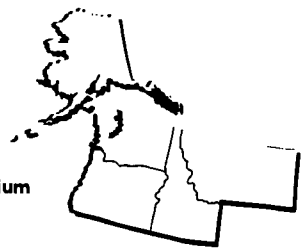

consortium

Science and Mathematics Consortium for Northwest Schools
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demo site

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Southeast Region
Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina

consortium

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demo site

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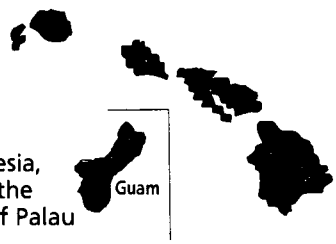
Pacific Region
American Samoa, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Hawaii, Republic of the Marshall Islands, Republic of Palau



consortium

Pacific Mathematics and Science Regional Consortium
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askmathsci@prel.hawaii.edu
URL: http://w3.prel.hawaii.edu/programs/ms/math-science.html

demo site

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Fax: (808) 533-7599
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Southwest Region
Arkansas, Louisiana, New Mexico, Oklahoma, Texas

consortium

Eisenhower Southwest Consortium for the Improvement of Mathematics and Science Teaching
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211 East Seventh Street
Austin, TX 78701
Phone: (512) 476-6861
Fax: (512) 476-2286
Email: scimast@sedl.org
URL: http://www.sedl.org/pitl/scimast/welcome.html

demo site

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Eisenhower National Clearinghouse for Mathematics and Science Education
Columbus, Ohio

demo site

Gail Hoskins
Eisenhower National Clearinghouse
The Ohio State University
1929 Kenny Road
Columbus, OH 43210-1079
Toll-Free: (800) 621-5785
Phone: (614) 292-7708
Fax: (614) 292-2066
Email: ghoskins@enc.org
URL: http://www.enc.org/

Eisenhower National Clearinghouse for Mathematics and Science Education

ENC Capital Collection & Demonstration Site
Washington, D.C.

demo site

Shirley DeLaney-Butler
The George Washington University
Instructional Media & Materials Center
Gelman Library, Room B06
2130 H Street, NW
Washington, DC 20052
Phone: (202) 994-7048
Fax: (202) 994-4520
Email: enc@gwis2.circ.gwu.edu

Connecticut is Buzzing about ENC

A Connecticut coalition works to introduce K-12 math and science teachers to ENC Online

by Christopher Shepard, Connecticut Mathematics, Science, and Technology Leadership Council

Where can teachers learn about state and national mathematics and science curriculum standards? What tools are available to assist them in identifying new instructional activities? How can they explore alternative assessment practices?

Most importantly, where can teachers find resources to assist them in investigating the alignment of their instructional and assessment practices with local student performance expectations?

To help teachers answer these questions, many of us have spent years developing guides, disseminating newsletters, and delivering workshops. But nothing brings up-to-date information into a teacher's classroom and home like the World Wide Web.

A visit to ENC's home base in Columbus, Ohio, revealed to Connecticut leaders that ENC Online provides just what we were looking for: a singular resource with a vast quantity of quality information made accessible through easy-to-use web tools. We agreed that every mathematics and science teacher in Connecticut should be introduced to ENC Online.

This goal will be accomplished through the Connecticut Mathematics, Science, and Technology Leadership Council, a coalition of local K-16 education professional associations, the Statewide Systemic Initiative, and the State Department of Education.

The Leadership Council, with assistance from the Northeast and Islands Regional ENC Demonstration Site at the Eisenhower Regional Alliance at TERC, will employ a "training of trainers" model to introduce two dozen presenters to ENC Online. The intended audience is the Leadership Council's own membership, professional development staff of the state's Regional Education Service Centers, and media specialists and faculty at colleges and universities involved in teacher preparation.

The training will support participants in incorporating the use of ENC Online into presentations at association conferences, professional development offerings, and preservice classes. It will also provide opportunities for follow-up and feedback.

Select participants will receive additional support to establish and operate six new ENC Access Centers at professional development sites across the state.

Thus, educators in every district in the state will be introduced to ENC Online within a year, and the broad array of presenters assembled by the Leadership Council eventually will reach every school. We'll keep you posted! ◎

For more information, contact:
Christopher Shepard
Connecticut Mathematics,
Science & Technology Leadership Council
(860) 346-1177
Email: cshepard@ctacad.org

For more information about the Connecticut Mathematics, Science, and Technology Leadership Council, visit:
http://www.ctacad.org/

Link to all the sites mentioned in this magazine by visiting the online version of *ENC Focus*:
http://www.enc.org/focus/change/

See Your Story on this Page!

Do you have a story about how you used ENC products or services? Please email it to us at editor@enc.org or mail to Focus Editor, ENC, The Ohio State University, 1929 Kenny Road, Columbus, OH 43210-1079.

Taming the World Wide Web

In each issue, ENC's Associate Director of Instructional Resources writes about her experiences using the Internet as an educator.

by Kimberly S. Roempler, ENC Instructional Resources

My basement has been the bane of my existence. It brings out the pack rat in me. It is so convenient—I just keep collecting things and shoving them downstairs. It takes me forever to find anything in that jungle—many times I just give up. In fact, I probably don't know what all I have down there.

At one time, I felt the same about collecting sites I found on the web. All the fascinating information on the Internet brought out the pack rat in me. I would find a great site and, with one click, save it on my bookmark list.

Before long, I had a list of bookmarks that defied definition. I couldn't remember what many bookmarks referred to because their titles didn't bear any relation to the contents of the web page they were marking. All too often, I caught myself saying, "I remember bookmarking a site about this topic, but where is it?" I would get that hopeless, searching-in-the-basement feeling. Many times I just gave up. In fact, I did not know what all I had on my bookmark list.

I finally realized that when you have invested so much time searching for sites that fill all your different needs, it is a shame when you can't access a particular site immediately when you want it.

Bookmarks (also known as Favorites) are very easy to create in both Netscape and Explorer: select the Add feature on the Bookmarks—or Favorites—pull-down menu while you are at the site you wish to save. Maybe this process is a little too easy because the important part is organizing and labeling the chosen sites in a manner that makes sense to you.

Following the three easy steps described here will help you do just that.

Step One: Create bookmark folders.

As in creating any filing system, establishing bookmark folders requires some thought. Are the folders going to be accessed by your students? Are the sites bookmarked for your own professional development? What about the ones you will use in your lesson planning?

How you plan to use web resources will, of course, determine how you organize them. The bookmark folders on my computer at ENC reflect the work I do. I create separate folders for upcoming *ENC Focus* topics such as assessment and equity. Other folders collect sites about grants, while others contain sites from collaborators. My work in selecting Digital Dozen sites requires its own folder.

Some educators set up folders with the names of the units they teach throughout the year. Others create folders by concept. Teachers tell us that as they peruse ENC's monthly Digital Dozen, they file sites that look interesting into the appropriate unit folders and spend more time really reviewing the sites when they are ready to teach the unit.

How to Find How-Tos

As you read the excellent advice in the accompanying article, you may find yourself motivated to set up a web site filing system but not sure exactly how to do it. Unfortunately, any specific directions for using Internet technology that we could provide in this publication would quickly become dated since there are often significant changes in the features of two consecutive versions of Netscape or Internet Explorer. And who can foretell what entirely new browser may come along next week?

Our best advice is for you to use your browser's Help feature to learn more about dealing with bookmarks (Netscape) or favorites (Explorer). An advantage of this strategy is that accessing Help does not require connectivity to the Internet. Best of all, it gives you information that is specific to your version of your browser.

Another option is to go to the web sites maintained for each browser:

For Netscape users, visit
http://help.netscape.com/faqs/bookmarks.html

For Internet Explorer, visit
http://www.microsoft.com/windows/IE/

From there, you will need to use the search function to find help about organizing your favorites. For example, the proper question will take you to http://support.microsoft.com/support/IE/InProductHelp/web_move_pages.asp, which provides information on organizing your favorite pages into folders.

Step Two: Edit web site titles as you bookmark them.

Both Netscape and Explorer obtain the title of bookmarks from the name that appears in the title bar for the page. But will that title mean anything to you later? For instance, the title "The Home Page of Peggy E. Schweiger" gives no indication that the site is chock-full of physics lessons.

Make your bookmark titles work for you. While the content of the site is fresh in your mind, edit the title of your bookmark to reflect what it contains.

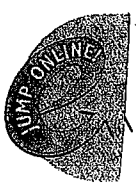
Step Three: Keep your bookmark folders up to date.

It is important to get into the habit of filing web sites as you bookmark them. Explorer and Netscape allow you to place web sites into existing folders as you save them. Explorer even allows you to create new folders in which to place web sites as you bookmark them.

It is also very important to take a critical look at your bookmark organization periodically. It won't take long to delete old sites and update and delete folder categories. I try to do this every month or so.

Learning to organize my own bookmarks gave me the confidence to use this technology in the classes I teach. Any time I ask my students to do research as part of a project, I ask them to email me a list of web sites that they used in researching their topic. They do this as a bookmark file. Students who don't have email save the bookmark file to a disk and turn in the disk as part of the assignment.

Once I felt the satisfaction of taming the World Wide Web through use of these techniques, I knew I could also tame my basement. It took me a weekend and a couple trips to the local discount store to buy containers to store everything, but I now have an organized space where I can find things when I need them. ◉



Link to all the sites mentioned in this magazine by visiting the online version of *ENC Focus:* http://www.enc.org/focus/change/

Roempler's Recommended Resources:

Here are just a few of the bookmark folders I have created along with recommended resources to place inside.

Folder Title: Math and Science Resources
ENC Online – http://www.enc.org/
ENC Digital Dozen – http://www.enc.org/classroom/dd/nf_index.htm
NASA Education Program – http://education.nasa.gov/
Math Forum – http://forum.swarthmore.edu/
Explore.com – http://explorezone.com/index.htm
Access Excellence – http://www.accessexcellence.org/
CIESE Curriculum Projects – http://njnie.dl.stevens-tech.edu/curriculum/currichome.html
New York Times Learning Network – http://www.nytimes.com/learning/

Folder Title: Search Tools
Altavista – http://www.altavista.com/
Yahoo! – http://www.yahoo.com/
Google – http://google.com/
HotBot – http://www.hotbot.com/
Ask Jeeves! – http://www.ask.com/

Folder Title: Educational Research
Ask ERIC – http://ericir.syr.edu/index.html
Search ERIC – http://ericae.net/search.htm
Pathways to School Improvement – http://www.ncrel.org/sdrs/pathwayg.htm
Third International Math and Science Study – http://nces.ed.gov/timss/
National Center for Education Statistics K-12 Practitioner's Circle – http://nces.ed.gov/practitioners/

Folder Title: Professional Organizations
Association for Supervision and Curriculum Development – http://www.ascd.org/
National Science Teachers Association – http://www.nsta.org/
National Council of Teachers of Mathematics – http://www.nctm.org/
American Association of Physics Teachers – http://www.aapt.org/
National Association of Biology Teachers – http://www.nabt.org/

Folder Title: Online Magazines and Newsletters
ENC Focus – http://www.enc.org/focus/
NPR Online – http://www.npr.org/index.html
Education World – http://www.education-world.com/
Education Week – http://www.edweek.org/

Folder Title: Reference
Zip Code Lookup – http://www.usps.com/ncsc/lookups/lookup_zip+4.html
Merriam-Webster Dictionary and Thesaurus – http://www.m-w.com/home.htm
555-1212 – http://www.555-1212.com/
Telephone Directories on the Web – http://www.teldir.com/eng/namc/us
Universal Currency Converter – http://www.xe.net/ucc/
MapBlast! – http://www.mapblast.com/mblast/index.mb
MegaConverter – http://www.megaconverter.com/

Folder Title: Personal
Epicurious: Food, Wine, Cooking, and Recipes – www.epicurious.com
Travelocity – http://www.travelocity.com/
Weather Channel – http://www.weather.com/homepage.html
Ask the Dietician – http://www.dietitian.com/
Library Spot – http://www.libraryspot.com/
FTD – http://www.ftd.com/
Amazon.com – http://www.amazon.com
Blue Mountain Electronic Greeting Cards – http://www.bluemountain.com/

The ultimate place to go to find reference and personal links:
Hot Sheet – http://www.hotsheet.com/

Going for Grants

Grant-Writing Tools from the Web

Learn about web resources that will assist you in writing grants. Concrete ideas from each site are included.

by Tracy Crow, ENC Publishing

Counting courses, books, newsletters, consultants, and web sites, there are hundreds of ways to learn how to write winning grants. Each book or web site outlines a variety of steps to take in preparing project proposals, but you need to give yourself time to tour several resources before you create your own step-by-step procedure. The web sites described on the left-hand side of each column in this article will give you a jumpstart. A handy grantwriting tip from every site mentioned is also provided.

First of All, Know the RFP

One piece of advice is common to every grantwriting guide on the planet: Read the RFP (Request for Proposal) and any proposal submission instructions extremely carefully. The RFP tells you the goals and objectives of the funding program, what grantees are expected to achieve and deliver, how proposals will be evaluated, and all of the specifics about length of the proposal, number of copies to send, and the deadline. If you have questions about the RFP, call the funding agency. Most RFPs have a contact name or at least an organization phone number.

Then, Apply Advice to Your Own Situation

Basic Elements of Grantwriting from CPB

http://www.cpb.org/grants/grantwriting.html

The Corporation for Public Broadcasting is a funding organization that reads hundreds of applications every year. They have created a guide that helps CPB grantseekers and applicants to other organizations. The web site is divided into three major steps: Preparation, Writing the Proposal, and Followup. The first two categories contain several substeps; for example, the Writing the Proposal section covers the narrative, the budget, and the appendices of a proposal in brief, as well as other technical aspects of the proposal.

Tip on... Defining the Project

- Clarify the purpose of your project and write a mission statement.
- Define the scope of work to focus your funding search.
- Determine the broad project goals, then identify the specific objectives that define how you will focus the work to accomplish those goals.

From http://www.cpb.org/grants/grantwriting.html
Accessed on 12/1/1999.

Writing a Successful Grant Proposal

http://www.mcf.org/mcf/grant/writing.htm

The Minnesota Council on Foundations has created this guide for grantseekers in Minnesota, but like other sites listed here, the information is useful for many applicants. The logical outline of the parts of a proposal narrative and of a budget provides examples to illustrate most of the suggestions. Variations for different types of projects are also described, and a few frequently asked questions are answered.

Tip on... Describing the Need for Your Project

- Describe a problem that is about the same size as your solution. Don't draw a dark picture of nuclear war, teen suicide, and lethal air pollution if you are planning a modest neighborhood arts program for children.
- Describe your issue in as local a context as possible. If you want to educate about HIV/AIDS in your county, tell the funder about the epidemic in your county, not in the United States as a whole.

From http://www.mcf.org/mcf/grant/writing.htm
Accessed on 12/1/1999.

Lessons from the Field

As we were preparing this column for publication, the following email arrived. Thanks to Judi Wilson for sharing her experience:

I just had an interesting experience in writing a foundation grant. I had a project that I wanted funded, contacted the organization via phone, and decided to write the grant.

The night before I submitted the grant, I looked up the foundation on the Internet. Listed on the site were the grants that had been awarded for the past two years. To my surprise, the size of the smallest grant awarded was at least double what I had requested. Since the project was due the next day, it was too late to revise my budget. That really would have required revising my entire project and submitting something different.

I decided to submit the proposal as it was and hope for the best, but I will never miss checking on the Internet site for a grant funder before I even start the grant application! So much for ignoring the Internet as a valuable source of information for grant writing and project development.

Sincerely,

Judi Wilson
Director, Science & Math
County Office of Education
San Joaquin, California

A Guide for Proposal Writing—NSF

http://www.nsf.gov/pubs/1998/nsf9891/nsf9891.htm

As one of the major funding agencies in the country, the National Science Foundation is an authoritative source of information for grantseekers. This web guide was written for applicants within the Division of Undergraduate Education and serves more as general guidelines for an applicant than as specific guidelines for a particular program.

The first half of the guide covers the review process and evaluation criteria, while the second half offers writing and preparation advice. Steps under preparation include getting started, building coalitions, and thinking about the target audience.

Tip on... Remembering Who Benefits from Your Project

The target audience of the grant should be clearly explained in terms of demographic characteristics, size, and special characteristics or problems/challenges faced by the group. The project design should be developed in a manner that will effectively assist the target group in addressing those special problems or challenges. The disparity between the educational sophistication of the project and the educational naiveté of the audience (e.g., a software package which is primarily being used for research that is proposed to be used in a developmental mathematics class) is usually noted by the reviewers and can be one reason for declination of funding.

From http://www.nsf.gov/pubs/1998/nsf9891/nsf9891.htm

Accessed on 12/1/1999.

A Proposal Writing Short Course

http://fdncenter.org/onlib/shortcourse/prop1.html

The Foundation Center should be on any list of grantseeker's resources. This web-based short course is thorough and filled with examples. Like other good guides, the course stresses the preparation required to create a winning proposal as well as the different parts of a proposal itself. Strengths are the sections on developing goals and objectives, methods to achieve the goals, and the evaluation plan.

Tip on... Your Evaluation Plan

An evaluation plan should not be considered only after the project is over; it should be built into the project. Including an evaluation plan in your proposal indicates that you take your objectives seriously and want to know how well you have achieved them. Evaluation is also a sound management tool. Like strategic planning, it helps a nonprofit refine and improve its program.

From http://fdncenter.org/onlib/shortcourse/prop1.html

Accessed on 12/1/1999.

EPA Grantwriting Tutorial

http://www.epa.gov/seahome/grants/src/grant.htm

From the Environmental Protection Agency (EPA), this tutorial provides users much of the same information found in other guides but in a different format. The site can be a challenge to navigate, since it leads users through a grantwriting activity while offering tips and examples on different screens. However, the information is valuable and worth exploring in full.

Proposal Writer's Guide

http://www.research.umich.edu/research/proposals/proposal_dev/pwg/pwgpage.html

While this guide from the University of Michigan is geared to academic researchers, the information works for all grantseekers. This site is strong on the descriptions of the different parts of a proposal, from the table of contents to the introduction to the references. The planning and preparation sections are less comprehensive than those in some of the other guides.

TechProf: Tips for Successful Grantwriting

http://www.nmsu.edu/techprof/backgrnd/31698.htm

Unlike some of the more comprehensive guides referenced here, this is a quick list of relevant tips for grantseekers. These ideas were part of a course on grantwriting taught at New Mexico State University. Visitors to this site will find other course materials as well.

Tip on... Project Design

- Describe in detail the activities that will take place in order to achieve desired results.
- Make sure your methods are realistic.
- Describe WHY you have chosen these activities. Justify them over all other approaches you could have taken.
- Show your knowledge of the bigger picture.
- Include a timetable of major milestones.

From http://www.epa.gov/seahome/grants/src/grant.htm

Accessed on 12/1/1999.

Tip on... Appendices

Some writers are prone to append peripheral documents of various kinds to their proposals on the theory that the bulk will buttress their case. Reviewers almost never read such appendices, and may resent the padding. The best rule of thumb is: When in doubt, leave it out.

From http://www.research.umich.edu/research/proposals/proposal_dev/pwg/pwgpage.html

Accessed on 12/1/1999.

Tip on... Common Pitfalls to Avoid

- Titles are cute but distracting, too long, confusing, or not project related.
- Summaries are not comprehensive, omit significant elements, too long, and often contain no overview.
- Introductions fail to focus the reader on project objectives or do not add to proposal.
- Problem statements deal with wants not needs.
- Problems are not documented or are not supported by current research.

From http://www.nmsu.edu/techprof/backgrnd/31698.htm

Accessed on 12/1/1999.

Innovators' Forum Online

Finally, Review Your Own Proposal

Once you've followed your own path to creating a winning proposal, you'll need one final web resource. A self-assessment for grants puts you in the reviewers' shoes to do a detailed reading of your proposal. The National TRU Program—Technology Transfer at http://www.t2ed.com/ shares with the public many of the ideas developed with federal funds for their Department of Energy project; you'll find quite a variety of documents on the site. One of them happens to be GRANTSAT, a comprehensive self-assessment. Other relevant documents include facilitator and participant notes for two grant-writing workshops. ◉

Link to all the sites mentioned in this magazine by visiting the online version of *ENC Focus:* http://www.enc.org/focus/change/

While no one has answers for all the issues facing educators today, progress is possible when classroom innovators, like yourself, exchange ideas.

To make such an exchange possible, the online version of *ENC Focus: A Magazine for Classroom Innovators* http://www.enc.org/focus/ features an electronic Innovators' Forum. Readers are invited to send concerns and comments via email to editor@enc.org. Selected messages will be published online, and of those, a few will appear here, so that readers of the print version of the magazine can participate.

Dear Innovators,

Wow! The recent issue of ENC Focus *on the topic Inquiry and Problem Solving (Vol. 6, No.2, 1999) was the most realistically informative to date. I actually read this issue from cover to cover and acquired a number of pedagogical tools that I'm sure may result in concrete student achievement.*

Ronald D. Anderson states in the article "Inquiry in the Everyday World of Schools,"(p. 16-17) that "it is possible to put inquiry teaching into practice, but it is a demanding task, and it is not clear how widespread one can expect it to become." I have mentored and modeled and discussed inquiry teaching with many a science teacher, and an alarming number, both young and old, have told me that they just don't want to put in the physical and mental work that it professionally demands.

Some of the constraints to the practice of classroom inquiry, according to these teachers, are the repetition of this arduous process at least five times a day in a traditional secondary school setting and a lack of rich content knowledge for its implementation by the teacher. There is also an awareness of parents' concern for student achievement as measured by regurgitation of memorized facts in the multiple-choice setting of traditional standardized tests. Although some colleagues are willing to practice in an inquiry-based learning community, I've discovered that many science teachers have no interest in teaching strategies beyond having the students "complete every odd question at the end of the chapter" or leading "cookbook labs" since they have a genuine belief in the value of conventional instructional methods.

I'll also add that there is a recurrent nationwide focus on teacher education/training and government-subsidized study committees, but very little money for equipment resources that a classroom innovator can effortlessly purchase to enhance student hands-on, minds-on learning.

Don Deresz
Science Teacher
Miami-Dade County Public Schools
Florida

Please keep in mind that Innovators' Forum offers a way for you to discuss issues with other classroom innovators. You can get information and answers to many educational questions from ENC's Information Services Department. Contact them by email library@enc.org or telephone (614) 292-9734.

When you contribute to Innovators' Forum, please include your full name, your title or the grade you teach, the name of your school or district, and your city and state. Please note that comments selected for publication may be edited for brevity and clarity and that by submitting them you are giving permission for your comments to appear in both the print and the online versions of this publication.

Again, the *ENC Focus* email address is editor@enc.org. Or send your comments by mail: *Focus* Editor, ENC, The Ohio State University, 1929 Kenny Road, Columbus, OH 43210-1079. If you send a letter, please include your telephone number so we can contact you if necessary.

There Can Be No Improvement Without the Teacher

Two internationally known authorities on educational change provide advice and support for classroom teachers who they believe must be at the heart of the improvement process.

by Michael Fullan and Andy Hargreaves, Ontario Institute for Studies in Education of The University of Toronto

The greatest problem in teaching is not how to get rid of the "deadwood," but how to create, sustain, and motivate good teachers throughout their careers. Interactive professionalism is the key to this. For us it entails:

- discretionary judgment as the heart of professionalism;
- collaborative work cultures;
- norms of continuous improvement where new ideas are sought inside and outside one's setting;
- reflection in, on, and about practice in which individual and personal development is honored, along with collective development and assessment;
- greater mastery, efficacy, and satisfaction in the profession of teaching.

We have pursued the theme of teacher transformation in our What's Worth Fighting For series, in particular in *What's Worth Fighting For in Your School* (Fullan & Hargreaves, 1992) and *What's Worth Fighting For Out There* (Hargreaves & Fullan, 1998). In the former, we developed a set of 12 action guidelines to help create collaborative cultures within the school; in the latter we concluded that teachers must also form alliances outside the school if they are to succeed—six guidelines are formulated to this end.

Editor's Note: The remainder of this article consists of highlights of the authors' explanations of each of the 12 points from What's Worth Fighting For in Your School; *highlights of the six points from* What's Worth Fighting For Out There *will be published in an upcoming issue of* ENC Focus. *Link to the full text of the article now by visiting* http://www.enc.org/focus/change/. *More information about both books is available on page 55 of this magazine.*

This article is excerpted from Fullan & Hargreaves' introduction to ENC's professional development project, "Teacher Change: Improving K-12 Mathematics." Link to the full text of the article by visiting http://www.enc.org/focus/change/

Michael Fullan is the Director of and Professor in the International Centre for Educational Change at Ontario Institute for Studies in Education at the University of Toronto. Andy Hargreaves is the Dean of the Ontario Institute for Studies in Education.

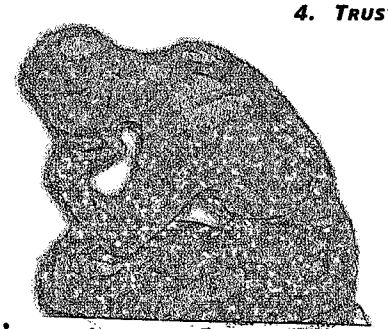
Creating Collaborative Cultures Within Schools

In essence our argument is that teachers and others must commit themselves to "reculturing"—creating professional learning communities that focus on the continuous improvement of instruction in light of constantly examining how well students are doing (see also Newmann & Wehlage, 1995).

To that end, we developed 12 guidelines to enable teachers to foster collaboration within the school (Fullan & Hargreaves, 1992).

1. Locate, listen to, and articulate your inner voice.

...Teachers have strong values about doing work that makes a difference. Because of overload and the rush of daily events, we often neglect our basic values. Guideline 1 suggests that we must ask and remind ourselves what values and goals are most important, what frustrates us most, and what we stand for. Locating and articulating our inner voice provide great sources of clarity and energy for transcending overload. The morality and practicality of improvement require that teachers locate this inner voice, that they listen to it seriously, and that they articulate it so as to make its power felt among their colleagues...



Thinking is nothing new. Deeper reflection that leads to new insights and improvements in practices is rarer...

2. Practice reflection in action, on action, and about action.

...In many cases "reflective practice" has become a buzzword or slogan. Sometimes, virtually any act of thinking has been hailed as embodying the principles of reflective practice. Because of this, the rhetoric of reflective practice has sometimes been used to dress up what we already do in new language, instead of inspiring us to do something different and better. Thinking is nothing new. Deeper reflection that leads to new insights and improvements in practices is rarer...(See example on p.29.)

3. Develop a risk-taking mentality.

....Teachers get exposed to countless new practices through professional development in the course of the year. Many will be attempted in one's own school. Trying out a new practice is immediately risky. It is new for students as well as for the teacher. It requires skills, coordination and familiarity, which are not acquired instantly. (See p.21.) Take one of these new practices that appeals to you, and try it out on a small scale....It is all right to fail as long as you learn from it...

4. Trust processes as well as people.

...Trust in individuals is no longer sufficient. When key individuals leave and leaders move on, exclusive reliance on personal trust can cause massive instability. This is why innovative schools spearheaded by charismatic leaders often revert to mediocrity when they leave. Another kind of trust is therefore called for in modern organizations like our schools: trust in processes... [including] improved communications, shared decision-making, creation of opportunities for collegial learning, networking with outside environments, experimenting with new ideas and practices, commitment to continuous inquiry, and so on...(See p.40.)

5. Appreciate the total person in working with others.

...Case studies from Nias et al. (1989) show that "valuing individuals as people" is a strong feature of collaborative schools. Interest in and consideration of the life circumstances of individual teachers are difficult because they mean balancing concern on the one hand, with respect for privacy on the other. Research on life cycles, career cycles, and gender factors in teaching all show how teachers' personal circumstances differ and vary over time (Huberman, 1991). If we do not relate appropriately to other people, we increase the chances of conflict, alienation, and mismatched responses or strategies...

6. COMMIT TO WORKING WITH COLLEAGUES.

...It takes a long time and a great deal of care to build collaborative work cultures. This is done through multiplying the number of small-scale examples [planning a unit with a grade partner, engaging in peer observation, etc.] engaged in by more and more teachers within and across schools. When it becomes natural fare for the vast majority of teachers to seek and engage in professional exchanges and action, we will know that we are approaching collaborative work cultures...

7. SEEK VARIETY AND AVOID BALKANIZATION.

...Some school cultures are balkanized, containing cliques of teachers keeping to themselves (Hargreaves, 1994). We usually think of such teachers as groups of reactionaries. However, groups of innovators can also become compartmentalized into subcultures. Sometimes this is because they have been deliberately sealed off by their colleagues. At other times, it is because they pursue innovation in a manner that distances themselves from other teachers. The solution is to seek some diversity in collegial action, and to avoid becoming part of an exclusive "club"...

8. REDEFINE YOUR ROLE TO EXTEND BEYOND THE CLASSROOM.

...Reform is systemic. Improvements inside the classroom depend on improvements outside it. The teacher...must "take responsibility for more than the minimum, more than what goes on within the four walls of our classrooms" (Barth, 1990, p. 131).... Each and every teacher has a direct responsibility for helping to shape the quality of the next generation of teachers. However good new teachers may be in academic qualifications and experiences, they still represent only raw potential. The conditions of teaching, especially at the beginning, influence and sometimes determine how good a new teacher will become. This one teacher will in turn affect the quality of learning experiences of hundreds of children over the next thirty years. What's worth fighting for is to make sure that these new teachers have better, much better, conditions for beginning their careers...

There are schools whose teachers regularly stay on until 7 pm and where their principals expect this. But these schools do not last long—neither do their teachers....

9. BALANCE WORK AND LIFE.

...The worst scenario emerging from our guidelines would be one where teachers treated their commitment to collegiality as add-ons to all their existing work. It is important to avoid still further overload. (We are advocating interactive, not hyperactive professionalism.) There are schools whose teachers regularly stay on until 7 pm and where their principals expect this. But these schools do not last long—neither do their teachers....The work is important, but so is the life.... Workaholics and careerists do not always make the best teachers...

10. PUSH AND SUPPORT PRINCIPALS AND OTHER ADMINISTRATORS TO DEVELOP INTERACTIVE PROFESSIONALISM.

...As teaching is a lonely profession, the principalship is all the more so. Lack of time, overload of responsibilities, uncertainty about their roles in leading change, fear of appearing unknowledgeable, and the stress of attempting to balance professional and personal lives put the principal in a difficult position to meet expectations....While some principals may be...ambivalent about their new roles as change facilitators, our guess is that most principals would welcome positive initiatives coming from individuals and groups of teachers. (See p.34.) After all, it helps them do—and be seen to be doing—their job more effectively...

11. COMMIT TO CONTINUOUS IMPROVEMENT AND PERPETUAL LEARNING.

...The single distinguishing characteristic of the best professionals in any field is that they consistently strive for better results, and are always learning to become more effective, from whatever source they can find. (See p.38.) The teacher as career-long learner is central to our guidelines....Teachers should push themselves to create the professional learning environments they want...

12. MONITOR AND STRENGTHEN THE CONNECTION BETWEEN YOUR DEVELOPMENT AND STUDENTS' DEVELOPMENT.

...The value of teacher development and teacher collaboration must ultimately be judged by whether these changes make teachers better for their students in ways that teachers themselves can see. (See p.33.) As Huberman (1990) puts it: "Most teachers would derive more professional satisfaction from resuscitating three sullen, low-performing pupils on the brink of dropping out than on raising class-level achievement tests by half a standard deviation in six months" (See p. 29)... ◉

REFERENCES AND SUGGESTED READING

[Editor's Note: This is the full list of references published with the original online version of this article.]

Barth, R. (1990). *Improving Schools from Within: Teachers, Parents and Principals Can Make the Difference*. San Francisco, CA: Jossey-Bass.

Block, P. (1987). *The Empowered Manager*. San Francisco, CA: Jossey-Bass.

Campbell, E. (1996). Ethical Implications of Collegial Loyalty as One View of Teacher Professionalism. *Teachers and Teaching: Theory and Practice*, 2(2), 191-208.

Connelly, F.M. and Clandinin, D.J. (1988). *Teachers As Curriculum Planners: Narratives of Experience*. New York: Teachers College Press.

Fullan, M., & Stiegelbauer, S. (1991). *The New Meaning of Educational Change*. New York: Teachers College Press; Toronto: OISE Press; London: Cassell.

Fullan, M., Connelly, M. & Watson, N. (1990). *Teacher Education in Ontario: Current Practices and Options for the Future*. Toronto: Ontario Ministry of Colleges and Universities and Ontario Ministry of Education.

Fullan, M., Galuzzo, G., Morris, P. & Watson, N. (1998). *The Rise and Stall of Teacher Education Reform*. Washington, DC: American Association of Colleges of Teacher Education.

Fullan, M. & Hargreaves, A. (1992). *What's Worth Fighting For? Working Together for Your School*. Toronto: Ontario Public School Teachers' Federation; New York: Teachers College Press.

Giddens, A. (1990). *The Consequences of Modernity*. Oxford: Polity Press.

Goodson, I. (1991). Sponsoring the Teacher's Voice: Teachers' Lives and Teacher Development, in A. Hargreaves & M. Fullan, (Eds.), *Understanding Teacher Development*. London: Cassell.

Goleman, D. (1995). *Emotional Intelligence*. New York: Bantam Books.

Hargreaves, A. (1986). *Two Cultures of Schooling: The Case of Middle Schools*. Lewes: Falmer Press.

Hargreaves, A. (1994). *Changing Teachers, Changing Times: Teacher Work and Culture in the Postnuclear Age*. New York: Teachers College Press.

Hargreaves, A., Earl, L., & Ryan, J. (1996). *Schooling for Change*. New York: Falmer Press.

Hargreaves, A. & Fullan, M. (1998). *What's Worth Fighting For Out There*. New York: Teachers College Press.

Hart. A. & Murphy, M. (1990). New Teachers React to Redesigned Teacher Work. *American Journal of Education*, 98 (May), 224-50.

Huberman, M. (1990). The Social Context of Instruction in Schools. Paper presented at the meeting of the American Educational Research Association. Boston, Mass.

Huberman, M., (1991). Teacher Development and Instructional Mastery, in A. Hargreaves, & M. Fullan (Eds.), *Understanding Teacher Development*. London: Cassell.

Louden, W. (1991). *Understanding Teaching*. London: Cassell.

Lytle, S. and Cochran-Smith, M. (1990). Learning from Teacher Research: A Working Typology. *Teachers College Record*, 92(1), 83-103.

Manitoba School Improvement Program (1997). Toronto; Winnipeg: Walter and Duncan Gordon Charitable Foundation.

Mortimore, P., Sammons, P., Stoll. L., Lewis, D., & Ecob, R. (1998). *School Matters: The Junior Years*. Somerset: Open Books.

Newmann, F. & Wehlage, G. (1995). *Successful School Restructuring*. Madison, WI: Center on Organization and Restructuring Schools.

Nias, J., Southworth, G., & Yeomans, R. (1998). *Staff Relationships in the Primary School*. London: Cassell.

Oatley, K. (1992). *Best Laid Schemes: The Psychology of Emotions*. Cambridge, MA: Cambridge University Press.

Rudduck, J., Day, J., & Wallace, G. (1997). Students' Perspectives on School Improvement. In A. Hargreaves (Ed.), *Rethinking Educational Change with Heart and Mind, The ASCD Yearbook*. Alexandria, VA: The Association for Supervision and Curriculum Development, 73-91.

Richardson, V., & Anders, P. (1990). The Role of Theory in Descriptions of Classroom Reading Practices. Paper presented at the meeting of the American Educational Research Association, Boston, Mass.

Saul, J. (1995). *The Unconscious Civilization*. Toronto: Anansi Press.

Schon, D. (1987). *Educating the Reflective Practitioner*. San Francisco, CA: Jossey-Bass.

Sikes, P. (1997). *Parents Who Teach*. London: Cassell.

Storr, A. (1988). *Solitude*. London: Flamingo Press.

Werner, E., & Smith, R. (1992). *Overcoming the Odds*. Ithaca, NY: Cornell University Press.

Resources to assist teachers in facing the Reality of Change have been selected from ENC's Collection. See page 45.

Changing Habits of a Lifetime

A physics teacher's journal entries reveal the struggle successful teachers face as they leave the safety of the familiar and learn to use new tools and techniques.

by Marsha Paulus Nicol, Capital University, Columbus, Ohio

> Perhaps the most valuable results of all education is the ability to make yourself do the thing you have to do, when it ought to be done, whether you like it or not.
> —Thomas Henry Huxley, *Technical Education*, (cited in Gallian, 1986, p. 333)

There are many facets of teacher change. Teachers who want to change have decided that they need to change. Their classroom experience, social interaction with colleagues, or perhaps their participation in professional development programs has helped to build that desire to change. Teachers who want to change are teachers who want to grow. They are teachers who do not believe that the status quo is adequate. They are teachers who are reflective and who are continually trying to do what is best for their students. Schubert and Ayers (1992) contend that "It is only reflective teachers (not those who teach by recipe, technique, or doctrine) who are able to grow continuously." It seems that a pervasive factor of teacher change is ongoing reflection.

Teachers who want to change are teachers who want to grow. They are teachers who do not believe that the status quo is adequate. They are teachers who are reflective and who are continually trying to do what is best for their students.

Mike Smith, a physics teacher in Worthington, Ohio, is just such a reflective teacher, one whose teaching and mathematical understanding went through much change as he implemented technology in his classroom. Although I was the researcher in this study, the story that follows is Mike's story. Because Mike is a professional colleague, I want him to be recognized and credited for his contributions to educational reform (Shulman, 1990).

Mike and I used to teach together. Among other subjects, he taught physics, and I taught precalculus and calculus. I used the graphing calculator in my classes, but Mike refused to use it in his. He believed it would hamper his students' understanding of physics if they used the graphing calculator, and we had many discussions about it. I eventually left high school teaching to pursue my Ph.D. I found out that Mike had an emerging interest in graphing calculators, and since teacher change was my research focus, I asked Mike about doing a case study on him. Mike agreed, and I became a participant observer in a case study involving Mike and his change as he struggled to implement graphing calculators into his classroom teaching.

The Catalyst

Mike and I attended a week-long professional development program, the Connecting Mathematics and Science (CMS) Institute, in which we used a graphing calculator and Texas Instruments Calculator-Based Laboratory (CBL). The CBL is a hand-held data collection system that uses probes, such as temperature, light, and voltage probes, to gather data into a graphing calculator. The lists of data can then be graphed, regression models can be fitted to the graphs, regression equations can be determined, and the graphs can be traced and analyzed.

During the year-long case study, I asked Mike to keep a journal. After the second day of the CMS Institute, Mike recorded:

> My reaction after a second day is that I'm realizing that the power of that calculator intimidates me. A tremendous amount of math appears to be necessary to know—so that you can answer the questions that the calculator is asking you. . .quite frankly, it's like I'm afraid it's going to reveal too much about what I don't know. And it does it at such a rate that it never allows you to recover. Some functions I'm becoming more familiar with, and I feel that maybe they're not as scary as I thought. There is a tremendous amount of knowledge needed to operate it. It's not a matter of just a black box.

Mike learned much at the Institute and was excited about what he had learned. He began to understand that there is more to the mathematics in physics than merely the algebraic manipulation that he was using. He was seeing a need to understand more mathematics.

Changes in Mike's Teaching

I phoned Mike shortly after the school year started. He told me, "I keep checking my ID to see if it's really me!" He was becoming a real convert to the use of the graphing calculator. Among other classes, Mike taught a ninth grade Investigative Physical Science (IPS) class, which was a required introduction-to-science class, and a marine biology class. He had planned on using the new technology in his marine biology class, but he had been unsure of how to implement any of what he had learned.

During our telephone conversation, Mike told me about a lesson he had taught his IPS class. He wanted to teach them unit conversions, so he had students take measurements in both centimeters and inches. They recorded their data in lists on the calculator and graphed their results. The equation proved to be linear with the slope equal to 2.54 cm/in (when the inches were assumed to be the independent variable). The discussion then centered around the slope and its implications for unit conversion.

I asked Mike if he had ever attempted to give students a visual description of the conversion of units. He said in previous classes he simply had given them the formulas. He was excited about the new way of teaching conversions because students could participate in deriving the formulas and in interpreting the graphical models. Mike had already begun using the graphing calculator in innovative ways to facilitate student understanding.

In Mike's marine biology class, some students asked if it were true that every seventh wave that came in onto the beach was larger than the others. Mike answered with the graphing calculator! He showed them that wavelengths are sinusoidal and they have different frequencies, depending on what caused them. He put several sine functions with different frequencies together and showed them that there was a pattern in which one of the waves would be larger than the others, and that the pattern was a repeating one. I was excited that he had thought about answering the question with a graph, especially since he had avoided sine functions in previous courses that he had taught.

One day I visited Mike's IPS class. They were discussing the Periodic Table of the Elements. The day before, Mike had given students several colored rectangles with notches and holes cut into them. The colors were various shades of red, yellow, and blue. Students were asked to discover patterns in the rectangles and place them together so that an obvious overall pattern emerged. By doing this, students could tell how a missing piece should look. Students worked in groups trying to discover patterns, and when they finished they had experienced some of the beauty of how the Periodic Table was developed.

When I asked Mike if he had ever done anything like this before, he said that his mode of teaching had been generally straight lecture. He had seen the manipulatives somewhere and had decided that using them would be beneficial to his class.

Then he reflected on our week at the CMS Institute. Mike and another teacher and I had worked together on a group project that we presented to the others at the Institute. He remembered how well our group had worked together, and he reflected on how valuable it was to be able to interact with others—he had helped me with the science, and I had helped him with the mathematics. He decided that he would try a similar approach in his class by putting his students in groups. He also liked the discovery approach we had taken during the institute, and he wanted to experiment with that.

This highly reflective teacher had attempted to teach his students, not from the theory he had learned from a textbook, but rather from the practical things he had learned in his experience. At that time, he did not even realize how much mathematics he was using as he taught his students to learn by discovering patterns.

So, what major changes had Mike made up to this point? He said when we returned from the CMS Institute he had a difficult time "getting back to reality." He had found a new toy and he wanted to get comfortable with it. The way he put it was, "Throw me some raw hamburger and leave me alone!"

It is really difficult to take risks as a teacher because so many people believe that the good teacher knows all the answers and can explain them effectively to his/her students. *(See Guideline 3 on p. 17.)*

The major change as Mike saw it was:

> I'm seeing the calculator as a tool to get where I want to go rather than as an obstacle to keep me from going where I want to go.

Mike also saw his courses evolving to more and more hands-on work. I saw that, too, as I observed his IPS class a few more times. Where he would have formerly given students a worksheet to take home and complete, he would now allow students to work in groups during class because—from his own experience—he believed it was what was best for his students.

Stumbling Blocks to Implementation

Losing Control

One of Mike's biggest stumbling blocks in implementing the calculator in his lessons was his concern about losing control of his classroom. Why is it so difficult to remember that teachers do not need to be omniscient? Mike and I talked about that.

It is really difficult to take risks as a teacher because so many people believe that the good teacher knows all the answers and can explain them effectively to his/her students. We teachers ourselves often believe it. Even when we say we do not, we show by our actions that we do. Mike mentioned on several occasions that, when his students knew more about the calculator than he did, he felt a lack of control. Mike recorded his feelings about control in his journal:

> There was this part of you that when you first started teaching that, I don't know, somewhere deep within me, I had this belief that—you know—the teacher always knows everything—the teacher's never wrong. And I don't know if that's when I was growing up, I always looked at the teachers with that kind of admiration, or if it's just my own ego problem. But I think one of the things that I really enjoy as being a teacher of 15 years plus is that I'm no longer in that insecure position anymore, because, number one I am very comfortable with the subject, and second, I thought I had reached the point where I understood I don't know all the answers, and that's not a big deal. That's one of those times it's an opportunity to let the student learn as you learn. But the calculator was a new technology that totally put me back into that insecure moment of being a new teacher again. Here I was a teacher for 15 years and kids were walking in with this machine that did things that I had no idea how they did what they did—I had no idea what its capacities were, and I felt very insecure.

He recounted a story in which students had shared answers during a test via the calculator, and Mike had been oblivious to it all because he did not understand the capacity of the calculator. He then continued:

> And so, it suddenly hit me that a lot of my problem with this calculator may be the fact that I fear not being in control. I fear not being in a position that I'm controlling what's going on, because I don't know its limitations. And part of the difference that's happening right now, is even though the kids know the calculator, they don't know the CBL, and that puts me back in control again. I've got the ability to teach them, because they don't know as much as I do. So maybe part of my willingness to jump into this is the newness of the CBL putting me just as knowledgeable as they, and second, the CBL has forced me to find out that the graphing calculators aren't as scary as I thought they were.

Mike told his physics students about his experience with tennis and related it to his change in teaching. He had taught himself how to play, and as a consequence, he had developed some bad habits. However, his tennis game was quite good, and he had a powerful serve. When he got on the freshman tennis team at The Ohio State University, his coach told him to change the way he held his racket. It was quite difficult for him to change, and after he made the change he never got his game back. His journal records what he told his students:

> I was self-taught. I had bad habits, and because I had bad habits, they were very well entrenched. Well, I'm self-taught in physics. I hated it in high school. I hated it in college, and I had to teach myself physics when I had to start teaching it. So, I'm scared to death that by changing my grip right now, I may get very insecure with you guys. So, if I cry a lot, that's my problem. . . . So, let's hope it doesn't mess me up.

Notice how real Mike was with his students. He was always honest with them and did not try to cover up any weaknesses. With his confession, he was making himself vulnerable to his students, and that is not an easy thing for a teacher—especially for one who wants to maintain control of the classroom. For a teacher like Mike, who is well respected by students and colleagues, this kind of vulnerability can be an asset. Students have told me that they appreciate a teacher who does not profess to know all and who is not afraid to admit weaknesses and mistakes. However, acknowledging weakness is still difficult.

Lack of Time

One of the major obstacles to teacher change is the teacher's lack of time to do what is necessary to implement change. In his journal, Mike addressed the time factor as being a great stumbling block.

> I've spent a lot of time with this machine. I guess that's the biggest drawback. And it's a temporary drawback because it's something new and it takes a lot of time when you're just learning it. That's probably one of the reasons I held off—not learning it, because it just wasn't something that was going to happen overnight. It was going to only happen if I took some concentrated time—spent time with it and got comfortable with it. And I didn't have the time and I didn't see the need to do it because I felt I was successful without the technology—without the device. Not knowing the machine, I had no idea how I could use it to teach, and I was using a different way of teaching; and the machine, I felt was interfering with that different method. And I kept resisting it, thinking that my method was better because I had been successful ten years ago with it, and I really didn't see the need to change.

He talked about the students being more responsive to the calculator than to other methods, and he speculated as to why. Maybe it was because they had grown up in a technological age, an era of

instantaneous gratification. Whatever the reasons, as he prepared for his physics classes, he was more willing to spend time on lessons and experiments that were calculator enhanced. He said that his students were enjoying doing their laboratory assignments and that was unusual. He continued:

> The same subject now taught through the calculator seems to maintain their interest. . . . Because of their response it's made it easier for me to put the hours in and to try things that are a little bit different. . . . So it's been different, and yet it's starting to produce.

TIME MANAGEMENT IN THE CLASSROOM

Mike mentioned the time-management problem in two different journal entries. One entry was made at the beginning of his physics class. At that time he had said:

> I wish we would have had a little bit more time [to complete a laboratory experiment]. . . . Of course the one thing that's happening is that the number of chapters I'm looking at covering this year has dropped drastically. And I'm not talking just one or two chapters. I'm talking about possibly cutting it in half if I continue going at the rate I'm going. And so I'm facing the dilemma of which is of a higher priority—allowing them to develop this critical approach to data and laboratories, or whether I need to maintain the survey status of this class where I'm giving them an exposure to various areas of physics. At the moment I've kind of given up the survey approach for the analytical approach. I'm not sure if that's a good decision or not, but it's the direction I'm heading, and I'll continue thinking that through. And a lot of it again is because of this new tool.

Toward the end of his physics class, Mike was still struggling with time management in his classroom. He recorded another journal entry:

> I guess the biggest problem I'm facing right now is all these type of processes in class take much longer than a quick "put the values in an equation and kick out an answer." And so I find myself running into a time restraint. And that's why I keep oscillating back and forth between—you know, my old approach of straight, what I used to call plug and chug—put the numbers in the equation and kick out an answer—into more of an intuitive approach. I don't have time to do the whole course that way [using the intuitive approach—with the calculator], so I've either got to leave out sections or I've got to become more efficient about what I'm doing. But yet what I've taught I've felt very good about. And I haven't resolved that time management right now.

It is a dilemma that all of us in education face. Sometimes less is more. In Mike's own field, science education, the recommendation is to teach less material but more in depth: "To ensure the scientific literacy of all students, curricula must be changed to reduce the sheer amount of material covered" (American Association for the Advancement of Science, 1989, p. 5).

> *"...probably one of the reasons I held off—not learning it, because it just wasn't something that was going to happen overnight. It was going to only happen if I took some concentrated time—spent time with it and got comfortable with it. And I didn't have the time..."*

Persevering

In spite of all of the stumbling blocks, difficulties, insecurities, and risks, Mike persevered. His classes continued to become more student centered and less teacher centered. His understanding of mathematics increased. He implemented the "less is more" philosophy.

Mike Smith now travels all around the United States teaching in professional development institutions. He helps other teachers in their own process of change in implementing technology in their classrooms. In preparing for one of his first presentations, Mike decided to begin by telling the participants that he wanted to use an instrument that did not need batteries, was not expensive, was not intimidating, and could be used by students without fear of cheating—the slide rule. He told me, "I want them to know that I came into this kicking." Change is difficult for us all, and we need to recognize that. ◉

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REFERENCES

American Association for the Advancement of Science. (1989). *Science for All Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology.* Washington, DC: Author.

Gallian, J. A. (1986). *Contemporary Abstract Algebra.* Lexington, MA: D.C. Heath and Company.

Schubert, W. H., & Ayers, W. C. (Eds.). (1992). *Teacher Lore: Learning from Our Own Experience.* White Plains, NY: Macmillan.

Shulman, J. H. (1990). Now You See Them, Now You Don't: Anonymity Versus Visibility in Case Studies of Teachers. *Educational Researcher,* 19(6), 11-15.

What do you do about staff in your own school or district who resist when you are trying to implement change? Should Will, Pat, and Irene, (the perpetual resisters in the simulation game described in this article), get lifelong cafeteria duty, be fired, or be included in the process of change? When should you include Al (the superintendent) in your activities? Who else needs to be involved? These are just some of the many questions teams who play the Systems Thinking/Systems Changing simulation face. One participant, Karen Falkenberg, Program Manager for Elementary Science Education at the NSF Local Systemic Initiative, Atlanta, Georgia, commented, "All teams began with the same resources and all appeared to be equally 'busy,' but in the end, not all teams were as successful as measured by benefits gained. This clearly illustrated that being strategic is critically important to successful reform efforts. Working smarter, not necessarily harder, is what is important."

by Carol Bershad and Susan Mundry, Co-developers, Systems Thinking / Systems Changing Simulation Game

Playing to Learn: Systems Change Game Challenges & Teaches

Systems Thinking/Systems Changing is a complex, interactive simulation boardgame that is experienced by teams in a workshop setting. The simulation creates a lively environment that engages people in learning what it takes for school districts to make effective systemwide change. Playing the game encourages participants to reflect on how change happens in their own settings; as a result, they can plan more effective strategies for use in real life.

The teams play the simulation game with the goal of changing a hypothetical school district into a continuously improving learning organization. They do this by moving staff and students through the stages of change on the gameboard and accumulating as many learner benefits as possible. The teams actively make decisions about what to do and who to involve. Along the way, they get constant feedback that forces them to reflect on their progress and process.

Lessons to be Learned

Working through the simulation helps participants learn at least eight important lessons about effective systemwide change:

LESSON 1: EMBRACE YOUR CURRENT REALITY.

During the simulation, participants learn that to put systems thinking to work, they must understand their current reality and be willing to examine both the good and bad news. Getting the most complete picture of what is going on right now provides the information needed to make good choices for the future and to solve the right problems. School leaders must select or design programs that address their school's particular needs and goals, keeping in mind the knowledge from research and practice that defines effective learning. To do so, the whole school community must know the current reality and see if there are gaps between where they are and their vision for the future.

LESSON 2: KNOW YOUR ASSUMPTIONS.

We are always acting on our assumptions even though we often don't consciously know what they are! Trying new approaches without examining our deeply held beliefs may bring about small incremental change, but not the transformation most of us want for our schools. The simulation creates situations that help teachers and administrators examine how holding on to old assumptions about teaching and learning may undermine the effectiveness of the changes they want to make.

The simulation also brings to the surface people's assumptions about competition versus cooperation. In all the times we have led the simulation, only a couple of participants have ever gotten up to talk with other teams during the playing of the game. Teams have voiced their belief that this learning from others would be "cheating." They also don't think of sharing resources by borrowing from a team with more "bits" (which stand for money and other resources) left near the end of a game segment or "school year."

Thus, the simulation demonstrates how our assumptions limit us, preventing us from thinking more creatively about possibilities.

LESSON 3. DEVELOP A SYSTEMS VIEW.

Systems thinking helps us understand that the cause and effect of actions are not always close together in space or time and that only through questioning and looking for patterns and root causes can we begin to see what is truly happening in the system. But having a systems view requires getting all key stakeholders involved, it involves gathering and questioning data from a variety of perspectives, and it requires thinking outside the immediate boundaries of the school, into the community and the larger system of which the school is a part. The simulation helps participants see that when they fail to include a variety of perspectives or when they look at data narrowly, they will not be successful.

The simulation also gives participants an experience that helps them reflect on the past successes and failures they have had in their own schools. Something may not have worked, but they may not have examined why—Were people ready for the particular change? Were the leaders on board? Were important stakeholders included in the process? Had they failed to do some important planning before they made a change? Did the change fit within the school's culture and environment?

Also during the simulation, teams are guided to learn from one another during the "summer break," a short time segment between the simulated school years. Significant learning can result when a team doesn't fully understand the uniqueness of its own system. Here's what one participant said about that experience: "Benchmarking is not always what it seems to be! The first time I played the game, our team went around during summer breaks and benchmarked other teams. When we tried to implement techniques other teams had used successfully, we did not clearly understand what they had done. In our circumstances, those same practices did not carry the same net positive outcomes. Copycat reform is not productive! Applying new knowledge to our specific context would have been a much wiser idea, i.e., we needed to design our own model...."

Carol Bershad is an independent educational consultant who has worked in educational settings for 30 years. She is a recognized authority on a variety of topics, including personal behavior change for adolescents, health and wellness, and process management, as well as organizational change. Her early experience as a high school biology teacher in the Newton, Massachusetts, Public Schools shaped her ecosystems approach to education and change. She is currently serving as chair of the board of Educators for Social Responsibility.

Susan Mundry has been a teacher, educational researcher, and developer of educational products for many years. She is currently Senior Research Associate at WestEd where she conducts projects to improve the quality of professional development for teachers for the National Institute for Science Education. She also co-directs the National Academy for Science Education Leadership, which prepares educators to lead change efforts and direct educational reform.

Lesson 4: Learn teamwork.

One of the best ways to build a team is for a group of people to work on an important and challenging problem and solve it together. The simulation creates such a situation. Participants work together, experiencing frustration and excitement as they meet the challenge before them. They get so caught up in the play that they engage in their real behavior, bringing out the ways they usually interact in a group and the assumptions or mental models they hold about teamwork. In educational settings we often don't teach people how to work in teams, but we expect them to work together effectively without building the skills and team behavior they need. High-performing teams develop conscious processes to make decisions, evaluate effectiveness, and take action.

The simulation creates an environment in which co-workers talk with one another about things they rarely discuss—their vision, assumptions, and beliefs about education, and how to bring about improvements. They are encouraged to engage in dialog, suspend their assumptions, and think together as a team. Some school districts have used the simulation to prepare teams of people who will work together in the future. It gives them a common experience and language and helps to connect people from different roles and grade levels in the district—a side benefit that people have appreciated and commented on.

In addition, as one participant commented, playing the game, "allowed them to make 'mistakes' in a risk-free, no-cost environment. In real-life systemic reform, some decisions do not allow for 'another chance' and can use valuable resources or create unintended consequences. In this simulation, participants can learn through those mistakes without 'real' consequences."

Lesson 5: Build a shared vision.

The simulation demonstrates the use of vision as a driving force. Most school districts say their vision is to get all children to meet the education standards set for them and reach their highest potential. However, they rarely get collective agreement that all members are part of the vision, nor do they take the next step and align their systems, structures, and learning practices with their vision. What they get is a school community whose vision is one thing—learning for all—but whose practices create something else entirely.

The simulation suggests that organizations need to develop a collective vision. Often, many good things are going on in schools, but these successes are isolated—they aren't guided or connected by a vision, nor do others in the school and wider community know about them. Having a collective and communicated vision with actions tied to it conveys a powerful sense of purpose and accomplishment. People understand why they are doing what they are doing and know what results count. This helps to motivate people and to build momentum for further success.

Vision has gotten a bad name in education largely because it has been seen as an end in itself, rather than as the guiding force for the collective energy and action in the community. Simulation participants usually haven't thought about vision this way and experience a real breakthrough when they see how vision ties together everything in the organization.

Lesson 6: Give change the time and persistence it needs.

People who play the game tell us that their change efforts in real life are not given adequate time to show impact and that leaders often have unrealistic expectations for immediate results. Systemic change takes a long time; in fact, it never ends. But people planning systemwide change must set realistic milestones along the way to assess and recognize progress and make mid-course corrections.

During the simulation, players earn points that represent learner benefits. These provide indicators of their progress. One thing that emerges as they play is that if they don't get some results and benefits early on, people lose the energy they need to change. In real life, too, we need to gather continuous evidence of progress and benefit for students and to communicate it to everyone. This helps to build the momentum and the energy needed to persist through tough times.

Lesson 7: Pay attention to people.

Organizations learn when people learn. Unfortunately, many districts only value the time teachers spend with students. They don't see the importance of teachers interacting with each other and learning continuously themselves to create and model the kind of place they want their schools to be. The simulation points out the need for people in school organizations to have quality professional development experiences tied to the vision of the school, opportunities to reflect with colleagues, and time to learn from other schools that have faced similar situations.

The game also illustrates that leaders of successful change efforts continuously assess where people are in the change process and how they are growing along the change continuum. Participants learn activities that must be tailored to meet the wide range of needs of people in the school. They also plan strategically to involve representatives of all the different stakeholder groups in the community to ensure that all viewpoints are included in the change effort.

LESSON 8: UNDERSTAND THAT RESISTANCE CAN BE A GOLDMINE.

In facilitating the simulation, we have found that many people are interested in discussing resistance to change—how you address it, turn it around, and use it to your best advantage. As people play the game, they encounter Irene, Pat, and Will, who are annoyingly resistant to change. These representative characters are alive and well in all districts. One man called us over while playing the simulation and said, "I'm Pat and he's Irene!"(pointing to his teammate.)

There may be some of Pat and Irene and Will in all of us, and for good reason. All change is not for the better. Sometimes it's the wrong time or the wrong change. Resisters can surface these concerns early and help you avoid a mistake. We have found that if you have the courage to listen to the resisters, rather than just writing them off, they can be a goldmine of information.

Making Best Use of the Experience

As we have traveled around the country and worked with many educators in different settings, we have seen the game used in a variety of ways. Some school districts plan thoughtfully about how to use the simulation. They use it to kick off to a major reform initiative, build teams, develop an understanding of the many parts of the system that need to be addressed in large scale reform, and/or to reinforce prior learning. Others use it as a leadership development experience to increase leaders' understanding of systemwide change and provide an opportunity to inventory their own past efforts and plan next steps. These are all very effective uses of the simulation.

We have also seen some poor uses of the simulation that we hope people will avoid in the future. We've seen situations in which the organizers did not create the context for why they were offering the game to their staff. In these "y'all come" situations, people often don't know why they are there or what expectations the district has for them.

Even worse, we have found that some groups have shortchanged the debriefing activities that must always follow the simulation play. The game should never be used unless there is ample time for processing. Learning comes not from the simulation experience so much as from reflecting on and connecting the experience to one's real-life situation. One participant wrote, "The debriefing sessions were productive learning times for me and my group. It once again confirmed for me...that reflection is an integral part of learning."

The simulation works best when people are encouraged to think carefully about their own situation before, during, and after the simulation. Otherwise it's a fun learning experience, but it doesn't help participants move their own schools forward. As one participant said, "Learning is more powerful when it can be directly connected to a person's life, and this simulation provided me with that kind of experience. As a participant, I was able to identify similarities between the simulation and the real-world project with which I am involved."

One technique that helps participants link the simulation with their own setting is to ask them to read a related article ahead of time or to think about past change efforts in their own organization so they have something to ground their experience as they play the game. We have also seen some organizations use the simulation over a longer period (multiple days and weeks), which gives them time to reflect in teams on their own school practices and how they compare to the simulation.

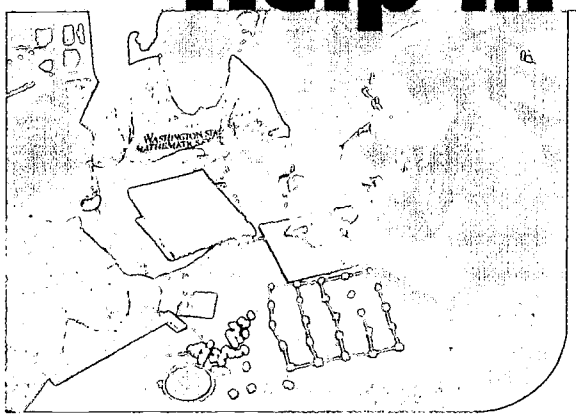
At one site, the game was used to train teacher leaders; participants conducted a follow-up session to decide how to take the learning from the simulation into their work with other teachers. Another district looked at changes they had attempted in their school district over the years and reflected about the changes that did not work, guided by the experience of playing the game. Based on this reflection, they then thought about what they could do differently in the future.

Immersion into a change process for a full day heightens awareness and engagement. As one participant who had been part of a leadership team in her district for three years commented, "I had more insights playing this game for one day than I did in three years of workshops." With the simulation, something physical happens; it creates a lot of energy and the time goes by very quickly. In fact, the time goes so fast that we often hear a collective groan when we announce that the game is over—sometimes the participants even talk us into playing for a little longer! As Barrie Bennett of Ontario Institute for Studies in Education at the University of Toronto put it, "It's brain friendly, safe, (with) time to talk and make connections." ◉

For more information on purchasing the simulation, attending a simulation training, or organizing a Facilitator's Institute, please contact:
Carol Bershad
ST&C Associates
25 Hammond Road
Natick, MA 01760
(508) 652-9954
Email: cbers@aol.com
Additional information about the game is in the Focus on the Collection Section of this magazine. (See page 57.)

Help in Making Change:

SummerMath for Teachers Serves as a Model



This professional development experience allows teachers to become learners in the kind of classroom they are expected to create for their students. See page 31 for an article about the participants

by Virginia Bastable, Program Director, SummerMath for Teachers

"The institute has made me question some of my practices as an educator. When you seriously question what you are doing, then that's the beginning of change."

Contemporary reform efforts in mathematics education are based on a view of pedagogy that is very different from the one most current teachers experienced when they were learners. Now classrooms are viewed as places where students pose questions, formulate and test conjectures, debate, and develop their own procedures to solve problems. Additionally, mathematics is seen as a process of testing and revising hypotheses, rather than as a collection of rules to be memorized.

A basic premise of SummerMath for Teachers (SMT) is that before teachers can create such classrooms for their students, they need to have opportunities to experience learning this way for themselves. Only when teachers experience learning in classrooms that enact these instructional principles and reflect on their own learning processes will they be able to create such classrooms for their own students. SMT supports teachers as they examine their beliefs about the nature of mathematics, as they analyze how children develop mathematical ideas, and as they consider the implications of these ideas for classroom instruction.

How the Institute Works

"There is a different feel here—one of cooperation, not competition—but still high standards."

SMT offers two-week, open-enrollment summer institutes: one for teachers of grades K-6, one for teachers of grades 7-12, and one for teachers of all grade levels returning for a second or third experience. All SMT institutes have three objectives:

1. To provide teachers with the opportunity to revisit the mathematical concepts in the elementary curriculum through a problem-solving and inquiry approach.

2. To provide a model of a classroom predicated on the belief that people learn by constructing their own meaning and to enact the pedagogical techniques inherent in such a classroom.

3. To enable teachers to create lessons and classroom structures that provide this model of instruction for their own students.

These goals are not addressed separately but are interconnected throughout each two-week institute. For instance, math sessions led by the staff not only provide opportunities for teachers to expand their mathematical understandings but also serve as a context for reflections on learning and teaching.

This article describes just one of many excellent professional development programs that help teachers change their practice. For information about some of them, see ENC publications *Ideas That Work: Mathematics Professional Development* and *Ideas That Work: Science Professional Development*, which are available online at http://www.enc.org/ **(Free print copies are also available; see the inside front cover for ordering information.)**

Please note that this is a condensed version of an article published on ENC's web site Teacher Change: Improving K-12 Mathematics. Visit http://change.enc.org/ **and click on Exploring Teacher Practice, then Cases and Narratives for the complete article and for sample activities used at SummerMath for Teachers.**

Program Activities

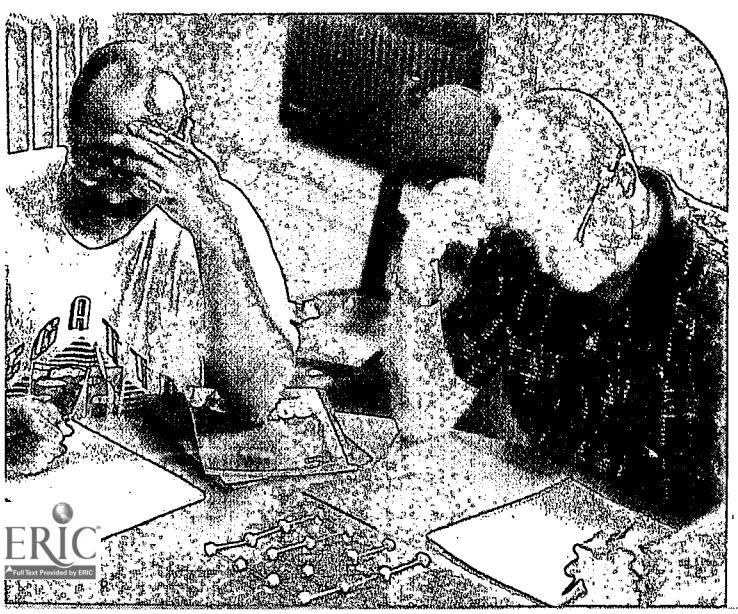
> *"The institute has certainly had an impact [on my thinking] regarding group work, questioning, perceptions of student learning—to name but a few. I was challenged to change my way of thinking as an educator."*

In the introductory institutes, the first week's activities consist primarily of mathematics lessons and discussions reflecting on those lessons. Participants are encouraged to take the role of learner and to try problem-solving approaches, such as using diagrams, computers, or writing, that might be new for them. The beginning of the second week is devoted to preparing and conducting two-day interviews with children in which participants have the opportunity to experiment with new ways of working with students, such as asking open-ended questions and working to follow the thinking of others. The latter part of the second week is devoted to issues of implementation.

The advanced institute has a similar structure; the first week is devoted to mathematics lessons and reflection. However, the second week focuses very specifically on implementation including assessment and lesson design. In the culminating project of the second week, each participant develops a lesson plan that is analyzed and modified by teams of peers.

While the specifics of the SMT curriculum are different each year, program activities fall into four main categories:

- Doing Mathematics
- Reflecting on the SMT Experience
- Listening to Mathematical Thinking
- Making Connections to the Classroom



Doing Mathematics

> *"SMT lessons led me to learn to think and explore, formulate rules, test them out, and finally conceptualize. I had only memorized math previously."*

SMT mathematics activities allow participants to explore more deeply the mathematical ideas embedded in the curriculum they are responsible for teaching. The topics in the elementary institutes include the nature of the base-10 number system, the meanings and structures of operations, the procedures of multi-digit computation, and perimeter and area.

In the secondary institute, math topics include the interplay of algebra and geometry, a study of rational numbers, an examination of measures of central tendency, using graphs to express change, and probability. The advanced institute includes work on area and perimeter, combinatorics, rational numbers, and a study of rates of growth related to pattern-making.

SMT staff conduct lessons in ways that are compatible with the ways teachers are being asked to teach in their own classrooms. Participants work in groups, use a variety of manipulative materials to model their ideas, are asked to explain their thinking, and come together as a whole group to share their results and to identify further questions. Computer software and calculators are available, but these are seen as tools to support participants' mathematical work rather than as the object of the lesson.

Reflecting on the SMT Experience

> *"I was pleasantly surprised when I caught myself not being able to stay uninvolved and intellectually aloof. I bit the bait and was taken for an incredible ride of self-discovery."*

All SMT institutes include opportunities for participants to analyze their own experiences as learners in the program. Daily journal writing is the main tool for reflection. While participants are free to write about whatever is of interest, sometimes specific topics are suggested. (See Guideline 2 on p.17.)

For instance, on the second day, participants are asked to reflect on the experience of working in a group and to write a response to this statement, "There is sometimes a tension between what you need to do for yourself as a learner and what you need to do to participate in a group. What are some of the tensions you have

experienced and what do you do to resolve them?" Journal entries are read but are not commented upon by staff.

Each week, participants write brief papers in which they articulate their current ideas about learning and teaching mathematics. Staff comments on the papers serve as a beginning point for dialogue during the second week.

Listening to Mathematical Thinking

> *"Previously, my perspective about questioning students was to guide their thinking to get it in synch with mine. Now I realize that my questions need to facilitate my discovery of what they know and understand."*

Many SMT program activities focus participants' attention on the importance of listening to the mathematical thinking of students. The prime activity occurs during the second week of the introductory institutes, when participants conduct interviews with students. Elementary-aged students are recruited from the local communities. Middle and secondary school students are from SummerMath, a six-week residential program for young women on the Mount Holyoke campus.

Several program activities are designed to prepare participants for these interviews. One activity has been specifically designed to promote discussion about the process of listening and an analysis of questioning techniques. SMT participants discriminate between questions that lead students to specific solutions and those that ask for clarification of the student's ideas. To provide themselves with examples of clarifying questions, the group compiles a list of questions such as: What are you thinking? Why did you decide to do that? Can you explain what you just did?

In addition, video and print cases presenting the mathematical thinking of students are used in the program. Participants analyze the mathematical thinking of students on videotape and examine student thinking in teacher-written narratives.

Making Connections to the Classroom

> *"SMT allowed me to experience change for myself.... Now, I am equipped to use these techniques in the classroom."*

As SMT participants reflect on their experiences as learners in the institute, they begin to ask how they can structure mathematical investigations for their own students that are similar to ones they have experienced. During the second week, activities support participants as they consider how to change their classroom instruction.

In addition, sessions devoted to issues of implementation are scheduled for the last two days of the program. Topics vary each year but have included alternate assessment, how to encourage effective group work, how to communicate with parents, how to create project-oriented assignments, and/or how to incorporate writing in mathematics classes.

In these final sessions, staff participate as fellow-teachers. Everyone in the group works to pose questions, to share experiences, and to offer possible solutions. These sessions provide a model of collegial interaction for teachers to take with them as they return to their schools. ◉

The SummerMath for Teachers (SMT) has been offering inservice programs on the teaching and learning of mathematics since 1983. For the latest information, please contact:

Virginia Bastable
SummerMath for Teachers
Mount Holyoke College
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(413) 538-2071 / Fax: (413) 538-2002
Email: vbastabl@mhc.mtholyoke.edu

Recommended Resources

Butts, T. (1980). Posing problems properly. In: *Problem Solving in School Mathematics. National Council of Teachers of Mathematics 1980 Yearbook.* Krulik, S. & Reys, R.E. (eds). Reston, VA: National Council of Teachers of Mathematics, Inc.

Chakerian, G.D., Crabill, C.D. & Stein, S.K., (1987). *Geometry, A Guided Inquiry* Pleasantville, NY: Sunburst.

Rhoad, R., Milauskas, G. & Whipple, R., (1988). *Geometry for Enjoyment and Challenge,* Evanston, IL: MacDougal, Littell.

Schifter, D. & Fosnot, T.C., (1993). *Reconstructing Mathematics Education.* New York: Teachers College Press.

Schifter, D., (In press) *Developing Mathematical Ideas.* Cuisenaire, Dale Seymour.

Schifter, D., (1996). *What's Happening in Math Class?* New York: Teachers College Press. (Volume 1: ENC 120057; Volume 2: ENC 120059).

Whiten, D.J., (October, 1993). Becca's investigation. *Arithmetic Teacher,* pp. 78-81.

Teachers Transformed

Valerie Penniman

Once an advocate of skill drills, this elementary teacher now bases her mathematics instruction on her students' understanding. A professional development program, SummerMath for Teachers (see article on page 28), helped her make the change.

by Annette Thorson, ENC Publishing

Like many elementary school teachers, Val Penniman's own learning experiences in mathematics were somewhat negative:

> "I was never a great math student. At one point in algebra class in high school, I was told to stop raising my hand!"

That she can remember this with a laugh illustrates Penniman's current confidence in her accomplishments as a math educator. At this point in her 20-year teaching career in Amherst, Massachusetts, Penniman has been chair of the district-wide mathematics committee. She recently served as the district's first mentor teacher assigned specifically to assist teachers new to the district, and she has developed and marketed an innovative set of calendar-based mathematics materials.

Perhaps even more significantly, Penniman has several years experience as staff member and Director of the Elementary Institute at SummerMath for Teachers (SMT) at Mount Holyoke College. It is this program that Penniman credits with transforming her from an elementary teacher who clung to skill drills and homogenous grouping to one who creates problem-solving lessons for students with a wide range of abilities. Formerly an advocate of text-based teaching, Penniman is now adept at planning classroom activities based on careful attention to what her students tell her about their mathematics understanding.

Making the change was not a quick or easy process.

Resisting Change

The first steps of Penniman's journey began in 1989, right as the standards of the National Council of Teachers of Mathematics (NCTM) were being published. At that time, Penniman's building was set up as a multi-age school organized in teaching teams. She and a partner team-taught 50 to 55 children in a combination second and third grade class. Penniman's first contact with SMT was through her teaching partner.

Penniman remembers, "She said that she was going to be taking this course that would help her teach math. At that time, we split the students by ability grouping; I took the 'high' kids, and she took the 'low' kids. I can remember the conversation. She was explaining that this was a program that would help her teach students to really understand the concepts about math more than just the skills, and, for instance, they might spend the entire period working on one problem."

She laughs, "We had a big argument. I said, 'No way are they going to learn math if they only do one problem a day. This is crazy!' In fact, it got to the point that she reminded me that I didn't work with the students who 'don't get it' and that I

Other Teachers Reflect on their Own Transformations

Valerie Penniman is just one of many teachers who have successfully transformed their classrooms after a summer professional development experience. The quotes below are taken from the change stories of four other teachers. Full accounts of their change experiences are available on ENC's web project, Teacher Change: Improving K-12 Mathematics. Visit: http://change.enc.org/

Betsy Adams, High School Math Teacher, Rancho Palos Verdes, California

After her first experience at SummerMath for Teachers (SMT), Adams struggled to make the changes she knew she wanted for her classroom. The second summer, in a conversation with program director, Virginia Bastable (see page 28), Adams confided:

...I hadn't been successful. I had wanted to try all of these things, and I wanted to do all of these things, and I was just having a lot of difficulty. And she said something to me that has become a memorable thought to keep in my mind when things get rough.

She said: "Betsy, vision always precedes practice."

It was such an eye-opening statement and yet so obvious. What you want to do and what you are able to do are not going to be congruent. Her statement has helped me realize that it is okay not to succeed at the level I want to succeed with my students. I can still keep striving for that vision and my practice will improve as long as I am willing to keep the vision.

Continued on p. 32.

Continued from p. 31.

DONNA JACOBS NATOWICH,
ELEMENTARY TEACHER,
BRATTLEBORO, VERMONT

Natowich found that keeping a journal of her reflections on her teaching, a habit she developed at SMT, helped her truly transform her classroom:

As I spent more time thinking and writing about what the children had actually said, I began to see that I was formulating new ideas based on their thinking. So much of what had gone on the day before provided wonderful fodder for the next day's activities.

Still, I was frustrated that my reflections revealed opportunities I let slip away. I began to focus on taking time to think during the lesson or discussion. I gave myself 'wait time,' something I ordinarily reserved for the children.

Slowing down helped me remember that my role should be that of a questioner, not a teller. I began to catch myself as I was about to answer a question that should not be answered yet. Instead of an answer, I learned to take time to think of another question that would help students find their own solutions. As I caught myself before I gave away the answer, I grew more pleased with the resulting discussions. It began to feel more like the inquiry type of environment I was looking for.

Continued on p. 33.

didn't understand. With that challenge, I started working with some of the struggling students, too."

By the next summer, Penniman was ready to try the first two-week course at SMT; her teaching partner was scheduled for the second, advanced SMT institute. Penniman was still skeptical, and she later discovered that her partner "actually warned some of the staff that I was coming and that I was going to be a hard sell since I was a complete non-believer at that point."

Accepting Change in Your Approach to Problem Solving

SMT was a challenging experience for Penniman. "Remember, I don't come from a strong math background. So here I was taking this two-week math institute, and my friend was not with me. I was pretty much on my own. It was really earthshaking to me because a lot of what I believed was questioned, and a lot of what we were doing was pushing me past where I was comfortable."

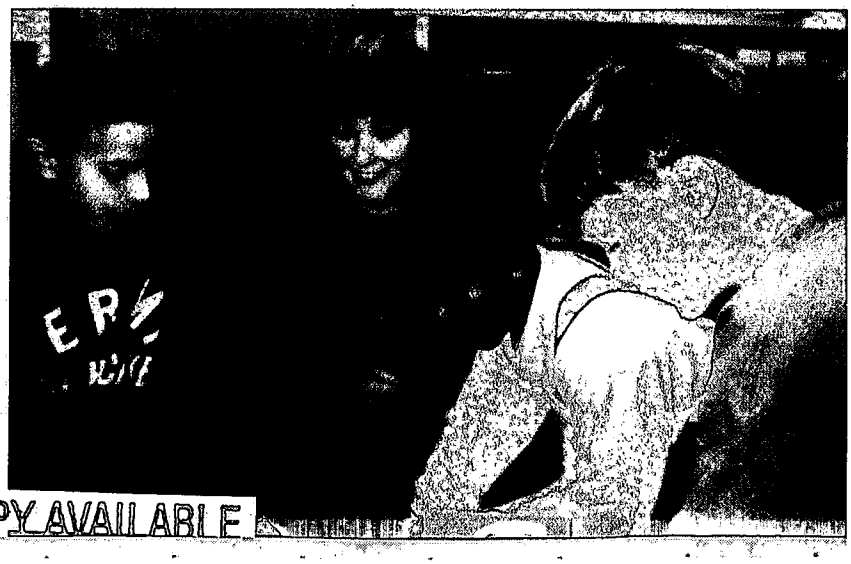
She continues, "SMT is very intense. It is set up to question your foundations in teaching and learning. The first week focuses on problem solving, and it begins with some fairly challenging problems that I just didn't know how to begin to solve. I suppose you could solve them using algebra, but I had forgotten most of my algebra. . . . We learned about accepting different ways people solve problems and learning to value that; we spent a lot of time paraphrasing how people solved the problems to begin to understand better. SMT staff members would never tell you or show you how to solve the problems. They would ask you questions to keep you thinking.

"SMT is really different from the stereotypical math class in which someone tells you how to do something and then you practice it until you can do it. That is not what this was about. They were actually modeling what we were supposed to do later in our own teaching. I could see it was working for me, and that convinced me a little bit."

Still, Penniman reports, "I was anxious. A lot of people were anxious. The idea is to look at your mathematical understanding, and if you don't think you have any, you are anxious. Plus, I thought I did a good job as a math teacher, and then all of a sudden, I am finding out that maybe I didn't do so well. It kind of shakes your confidence in yourself as a learner and a teacher."

Penniman was relieved to find that fortunately, "The institute is not at all competitive. SMT staff set the whole tone for working together and valuing each other. We read about Piaget and learned a very important word: disequilibrium. Each night you write in a journal, and at the end of each week you write a synthesis paper on what has happened for you, what you have been learning. The staff responds with more questions for you.

"I can remember writing, maybe not the first year but later, 'When am I ever going to get there? I want to be there.' My instructor's written response was 'Just as you are getting closer, you will find a new place where you want to be. So you are never going to get there—you will keep expecting more of yourself.' As you learn more, you realize, of course, that there is more to learn."



Continued from p. 32.

Accepting Change in Your Approach to Teaching

The second week of the initial SMT institute focuses on applying newly formed understandings to actual work with youngsters. Elementary-aged students come to the Mt. Holyoke campus, and participants each interview a student, then prepare a lesson for that child based on his or her current understanding. To help them prepare the lesson, the interview is taped and then participants listen to the tapes in pairs and discuss how to plan the lesson.

Penniman relates, "This is a whole new thing to interview a child and ask about math knowledge, which is done with some kind of manipulative or drawing or pictures. It isn't skill work. Everything is new. Nothing is 'Open your book and learn how to do this.'"

SMT also guides participants to listen to one another solve problems and to frame questions that help them understand the way people go about solving a problem. Penniman explains, "The ideas of listening and asking questions rather than telling someone how to perform a task are themes that are repeated often and that are modeled often."

By the end of her first two-week session at SMT, Penniman relates, "I was pretty much converted." Now she faced the challenge of applying her new beliefs in her classroom.

Making Change Work

Since both Penniman and her teaching partner had been to SMT, they agreed on the changes they wanted to make in their classroom. Says Penniman, "The support for each other was magnificent. We did not break the students into homogeneous groups; we kept them in heterogeneous groups, and that was a very big change."

The two also decided not to use the textbook, which was a tremendous challenge. "It was very hard work," recalls Penniman. "There were no materials out there at that time, so we would write a couple of problems to try out during the day with the students and then we would get together and ask 'What are the next steps? What should we do? Where should we go?' We were just staying about one step ahead."

She describes an example of the type of problem they tried to find: "We have coat hooks out in the hall, and at the beginning of the year we have something like 60 new students in the quad. That year when we were trying to figure out how many coat hooks each kid could have, we looked at each other and said 'We shouldn't figure that out—that is a problem for the students!' Those second and third graders took about a week and a half to solve that one problem."

In addition to the day-to-day challenges of running the classroom, each teacher had internal issues to work through. Penniman recalls, "I had the textbook scope and sequence memorized. I would be comparing, thinking, 'If we were using a book, we would be working on this skill. . . .' I was feeling a little less comfortable [than my partner] due to differences in teaching style. I couldn't really leave the textbook behind because it was in my brain so much."

The two teachers were fortunate to have received a grant that allowed Virginia Bastable, who was then the Assistant Director of SMT, to come to their school throughout the year to support them in the changes they were making. Says Penniman, "She would help us focus on questions like, 'What is it you want them to know? What could you do next?' She also enlightened us about the long-term goals embedded in the math we were teaching. At that time, working as a team was crucial for me."

JAN SCHOTT, JUNIOR HIGH SCHOOL MATH TEACHER, HADLEY, MASSACHUSETTS

Schott describes in detail the environment she creates to encourage her algebra students to begin thinking for themselves, but first she explains why she changed her practice:

My previous definition of teaching can be simply summed up as follows:

> Pour information into the students' brains with clear, concise explanations and lectures while simultaneously stopping the leaks.

This philosophy recognizes, but does not really address, the problem that all information that doesn't make sense or assimilate into students' scheme of things will indeed leak out and be lost forever. To address this issue, I realized that I needed to do less preaching and teaching. Instead I have been urging my students to explore their ideas and voice their thoughts. In essence, I have been working on encouraging them to be mathematicians.

I have found that by working together in small groups and in whole class discussions, students discover mathematics for themselves. I believe that they learn more from each other than from my preaching. Students often understand each other better than I understand them because they often have just recently 'been there' themselves. (See Guideline 12 on p.19.)

Continued on p. 34.

Continued from p. 33.

MARY FLYNN, HIGH SCHOOL MATH TEACHER, NORTHHAMPTON, MASSACHUSETTS

A highly successful veteran teacher, Flynn experienced a moment of truth on the very first day of an algebra II class with a group of students she had taught in seventh grade, eighth grade algebra I, and ninth grade geometry. Here's what happened:

On that September morning, when I questioned the students about topics I had taught so eloquently and thoroughly in the previous years, no one responded with any acknowledgement. I knew that I had before me a group of dedicated young people who had performed all that I had asked of them in past years and yet no one "remembered." Very often teachers wonder what the previous teachers did or didn't teach. However, in this case, the previous teacher was me, and I knew that the material had been taught.

Although with some review we were back on track again, this experience made me question the traditional methods of teaching and what I thought learning was. . . . What had happened? Was I losing my confidence? Had I been doing it the wrong way all those years with all those students? Questions were churning around and around in my head like a tornado about to touch down....

My conflicting thoughts increased as I participated in many courses and summer institutes, including SMT. In these experiences I found out that not only could I learn a great deal from my students but that the students could learn a great deal from each other.

I also learned that I was not the only teacher who felt ineffective in my own domain, in search of the invincible. I learned to be a learner and not just the teacher. I learned to be a listener and not just the teller. I learned the value of a student-centered classroom, a place where students were actively engaged in building their own learning. I learned that the student who builds on past experiences has a deeper and more comprehensive understanding than a passive learner. I learned that a change had to occur within me before I could direct my efforts toward change in the curriculum.

I was inspired with the challenge of change.

Not one of these inspired teachers would say that their stories have a "happy ending." As Penniman relates in the accompanying story, when she asked her SMT mentor, "When am I ever going to get there? I want to be there," the response was, "Just as you are getting closer, you will find a new place where you want to be. . . ."

s one of the greatest challenges of change. ◉

Garnering Support for Change

Penniman and her partner found that their second and third graders were quick to accept this way of learning math, and even the parents did not question it. This she attributes to preparation, "At the beginning of the year, we had borrowed a tape from SMT to show at parent night to begin to explain to them what we were doing. We didn't say this is earth shattering. We didn't say this is new math. What we did talk about is children getting to a better conceptual understanding of the math that they were learning."

The school administrators were also receptive. Says Penniman, "The principal didn't really quite understand, but he had heard of SummerMath and he was a supporter. (See Guideline 10 on p. 18.) There were a few people who had attended SMT before, so this wasn't a brand new idea. And we didn't talk about it a whole lot to other staff members unless they were interested. It wasn't like we were trying to reform anyone or say this is what you should be doing.

"The principal would sometimes send people in to observe what I was doing. Sometimes they would understand and sometimes they didn't. The assistant principal in our school liked what I was doing a lot, and she would often come in. If there were something fun going on in class, I would invite her in to see it. She encouraged me to do mathematical bulletin boards out in the main hall, which was something we had not done much before."

Committing to Change

It is easy to stay committed to a change decision when things are going well. Then there are the difficult days. Penniman admits, "There were a lot of times when we were stuck. We would say, 'What are we doing?' I would be thinking that students were way behind where they should be, or we would be worried about some of the kids who didn't seem to be getting it.

"I can remember once when I was having a very hard time with getting the students to multiply, and I remember what I call sort of 'falling off the wagon' because I just couldn't get [the concept] across with what we were doing." Penniman showed the children the traditional algorithm, and when she turned around, "these kids are staring at me—just these blank faces, like, 'What are you talking about?'

"I realized then that I couldn't go back to the old method of teaching. We had already made such a change in the way students were learning math that just to get up and show them how to do something wasn't going to work anymore. I can remember thinking, 'Well, we have made the change, and I can't just switch back to the way we used to teach.'"

And Penniman would not have it any other way. Her students' scores on standardized tests have remained high and are especially strong in mathematical applications. Even more important to Penniman is the attitude her students have toward mathematics. "Students like getting up and telling the class how they see things. It is empowering when you say to a kid: 'How did you solve this problem?' When the child explains, and the other students listen—hopefully attentively—they are exposed to a new way of solving a problem. Then we all clap." ◉

Evolving with the Internet: Taking Technology for Granted—Finally

A teacher who has used computers with students for years reflects on how advances in technology have improved its use in the classroom.

by Kristine Mueh, Science Teacher, Centennial Middle School, Boulder, Colorado

About five years ago, I wrote a story about my experiences and those of my students during an interactive Internet project called Kids as Global Scientists. The story was included in WestEd's 1995 publication *Tales from the Electronic Frontier.*

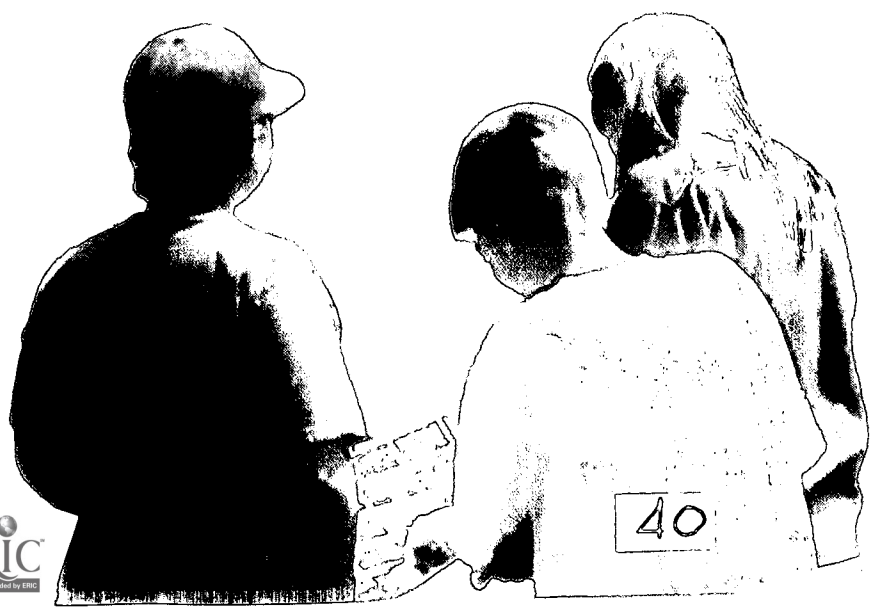
As I re-read that story recently, I remembered some things about the earliest years of the project that I hadn't mentioned in the article—

- days that the Internet was down in our building because direct connectivity was a new experiment in our district;
- the adventure of trying to evaluate the quality of student email correspondence by going into 60 different student accounts and searching for pertinent sent and received mail;
- the challenge of trying to learn about different aspects of meteorology by surfing around in the archaic, text-based "gopher" Internet browsing system.

We learned a lot about meteorology in the process, but we also had to struggle with plenty of "computer stuff" to get there.

THEN

In the early years of the Kids as Global Scientists project, we had a computer lab with 15 tiny black-and-white Macintosh computers, and we were sometimes corresponding with entire classrooms of kids who were working from only one computer and a modem. Only a few of our computers were capable of receiving some of the more interesting weather images. Students from the University of Colorado who were working on the project had to constantly download those images in complex ways so that my students could have some semblance of "real time" images.



One Sky, Many Voices

Kids as Global Scientists (KGS) began in 1992 with a grant awarded from the National Science Foundation. The KGS project focuses on maximizing the educational potential of a middle school weather curriculum through the use of a CD-ROM with Internet capabilities. This media, which can be used with or without an Internet connection, provides access to archived weather maps and data, as well as real-time and archival satellite and weather imagery.

Currently, there are more than 250 school or home-based sites from the United States and around the world registered to participate. The project goal is to help students use leading-edge technologies and resources to learn about weather and environmental science issues. The hope is that as students participating in KGS communicate with each other and with content experts via the Internet, they will not only collaborate in learning about weather, but will also get to know other students from different regions of the United States and the world, and learn about their geography and cultures.

The Hurricanes project is implemented during the month of October. This four-week project provides students with an exciting opportunity to collaboratively explore and study hurricanes with other classrooms all over North America. Participants can communicate with scientists and other students across the country through a threaded discussion board and track live hurricanes as they occur. The curriculum includes a 106-page book with lesson plans, activities, and student worksheets. During the four-week course, students learn about the structure of hurricanes, how they form and move, and the effects they can have on humans and habitats.

Additional resources included in the Hurricanes project is a CD-ROM with interactive explorations, an animated science glossary, interactive hurricane tracking maps, and a game that challenges students to predict the path of a hurricane. Teachers can participate in a listserv to share ideas and experiences, exchange hints and problem-solving tips, and provide support.

For more information about these and other programs, visit the One Sky, Many Voices web site at http://www.onesky.umich.edu/ or link to it via http://www.enc.org/focus/change/

Additionally, although this may seem trivial, the very process of typing in long email addresses and gopher sites was a frustration for my sixth graders. Even when they did make it to a promising meteorology site, they were often disappointed by meaningless (to 12-year-olds) strings of weather data or difficult-to-interpret information. There wasn't much on the web for them. And having 60 student teams, each with its own email address, was difficult for me to orchestrate at times. So although the experience was ultimately positive, it required a tremendous amount of technical support and preparation to make it work well for us.

AND NOW...

Even then, the increasing benefits of kids sharing data and talking to other kids around the world about science were evident, and the experience was powerful. But now...well, our current experience with Internet-based projects is beyond anything I would have envisioned when I first became involved in this kind of learning. Internet technology has evolved—and continues to evolve—from a sometimes-tedious tool with glitches that often overshadow the scientific concepts to be learned, to an invisible interface that we can generally take for granted. Increasingly, the Internet is less a distraction and more an effective tool for enhancing student learning.

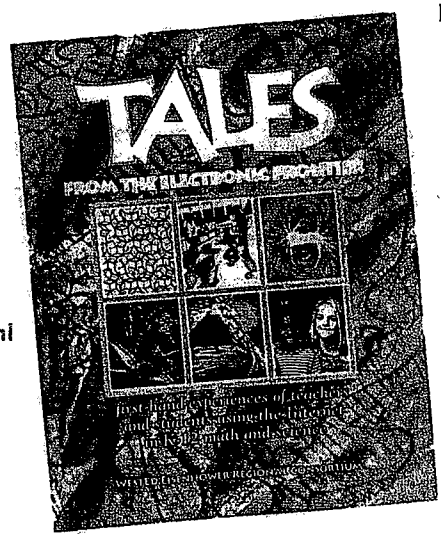
Teaching and learning with Internet technology are becoming ever more enticing because the necessary hardware and software are improving exponentially. This year we participated in Hurricanes '98, administered by some of the same people who learned how to do it with Kids as Global Scientists. They sent me a CD, I stuck it into our school's server, sent it out to the 25 Macintosh G3s my students would be using, and my hardware/software preparation was done!

The Hurricanes '98 software had an efficient menu of buttons from which students could choose. Students could write and respond to other students and meteorologists on a message board and explore hours-old satellite photos of hurricanes and see them in rapid succession to analyze patterns. They learned about air pressure and the coriolis effect with beautifully animated modeling activities and competed with other students around the country to predict the path of an active hurricane. The contrast between this experience and where I started is inspiring; I feel as though I am taking part in an amazing revolution.

GRAPPLING WITH CHANGE

At the end of "Of Wind and Weather," the article I wrote for *Tales from the Electronic Frontier*, some questions are posed about the effect of all this new technology on my teaching and on my students' learning. Throughout that story, I described my personal struggle with the need to tightly choreograph lessons in my classroom and the desire to simply let student learning happen as it would, without a lot of structured plans.

Because I've experimented with technology in my science curriculum since the beginning of my career, that struggle seems to me to be a natural and productive part of teaching. And because there are always exciting new technologies in science and in science education, there will always be uncertainty for teachers willing to try new things. A willingness to experiment doesn't mean that a teacher must scrap student learning to experiment with new technologies, but it does mean that a teacher must learn to plan flexible lessons. It means he or she will be designing experiences in which the exact outcome is not certain, but certainly will be valuable.



As this article demonstrates, a great deal has changed since *Tales from the Electronic Frontier* was published in 1995. Nevertheless, the stories still are compelling for classroom innovators. Visit the electronic version at http://www.wested.org/tales/08wind01.html **This publication is also described in ENC's Resource Finder (ENC-004277).**

Our experiences during the early days of the Kids as Global Scientists project revealed how very important—and sometimes uncomfortable—such flexibility can be. Student learning was certainly happening, but since we were exploring a new technology together, the things my students were learning via their Internet communications were not exactly the science concepts I felt they needed. They also had to wade through quite a bit of frustratingly non-applicable information to get to something useful.

Today's ongoing advances in hardware and software have created a more appropriate flexibility. In the Hurricanes '98 project, I didn't know exactly what my students would learn from their Internet travels—since communications with other students and scientists, real-time satellite images, and real-life hurricanes can't be choreographed or planned. However, I did know the nature of what they would see to a greater extent than I knew what my Kids as Global Scientists students would encounter. And I also knew that the Hurricanes '98 CD came with resources that would facilitate learning the specific meteorology concepts I found important. So although students still learn through inquiry and there's still exciting flexibility in content, the newest Internet projects allow some strategic scripting of experiences to optimize student learning.

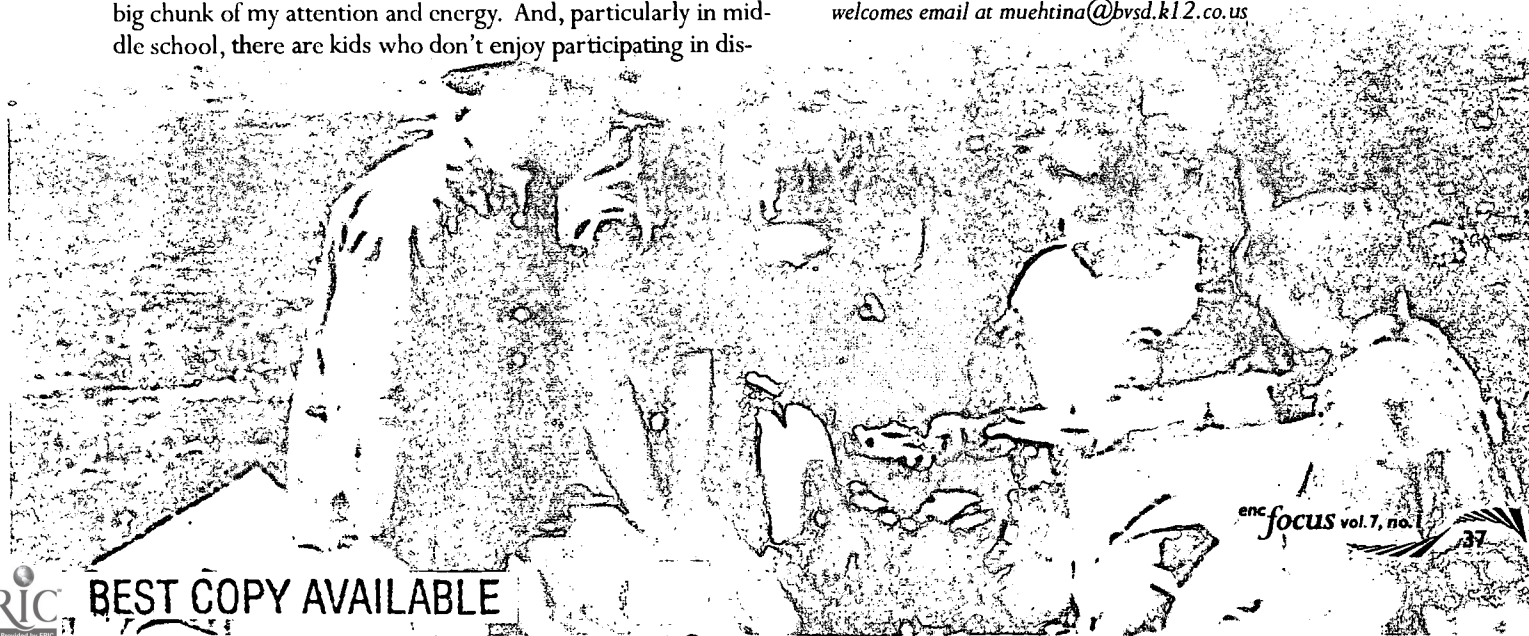
A WILLINGNESS TO EXPERIMENT DOESN'T MEAN THAT A TEACHER MUST SCRAP STUDENT LEARNING TO EXPERIMENT WITH NEW TECHNOLOGIES, BUT IT DOES MEAN THAT A TEACHER MUST LEARN TO PLAN FLEXIBLE LESSONS.

TECHNOLOGY INCLUDES EVERYONE

I think the most significant way Internet technology affects my students' learning is in giving a voice to those students who don't traditionally have much to say in a science classroom. Typically, there are a few boisterous, confident kids who claim a big chunk of my attention and energy. And, particularly in middle school, there are kids who don't enjoy participating in discussions because of a myriad of adolescent reasons—fear of seeming too smart or interested, fear of drawing attention to themselves because they don't like how they look, and so forth. The Internet offers comfortable anonymity: my reticent students can talk online to other students and to meteorologists about science, and no one knows what they look like, how popular they are, how shy they are, or what their grades are. I have seen many special education students, quiet types, and others who don't generally participate in or enjoy science class really thrive during Internet discourse. Also, I've seen students who are intimidated by adults—and adults who have a hard time talking to kids of this age—have wonderfully fruitful conversations over the Internet. These kinds of interactions just cannot be achieved via traditional classroom experiences.

As Internet technologies advance, we evolve with them. Because technology has always been part of my teaching, and because it's becoming increasingly more comfortable to use, I approach new technologies (and new things in general) with less and less trepidation. Similarly, every year I see less initial student fear of technology; more and more students are willing to dive in fearlessly because each new class has grown up surrounded by such resources to a greater extent than has the class before. And now that Internet technologies have become so seamless, we can begin to take them for granted and really use them to optimize teaching and learning. ◉

Kristine Mueh has taught middle school science for nine years—minus a two-year hiatus to get her master's degree in biology at the University of Colorado. She currently teaches sixth graders at Centennial Middle School in the Boulder Valley School District in Boulder, Colorado. She welcomes email at muehtina@bvsd.k12.co.us



12 SMALL STEPS TOWARD CHANGE

A veteran science teacher shares some low-risk techniques that can smooth the way toward a standards-based classroom.

by Lynda Titterington, ENC Instructional Resources

The last time I had a substitute teacher cover my biology class, I left her a copy of all of my materials for the unit on digestion. I didn't think she would get through half of it, but I thought she'd like to see the big picture. When I returned from the conference, I was amazed at all the information she presented. Thanks to her, I was a whole week ahead!

Now for the bad news: my students were overwhelmed and confused. As one student told me, "It was a waste of time. She just talked too fast and I couldn't keep up with her, so I decided to go and read the book." However, the entire class was absolutely thrilled to have me back. I had never before felt so appreciated. We took a day to review, and then got back on track.

So, what is it that I do differently? It's not that I don't lecture. In fact, I lecture a lot more than I want to, especially when I'm feeling like time's running out and we still have so much to do! Every time I hear about a teacher who is using conceptual change or problem-based learning in her classroom, I hear myself whisper, "I wish I had the time/materials/courage to try that."

Changing our teaching requires more than just time to investigate new methods. It also involves a personal commitment and courage to try new things. Leaving our "comfort zone" is, well, pretty uncomfortable, if not somewhat scary. However, as I compared my current classroom dynamic with the substitute's traditional lecture style, I felt encouraged. I realized that, over the years, I have taken some small steps that have moved me not to but toward the place I want to be and that have brought big changes to my students' learning experience.

One key thing I have learned is not to limit myself to materials or ideas developed for my particular level, which happens to be community college. (See Guideline 11 on p.18.) In my work with K-12 teachers and materials at ENC, I have found lots of ideas for all levels that are easily modified to fit my needs. In fact, I started out by borrowing ideas from elementary school teachers for some simple writing and discussion activities to engage my students during non-laboratory classes. By the same token, you will be able to adapt the 12 ideas described here to suit a wide variety of situations.

Lynda Titterington is senior science abstractor for ENC. She also teaches life science courses at Columbus State Community College. Email her at ltitter@enc.org

INTRODUCTIONS

2 GETTING TO KNOW STUDENTS BY ASKING THEM TO "WRITE YOUR AUTOBIOGRAPHY AS A SCIENTIST."

I pass around brightly colored note cards and ask them to write a short autobiography about their science classes to give me a handle on their background. This brief history also benefits the students because it allows them to reflect on how science affects their lives outside of school. I hope that they will conclude that they are more "scientist" than they previously thought.

3 USING STUDENT QUESTIONS TO INTRODUCE A UNIT.

Everyone writes a question about the topic at hand and puts it in a fish bowl. Student groups pull a question from the bowl and try to answer it in three minutes. Not only does this technique demonstrate that science is more about questions than answers, but it also focuses students' attention, stimulates deep processing, and promotes active learning.

3 STARTING THE LESSON WITH A QUESTION.

At the beginning of class, give students a question that reviews yesterday's material or introduces a new topic. Review questions can be very open ended, such as "What questions do you have about last night's homework?" Or they can be more specific to the day's topic, such as, "What would happen if _____." I ask my students to write their responses on half a sheet of paper. They are also welcome to collaborate with a partner. The writing helps students gather their thoughts and focus on the topic at hand. Take another minute to ask one or two students to share what they wrote, or collect a sample of papers to share with the class. I don't recommend grading this assignment—it works a lot better when students feel safe to explore and experiment with ideas.

4 FRAMING THE UNIT WITH A VISUAL.

Show the students a picture or flowchart, say of a wetland ecosystem, and ask them to make a list of what they see. Alternatively, you can show them a graph and ask them to interpret it. Collect the papers and put them away. Put up the same picture at the end of the unit and ask the student to make another list of what they see, then write a paragraph that explains the events or relationships in the visual to a friend. Invite students to share their writing with a partner, and then write another paragraph for the teacher to read. We always have fun comparing the "before" and "after" writings and sometimes my students even ask me to grade their final product!

ACTIVE LEARNING (AND EMBEDDED ASSESSMENTS)

5 VALUING SMALL GROUP TASKS.

Give students a task on an overhead or on a handout that specifies the question or problem to address, the time limit, and the final product. The time can range from a few minutes to a full class period as long as you allow time for group reporting. To keep students on task, their discussion should yield a product, such as an idea map, a flow chart, or a list of questions. In addition to sharing their work with the class, I collect and comment on their papers to let them know that I take their group work seriously.

6 USING THE JIGSAW.

Once or twice a term, I use this technique to help students make connections and distinctions. The jigsaw, a cooperative learning technique, works by dividing students into groups and giving each group a "piece" of the material to investigate. The task of these "expert" groups is to master the content and be prepared to share what they know. Next, the groups are reformed into mixed groups that have a representative expert for each topic. Usually I devise a problem for the mixed groups to solve that will require the expertise of each member.

7 CLARIFYING DIFFICULT CONCEPTS.

After you have covered a tough topic, take a break and ask students to summarize the main points. They can also identify the most confusing points. Sometimes I ask them to make a written list, and sometimes we go around the room and invite everyone to make a comment. Alternatively, I'll pause and ask students to do a "Think-Pair-Share" in which they jot down their understanding of the topic, then take turns explaining the material to a partner.

8 CONSIDERING THE TAKE-HOME MESSAGE.

Take a break from classroom activities and ask students, "Please summarize the main ideas of this lesson in one clear sentence." I usually have them write their sentences on colorful 3x5 cards, then I collect the cards and mark all of them with a check mark so the students know I read them. The next day, I choose five to share with the class and discuss. Some of the discussion questions might include, Is this really what the class was about? Is anything left out? Are the details in the proper order? Did we emphasize the right things? Writing a single sentence that says it all is difficult. To do this, students must think over the information and evaluate it to weed out the minor details. It also helps me identify trouble spots early.

9 EXPANDING CONCEPTS WITH METAPHOR REVIEWS.

In *Writing to Learn Science,* Bob Tierney uses metaphors as an imaginative way to find out what students understand. For example, during a unit on cells, he asks students to discuss this question: Mitochondria are like _____.

a. a battery
b. Wheaties
c. a tornado
d. a river

Although this question is framed as multiple choice, there is no clear right or wrong answer. As students explain their choices, they are encouraged to think about mitochondria (or any new topic) differently and in terms of what they already know.

TOWARD ACTIVE ASSESSMENT

10 INCORPORATING HIGHER-LEVEL THINKING IN A MULTIPLE-CHOICE WORLD.

Provide space beneath multiple choice questions for students to explain why they chose their answer. Not only does this strategy discourage guessing, but it also encourages students to think carefully about the question.

11 ENCOURAGING ESSAYS.

One option I include on tests is "Write your own question and answer it. Tell me about something you studied that wasn't on the test." An accompanying rubric reminds students that their question must be relevant to the course, that their answer must contain a prescribed number of key words, and that each key word must be clearly defined or used properly in the context of the question. An additional point is available for answers that are "dazzlingly complete."

12 OFFERING STUDENTS A CHOICE OF PROJECT TOPICS AND FORMATS.

I provide a menu of projects for students to choose from. The menu, designed to address multiple learning styles, allows them to choose to present information as a pamphlet, poster, or study guide; to write a science fiction story or children's picture book; or to create a PowerPoint presentation, home video, or model. I developed a simple rubric for each format and have the students use the rubric as both a checklist and a means of self-assessment.

ENC would love to hear about the steps—both big and small—that you have taken to change your teaching and enhance student learning. See page 5 and plan how you can share your ideas with other teachers nationwide. ◉

SUGGESTED READINGS

Bean, J.C. (1996). *Engaging Ideas: The Professor's Guide to Integrating Writing, Critical Thinking, and Active Learning in the Classroom.* San Francisco, CA: Jossey-Bass.

NSTA. (1996, 1997, 1998). *NSTA Pathways to the Science Standards: Guidelines for Moving the Vision into Practice.* Arlington, VA: National Science Teachers Association.

Rezba, R. J. (1996). *Readings for Teaching Science in Elementary and Middle School.* Dubuque, IA; Kendall/Hunt Publishing Company

Silberman, M. (1996). *Active Learning: 101 Strategies to Teach Any Subject.* Needham Heights, MA: Allyn & Bacon.

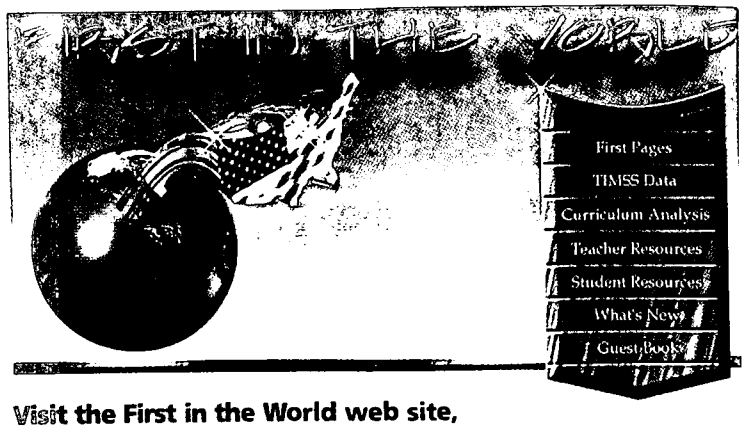
Tierney, B. (1996). *Write to Learn Science.* Arlington, VA: National Science Teachers Association.

First in the World Consortium:

Superintendents Lead the Way to Systemic Change

By participating as a "mini-nation" in the Third International Mathematics and Science Study (TIMSS), this Consortium of 19 school districts found a way to gather not only achievement data but also information about their educational systems and curricula. (See Guideline 4 on p.17.)

by Leah Poynter, ENC Publishing



Visit the First in the World web site, maintained by one of its partners, the North Central Regional Educational Laboratory (NCREL) at http://www.ncrel.org/fitw/homepage.htm

"If you are going to support reform efforts and deep change, you have to think seriously about breaking the old molds and look at new ways of thinking. If the leadership does not come from the superintendent, the teaching staff and other administrators have absolutely no reason to have any investment in this. Superintendents have to be passionate about change."

These are the passionate words of Paul Kimmelman and David Kroeze, two of 19 Illinois superintendents who have joined in a cross-district effort to face the challenge of goal 5 from the Goals 2000 Educate America Act—US students will be number one in the world in math and science achievement by the year 2000.

Calling their effort the First in the World Consortium, educators from the 19 participating school districts have developed partnerships with the US Department of Education, other governmental agencies, and local and national businesses. They began their work by asking how districts could benchmark their math and science achievement, and what they could do to guarantee they were providing a world-class education for their students.

Supporting Change Through TIMSS

By participating as a "mini-nation" in TIMSS, the Consortium found a way to gather not only achievement data but also information about their educational systems and curricula. Kimmelman asserts, "First in the World now has a benchmark that tells how our districts have done as an aggregate group in comparison to other countries around the world."

Looking at TIMSS as a system rather than just a piece of research, Consortium schools are using the study as a reform instrument to improve mathematics and science instruction. The superintendents explain, "If you are asking teachers to use that information to be part of the improvement process, then you have to work with the staff to help them understand what TIMSS has to say, and provide opportunities for them to reflect on instructional strategies and improve their skills." A commitment to providing professional development is an essential component of the Consortium's mission.

In support of this goal, the Consortium maintains four self-governing teacher learning networks (TLNs) in which groups of educators from member districts examine TIMSS data, formulate problems, and generate hypotheses and research questions to further explore curriculum and instructional practices. TLNs explore the achievement and contextual data from TIMSS as a way to re-examine classroom practice. The groups construct findings that will guide staff development. Over time, the networks might decide to reorganize or combine efforts to better serve the needs of member districts. Additionally, another network of instructional support personnel, primarily comprising curriculum supervisors and administrators, collaborates on getting more information and using it in their districts.

A critical goal of the Consortium is to cross traditional boundaries and collaborate across districts. These partnerships become adult learning communities that support the change process. However, the focus and details of instructional change will not be mandated at the Consortium level. Kimmelman points out, "The Consortium assembles the data and provides information, but each local district is responsible for making decisions as to how to use that information."

"Once you have the achievement data, there are other components to TIMSS that help inform systemic improvement as well," suggests Kimmelman. The study has provided a framework for reflection on instructional practice. For example, the videotape study showing classrooms in Germany, Japan, and the United States has been a valuable tool for working with teachers to recognize differences in instructional strategies. Kimmelman predicts that the Consortium will be using the comprehensive case studies of the educational systems in those three countries to further examine different approaches to teaching.

The First in the World Consortium also was selected to participate in the video study when TIMSS was repeated in 1999. TIMSS-R (TIMSS-Repeat) only tested students in Population 2, seventh and eighth grades. The Consortium, along with the nations that participated in the original study, will be able to examine the progress of students who were previously in Population 1, third and fourth grade.

First in the World will soon have the results of the curriculum analysis component of TIMSS being performed by Michigan State University. Initial findings suggest that Consortium schools teach higher-level thinking skills at an earlier age than is generally done in the United States, which might have contributed to some of the higher achievement levels obtained by the Consortium. Complex problems appear to be introduced at a younger age, and Consortium students more frequently are required to use reasoning skills as opposed to drills. Kimmelman makes another initial observation based on the study, "Our teachers appear to have more time to communicate with one another than their US counterparts; however, we certainly have a distance to go to improve ourselves."

Achieving Change Through Leadership and Cooperation

All 19 superintendents serve on the Board of Directors, which usually meets once a month. Throughout the course of the year, they are involved in book discussions that broaden their knowledge of contemporary leadership and change theory. They are using books such as *Intellectual Capital: The New Wealth of Organizations* by Thomas Stewart (Doubleday, 1997) and *Political Leadership and Educational Failure* by Seymour Sarason (Jossey-Bass, 1998) to facilitate their own change as educational leaders.

Consortium superintendents are committed to developing what Kimmelman calls the intellectual capital of the teachers and administrators in their districts because, he notes, "They are the ones who are going to make the difference." Intellectual capital refers to higher level, deeper understanding of important information that imparts a competitive edge. Kimmelman and Kroeze believe that to scale up their programs, superintendents must help teachers know more about what the research is saying about teaching practices along with providing curriculum information.

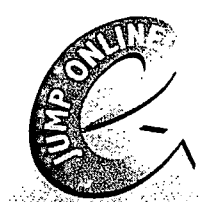
Kimmelman and Kroeze are emphatic in stating that deep change in curriculum and instructional practice requires a systemic approach. "One of the things we have learned from TIMSS is that no one single factor is going to make a difference." Instead, they and the other superintendents are looking at a number of "silver bullets" or strategies for change that can, as a whole, lead to improvement in math and science achievement. Kimmelman has written an article for *The American School Board Journal* titled "Looking for the Lone Ranger: Six Silver Bullets That Could Save our Schools." (This article is available online; see web address on this page.)

Sharing What They Have Learned

Part of the First in the World Consortium's mission is to disseminate information about its work nationally. Kimmelman points out that while additional districts may not be able to join the Consortium, other groups of districts can organize themselves for systemic change. "It is about replicating what the Consortium has done in your own area or region. This type of cross-district, cooperative venture requires a great deal of effort and understanding that you are attempting to improve your instructional strategies and your curriculum."

The superintendents hope other groups of schools and districts will look at the Consortium's work and then engage in their own networks for learning and improvement. "Bringing people together to work for change as a cooperative group has a far more powerful impact upon what you are doing than asking thousands of school districts in the United States to operate in isolation."

The First in the World Consortium's web site contains comprehensive information about its efforts including TIMSS findings, curriculum analysis and other research, and presentation slides. The materials provided are in the public domain so any school in the nation can benefit from the work being done by the Consortium. ◉



Complete information about TIMSS is available at ENC's web site, Teacher Change: Improving K-12 Mathematics at http://change.enc.org/ The site also provides the article about the First in the World Consortium printed here, from which you can link to the full text of Kimmelman's article "Looking for the Lone Ranger: Six Silver Bullets That Could Save our Schools."

Student Discourse in an Inquiry-Based Elementary Science Class

Involvement in classroom research deepens a second grade teacher's understanding of how her own role may change as she uses inquiry science with her students.

by Kathleen M. Collins, University of San Diego;
Fé MacLean, Paddock Elementary School, Milan, Michigan;
Annemarie Palincsar, University of Michigan;
Shirley Magnusson, Washtenaw-Livingston
Mathematics & Science Center

More About Research in the Classroom

Our community represents a professional development project in which university and school-based members work together to develop a particular form of inquiry-based science teaching, Guided Inquiry supporting Multiple Literacies (GIsML) (Magnusson and Palincsar, 1995). GIsML is an orientation to teaching developed from a social constructivist perspective (Palincsar, 1998). GIsML engages individuals in sustained inquiry about the physical world and provides opportunities for social interaction in ways that mirror the knowledge-building practices of the scientific community.

This paper is drawn from a strand of our work that focuses on several important features of clsssroom discourse within GIsML instruction:

1. attention to the multiple forms of representation, such as graphic documentation and oral discourse, in GIsML science;
2. explication of the ways in which these multiple forms enable classroom communities to refine their understanding of scientific principles over time; and
3. reflection on the ways in which teachers guide their students' representation and interpretation of the phenomenon they are investigating.

While we do not have the space to discuss our work fully in the accompanying article, we hope to represent enough of the spirit our research to help teachers reflect on their own classroom interactions. Development of the Guided Inquiry Community of Practice is discussed fully in Palincsar, Magnusson, Marano, Ford, and Brown, 1998; Brown, Palincsar, and Magnusson, work in progress; and Marano, Palincsar and Magnusson, work in progress.

The Authors:

A former high school teacher, Kathleen Collins is now an assistant professor of literacy at the University of San Diego, California.

Fé MacLean is a second grade teacher at Paddock Elementary School in Milan, Michigan.

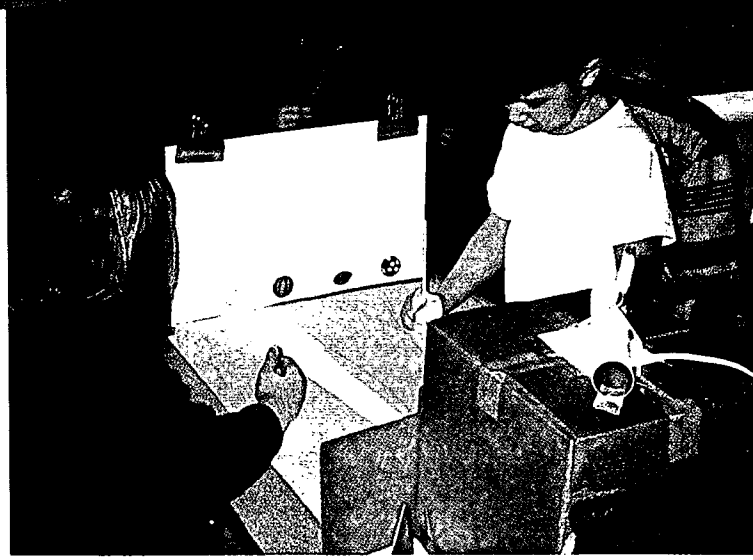
Annemarie Palincsar is an educational researcher interested in the design of learning environments that provide children meaningful occasions to acquire and use literacy.

Shirley Magnusson, formerly professor in science education at the University of Michigan, is currently director of the Washtenaw-Livingston Mathematics and Science Center, which provides resources in K-12 math and science education for two counties in southeastern Michigan.

The authors of this article have collaborated for more than two years as members of the Guided Inquiry Community of Practice (see box above). Through classroom research, the community has investigated various aspects of inquiry in science education. This experience has led the school-based members of the community to develop a special interest in the reporting or public-sharing phase of instruction. Videotaping of classroom discourse and close analysis of the tape transcripts has allowed teachers to reflect on the power of public sharing and how their practice supports it.

In the public-sharing phase, students typically work in pairs or small groups to present their data and their interpretations of that data to the class. Other members of the classroom learning community then have the opportunity to question and respond to the ideas presented by the students who are sharing.

Public sharing represents an important opportunity for developing two different kinds of understanding—substantive and



syntactic. Substantive understanding is comprehension of scientific principles, while syntactic understanding involves learning how to negotiate the norms of scientific investigation (Schwab, 1964; see also Collins, Palincsar, and Magnusson, 1998).

The part of our group's research reported here focuses on how these two kinds of understanding unfold in a guided inquiry investigation of the phenomenon of light in Fé MacLean's second-grade class. In analyzing the classroom video, our attention was captured by the participation of one student in particular, Robert (all student names are pseudonyms), who has been identified as learning disabled (Collins, MacLean, Palincsar and Magnusson, 1998).

Analyzing Classroom Interaction

To illustrate not only the interplay between substantive and syntactic understanding but also how to look carefully at classroom discourse, we share an excerpt from the transcript of Robert's sharing session (see also the analysis in Collins, 1997). This excerpt is taken from a point late in the sharing session, after Robert presented his data and was in the process of answering questions about his documentation. Photos show students working with their classroom-made lightbox and the sharing sesson recorded here.

Lenny: Why is there light outside, is that black or white outside? (Lenny was referring to the area of Robert's drawing that depicted the shadow cast by the edge of the light box, which protruded up into the window and cast a lighter shadow than those created by the sides of the light box.)

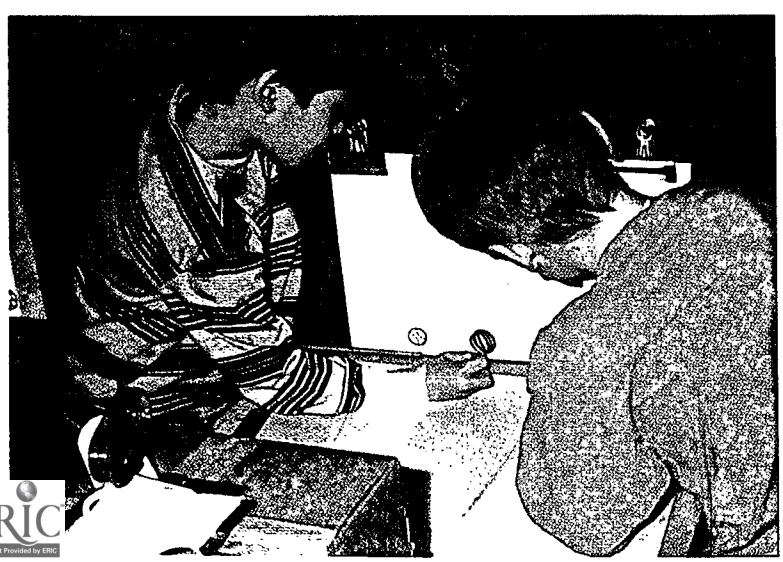
ROBERT: We colored that part with the side not with the tip [of the crayon].

MACLEAN TO ROBERT: Why did you color it black?

ROBERT: Because that was the shadow, part of the shadow, too.

MACLEAN: Where was the shadow coming from?

ROBERT: When we had the block right there (indicates square marked "block") there was light right there (indicates path of light, drawn in orange). There was light beside it but the light didn't go on the side (indicates shadow from box, colored gray).



MACLEAN: The light didn't go on the side. Why do you think the light didn't go on the side?

ROBERT: Because we had the block right there. It was like that (indicates path of light coming from source and hitting block) and it didn't spread out wide enough (stretches arms wide apart).

MACLEAN: Oh, it didn't spread out wide enough. OK.

This excerpt illustrates the ways in which MacLean's questioning supports both the students' syntactic understanding of the process of documentation in scientific investigation and their substantive understanding of the nature of light. Lenny's opening question invites Robert to clarify his documentation. When Robert responds, he does not connect the documentation to the phenomenon but rather describes the coloring technique he used.

MacLean then invites Robert to make the connection to his substantive understanding by asking, "Why did you color it black?" In this way MacLean supports the students in moving from talking about the documentation by itself to reflecting on the documentation as representative of the phenomenon they observed.

In her next question, MacLean supports this move further by asking for more clarification of the shadow as depicted on Robert's documentation, "Where was the shadow coming from?" Robert again clarifies the relation of his documentation to the phenomenon he observed. To push him to develop his substantive understanding, MacLean responds with another question that calls upon Robert to interpret his data further, "Why do you think the light didn't go on the side?"

Reflection

Careful analysis of this incident illustrates the multiple roles played by the teacher in such interactions, and the ways in which the teacher's ability to serve in these roles is enabled or constrained by her own knowledge. The discursive choices made by the teacher:

1. may either construct or constrain opportunities for students to build understanding of the phenomenon they are investigating,
2. may facilitate students' participation in the inquiry and communicative practices of scientists, and
3. may provide opportunities for students who struggle with print literacy, such as Robert, to construct and share understanding in other ways.

As we thought about the success of this classroom exchange, MacLean reflected on the contrast between her ability to guide students in this inquiry about light and the problems she faced in a different inquiry, which focused on reflection and refraction.

One of the materials MacLean provided for the students was an empty compact disc case. The students soon discovered that the case could, as several announced, "make a rainbow!" Making rainbows then became the focus of the investigation. MacLean reflected on how this unexpected turn in the inquiry was frustrating for her because of her own lack of understanding of the phenomenon:

> I was not ready for the questions the students were asking. For example, what was causing the rainbow? What was causing multiple rainbows? How can we project the rainbow to the ceiling? Will it reach the sky? What was frustrating at the time of my class investigations was my inability to provide direction. I was unable to ask the relevant questions that might have led the students to reasonable explanations of their discoveries.

A year after his class engaged in the guided inquiry investigation of light described in this article, Robert reported to us that the public sharing he participated in was the most memorable experience of that school year. He emphasized that the opportunity to "talk about my idea" and to "hear what other kids say about it" was important for him.

In addition, after reviewing the transcripts of MacLean's teaching, Collins and MacLean both independently reached the conclusion that Robert's public sharing had been a turning point in the inquiry conducted by this classroom community, particularly because of the opportunities for constructing substantive understanding it provided. The opportunity to combine his verbal explanations with his graphic documentation in dialogue with others was important for both Robert and the classroom community (Collins, MacLean, Palincsar, and Magnusson, 1998). ◉

This work is supported by funds from the Eisenhower Professional Development Funds from the Michigan State Department of Education and the Spencer / MacArthur Professional Development Program. The authors wish to acknowledge the support and contributions we received from our university colleagues (Nancy Brown, Jane Cutter, Danielle Ford, Adrienne Gelpi Lomangino, Susanna Hapgood, Karen Hopkins, and Nancy Marano) and from our school-based colleagues (Marlo Bearman, Pat Delaney, Jasmine Dudzik, Elaine Flaugher, Sally Freeman, Gretchen Geverdt, Cari Gittleson, Gwen Guthrie, Char Hanchak, Bev Ingraham, Lynne Kochmanski, Jane Levy, Margaret Mayol, Karen Morrison, Debbie Swanson, and Linda Verhey).

REFERENCES

Brown, N., Magnusson, S., and Palincsar, A. (work in progress). *The Quiet Quadrant: Inter and Intra Reflection in a Community of Practice.*

Collins, K.. (1997). *Talking About Light: The Construction of a Shared Discourse by First Grade Students in Guided Inquiry Science.* Paper presented at the annual meeting of the National Reading Conference, Scottsdale, AZ.

Collins, K., MacLean, F., Palincsar, A., and Magnusson, S. (1998). *Verbal and Print Literacy in Guided Inquiry Science: The Case of Robert.* Paper presented at the annual meeting of the National Council of Teachers of English, Nashville, TN.

Collins, K., Palincsar, A., and Magnusson, S. (1998). *Thinking Like a Scientist: Exploring Support for Knowledge Construction in Guided Inquiry Science.* Paper presented at the annual meeting of the American Educational Research Association.

MacLean, F. (1997). Guided Inquiry About Light: A Reflection. Paper presented at the annual meeting of the National Reading Conference, Scottsdale, AZ.

Magnusson, S. J. & Palincsar, A. S. (1995). The Learning Environment as a Site of Science Education Reform. *Theory into Practice,* 34(1), 43-50.

Marano, N., Palincsar, A., and Magnusson, S. (work in progress). *The Emergence of a Community of Practice: The Dynamics of Shared Understanding.*

Palincsar, A. S. (1998). Social Constructivist Perspectives on Teaching and Learning. *Annual Review of Psychology,* 49, 345-375.

Palincsar, A. S., Magnusson, S., Marano, N., Ford, D. and Brown, N. (1998). Designing a Community of Practice: Principles and Practices of the GIsML Community. *Teaching and Teacher Education,* 14 (1), 5-19.

Schwab, J. (1964). Structure of the Disciplines: Meanings and Significances. In G. W. Ford and L. Pugno (Eds.), *The Structure of Knowledge and the Curriculum.* (p-6-30). Chicago: Rand McNally.

Focus on the Collection:

Choosing Resources to Facilitate Teacher Change

by Terese Herrera and Kimberly Roempler, ENC Instructional Resources

As classroom innovators, you are among those most aware of the reform efforts codified in the mathematics and science Standards documents, and most aware that it is teachers' classroom practice that will give substance to the vision of those Standards. This issue of *Focus* looks at some realities of teacher change—how teachers are reinventing their practice, the issues they struggle with in the process, and the support they need as they accept the challenge to innovate. Often underestimated, the real costs of attempting new methods can be substantial. Workload increases. Students often initially resist the change, as do parents and, at times, the principal. The materials we feature in this issue focus on the teacher as an individual coping with the complexities of change within the classroom setting.

Please note that this section is based on abstracts found in ENC's database of K-12 materials. All ENC abstracts are descriptions rather than evaluative reviews. If you search the full collection of materials through ENC Online http://www.enc.org/ you will find complete records for these selections. Some records provide links to online, third-party reviews and/or references to journal reviews. Pricing and ordering information was verified in September, 1999, and is subject to change.

Searching ENC

When you go online to learn more about the materials highlighted here and others, you will find more than one option for searching through ENC's vast collection. Here are a few general tips for making best use of ENC's database of teaching resources.

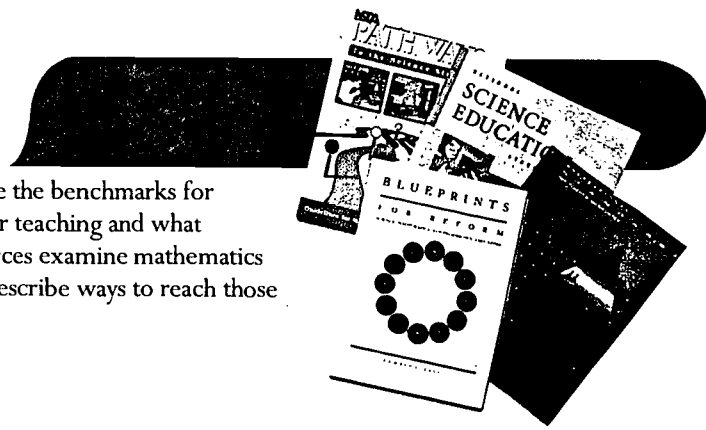
- **The simplest search on ENC Online allows you to type in any word, and select cost and grade level. Links at this search provide assistance in choosing words.**
- **The more advanced search options allow you to construct even more specific searches—this is great if you have very clear requirements in mind.**
- **The materials in this section were carefully selected by ENC's content specialists to fit the theme of this issue. If you would like to see more materials on this topic from ENC's collection, you can create your own search. Hint: To do our initial searches, we used terms such as**
  "teacher change"
  "inquiry teaching"
  "reform"
  "instructional improvement"
  (Be sure to include quotation marks around search words.)
- **The catalog records printed in this part of the magazine contain just the highlights of the full catalog record. To go directly to a specific record, type in the ENC number in the search window of any search option. It is important to type the ENC number exactly as it appears at the end of the item's abstract in this magazine.**

FEATURED RESOURCES

QUALITY STAFF DEVELOPMENT

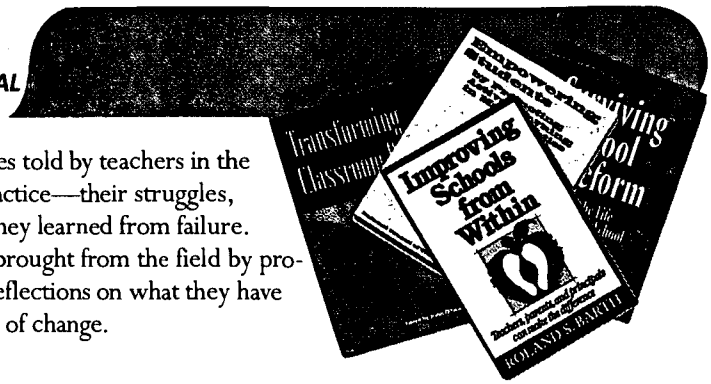
If teachers are asked to move from one place to another in terms of their teaching, they need a sturdy bridge to the future—a critical link that is carefully and uniquely designed to meet particular needs. The resources in this section provide strategies, descriptions of programs, and details on how to build that bridge.

STANDARDS & IMPLEMENTING STANDARDS



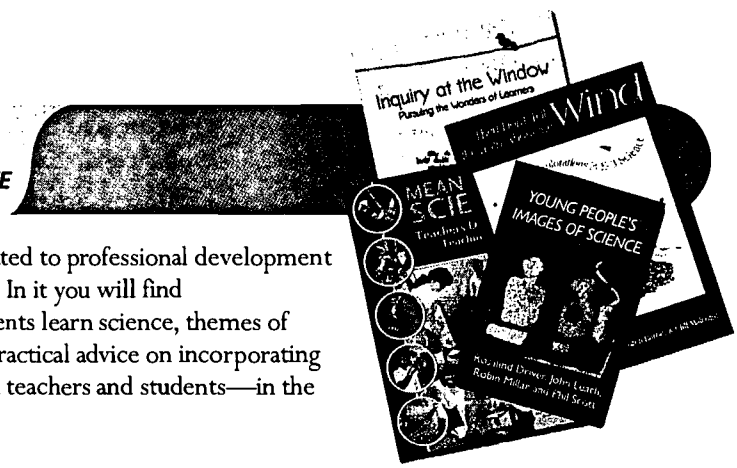
The resources in this section provide the benchmarks for where we want to be in terms of our teaching and what students need to learn. These resources examine mathematics and science content standards and describe ways to reach those standards.

CHANGING TEACHERS, CHANGING SCHOOLS: GENERAL



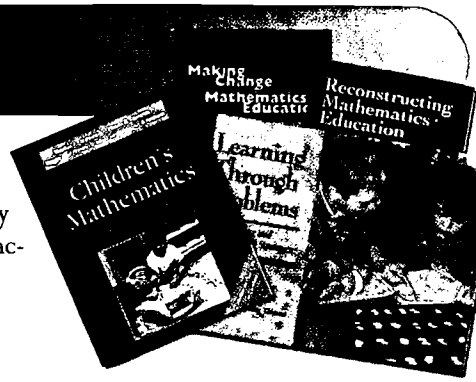
In this section you will find stories told by teachers in the process of transforming their practice—their struggles, their successes, and the lessons they learned from failure. What we offer here are insights brought from the field by professionals "in the trenches" and reflections on what they have taught us about facing the reality of change.

CHANGING TEACHERS, CHANGING SCHOOLS: SCIENCE



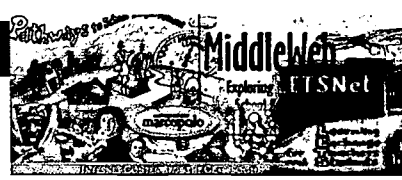
This section is specifically dedicated to professional development resources for science educators. In it you will find materials on ways in which students learn science, themes of science education reform, and practical advice on incorporating inquiry-based science—for both teachers and students—in the classroom.

CHANGING TEACHERS, CHANGING SCHOOLS: MATHEMATICS



This section focuses on professional development resources for mathematics educators. You will find a selection of videos, essay collections, and other books on topics such as Cognitively Guided Instruction (CGI), problem-centered learning, and practitioner-based inquiry.

ONLINE PROFESSIONAL DEVELOPMENT



The online resources in this section include web sites where teachers can communicate with others about the change process, resources where teachers can find opportunities to support their professional development, and information on the reform effort in both mathematics and science.

QUALITY STAFF DEVELOPMENT

Susan Loucks-Horsley uses a bridge as an analogy in describing professional development. "A bridge, like professional development, is a critical link between where one is and where one wants to be" (Ideas That Work: Science Professional Development, p. 2). If teachers are asked to move from one place to another in terms of their teaching, they need a sturdy bridge to the future—a critical link that is carefully and uniquely designed to meet particular needs. The resources in this section provide strategies, descriptions of programs, and details on how to build that bridge.

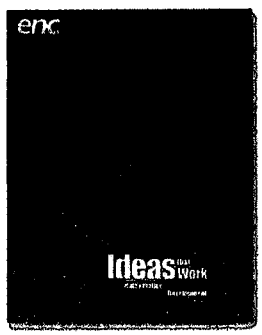
Ideas That Work: Mathematics Professional Development

Grades K-12
1998
Author: editor, Annette Thorson

Ordering Information:
Eisenhower National Clearinghouse
1929 Kenny Road
Columbus, OH 43210-1079
(614) 292-7784 / Fax: (614) 292-2066
Toll-free: (800) 621-5785
Email: editor@enc.org
http://www.enc.org/
FREE
Note: Full-text available at http://www.enc.org/reform/ideas/

Standards: NCTM Curriculum and Evaluation Standards (1989)

Based on the book Designing Professional Development for Teachers of Science and Mathematics by Susan Loucks-Horsley, et al, (1998), this guide uses the metaphor of a bridge to describe the role of professional development. Effective professional development, according to the booklet, bridges the gap between where educators are now and where they will need to be to help students learn more challenging mathematics. The guide is designed for anyone interested in breaking with the traditional schemes for professional development and exploring new designs for learning. It aims to provide structure to those with responsibility for designing or conducting professional development programs or initiatives. The goal is to show how successful professional development practices must be rooted in a five-part foundation that includes students and their learning at the core, the imperative to increase teacher knowledge of math content, and the belief that programs must be developed in an active learning style for the teachers. Outlined are descriptions of 15 successful strategies for professional development that include the elements necessary for its design and implementation, issues to be considered, and a real-life example of the strategy in action. Also found are longer descriptions of existing programs that effectively apply several of the strategies. Contact information is included. (Author/JRS) ENC-013274

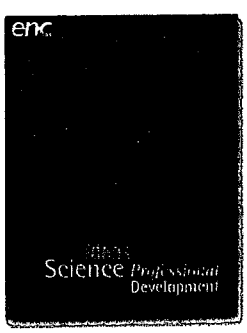


Ideas That Work: Science Professional Development

Grades K-12
1999
Author: editor, Annette Thorson

Ordering Information:
Eisenhower National Clearinghouse
1929 Kenny Road
Columbus, OH 43210-1079
(614) 292-7784 / Fax: (614) 292-2066
Toll-free: (800) 621-5785
Email: editor@enc.org
http://www.enc.org/
FREE
Note: Full-text available at http://www.enc.org/reform/ideas/

This booklet, the companion to the one described above, describes principles and strategies for designing professional development programs to help teachers learn more challenging science content and how to teach it. The first section identifies five principles of professional development and proposes a sequential four-step process of goal setting, planning, action, and reflection. Section II describes 15 strategies for professional development that can be combined in different ways to maximize diverse learning goals. The description of each strategy includes a real-life example of the strategy in action. Sections III and IV feature descriptions of additional programs, with full contact information, and Section V furnishes a list of organizations that offer professional training and information. (Author/LCT) ENC-014753



Learning Circles: Creating Conditions for Professional Development

Grades K-12
1998
Author: Michelle Collay, Diane Dunlap, Walter Enloe, George W. Gagnon Jr.

Ordering Information:
Corwin Press, Inc.
2455 Teller Road
Thousand Oaks,CA 91320-2218
(805) 499-9774 / Fax: (800) 4172466
Email: order@corwinpress.com
http://www.corwinpress.com/
$22.95 per book (paperback)
Order # 82114

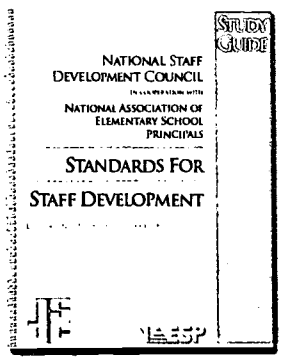
The stories, theory, and examples in this book describe a professional development approach that supports the formation of collaborative learning groups for teachers to improve the quality of teaching and learning. Six requirements are identified as necessary to initiating, maintaining, sustaining, and completing these teacher communities: building a community with other learners; constructing knowledge through personal experience; supporting other learners; documenting personal reflections; assessing expectations; and improving the classroom culture. The authors share personal stories of how they identified each requirement and the role it plays in creating learning circles. They also give suggestions for using these six activities to develop larger learning communities beyond the framework of teacher learning circles. Suggestions include creating learning groups at the school, community, and district levels and moving classrooms toward becoming healthy communities of learners rather than collections of students. References are included. (Author/JRS) ENC-015130

Standards for Staff Development, Elementary School Edition

Grades K-6
1995
Author: NSDC in cooperation with the National Association of Elementary School Principals

Ordering Information:
National Staff Development Council
PO Box 240
Oxford, OH 45056
(513) 523-6029 / Fax: (513) 523-0638
Toll-free: (800) 727 7288
http://www.nsdc.org/
$15.00 per book (non-member price)
$12.00 member price

Based on the belief that improvement is an ongoing process, the standards in this study guide can be used to stimulate discussion and analysis that lead to greater staff development effectiveness, no matter the current level of performance. The standards can be used by individuals and by groups who wish to understand and implement effective staff development techniques. The study guide rejects "sit and get" sessions, in which relatively passive participants receive the latest ideas from so-called experts, in favor of study groups, action research, and peer coaching. The standards are organized into three categories: context, process, and content. The appendix includes a self-assessment and planning tool intended to help groups determine their school's current state of implementation of the context, process, and content of effective staff development. Information gathered by the tool can be used to stimulate discussion and to prepare an action plan. (Author/RMK) ENC-012655

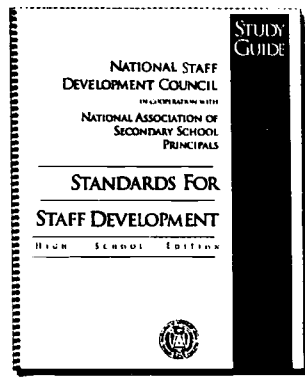


Standards for Staff Development, High School Edition

Grades 9-12
1995
Author: NSDC in cooperation with the National Association of Secondary School Principals

Ordering Information:
National Staff Development Council
PO Box 240
Oxford, OH 45056
(513) 523-6029 / Fax: (513) 523-0638
Toll-free: (800) 727 7288
http://www.nsdc.org/
$15.00 per book (non-member price)
$12.00 member price

This is the high school version of the study guide described in the preceding records. See the abstract for the Elementary Edition (this page) for additional information. (Author/RMK) ENC-012656



Standards for Staff Development, Middle Level Edition

Grades 5-8
1995
Author: NSDC

Ordering Information:
National Staff Development Council
PO Box 240
Oxford, OH 45056
(513) 523-6029 / Fax: (513) 523-0638
Toll-free: (800) 727 7288
http://www.nsdc.org/
$15.00 per book (non-member price)
$12.00 member price

This study guide, part of the same series described in the preceding entry, is intended to be used by middle schools and school districts to improve the quality of their staff development efforts. The goal is to increase student learning through greater staff development effectiveness no matter what the current level of performance. See the preceding abstract for additional descriptive information. (Author/RMK) ENC-012657

Like what you see here? Want to see more? The full-length catalog records for these materials and more on the same subject can be found by searching ENC's online database of more than 14,000 curriculum resources. Each record contains information such as a descriptive abstract, complete table of contents, information on funding sources, and—where available—links to third-party reviews and/or references to journal reviews. In many cases, you can also access the web site of the resource publisher and place orders directly. Go to ENC Online http://www.enc.org/ for more information.

STANDARDS & IMPLEMENTING STANDARDS

The resources in this section provide the benchmarks for where we want to be in terms of our teaching and what students need to learn. These resources examine mathematics and science content standards and describe paths to reaching those standards. How are we going to help teachers reach these goals? One of the most important steps is providing carefully designed professional development opportunities for teachers. These resources can be found in the section starting on page 49.

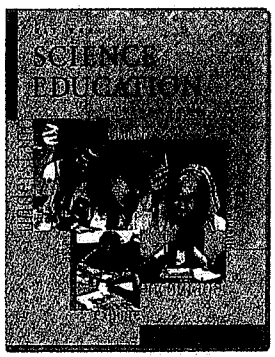
National Science Education Standards

Grades K-12
1995
Author: National Research Council

Ordering Information:
National Academy Press
2101 Constitution Avenue NW
Washington DC 20418
(202) 334-2334 / Fax: (202) 334-2793
Toll-free: (800) 624-6242
http://www.nap.edu/
$19.95 per book (paperback)
Note: Bulk order discounts available. Call for information.

Standards: National Science Education Standards (December 1995)

The National Science Education Standards present a vision of a scientifically literate populace. The standards espouse that science is for all students, learning science is an active process, and improving science education is part of systemic education reform. In addition, the standards describe an educational system in which all students demonstrate high levels of performance, in which teachers are empowered to make the decisions essential for effective learning, and in which supportive educational programs and systems nurture achievement. The introduction includes goals for school science, underlying principles, perspectives and definitions, and six categories of standards. The standards cover the topics of science teaching, professional development, assessment, science content, science programs, and systems.



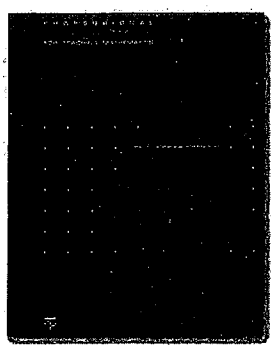
They describe the conditions necessary to achieve the goal of scientific literacy for all students, including opportunities for students to learn and for teachers to teach. The standards for teaching focus on what teachers know and do, while those for professional development focus on how teachers develop professional knowledge and skill. The science assessment standards are criteria against which to judge the quality of assessment practices; they can be used as guides in developing assessment practices and policy. The standards for content define what the scientifically literate person should understand and be able to do after 13 years of schooling. The science education system standards provide criteria for evaluating how well the science education system does at providing schools with the necessary resources for achieving the national standards. Samples, vignettes, and references are provided. (Author/KSR) ENC-006101

Professional Standards for Teaching Mathematics

Grades K-12
1991
Author: National Council of Teachers of Mathematics

Ordering Information:
National Council of Teachers of Mathematics, Inc.
1906 Association Drive Drawer A
Reston, VA 20191-1593
(703) 620-9840 / Fax: (703) 476-2970
Toll-free: (800) 2357566
Email: orders@nctm.org
http://www.nctm.org/
$29.95 per book
Order # 439
Note: 20% discount to NCTM members

The standards in this book consist of four components: standards for teaching mathematics; standards for the evaluation of the teaching of mathematics; standards for the professional development of teachers of mathematics; and standards for the support and development of mathematics teachers and teaching. Guides for teaching at different levels are presented in detailed explanations that outline each of the NCTM standards, and annotated vignettes show a range of situations in which good mathematics teaching and learning may take place. In the section on evaluating mathematics, vignettes illustrate a wide range of assessment activities and show a variety of personnel involved in evaluation. Comments in the margin of each vignette focus on the particular standard of teaching being emphasized. The standards for the professional development of math teachers focus on aspects of both the preservice and inservice phases of the professional development of teachers. In the next section, the focus is on the ways in which policymakers, schools, school systems, colleges, universities, and professional organizations may support teachers in adopting the vision of teaching needed to support the implementation of the standards. Following the delineation of the standards, the final section of this document discusses issues such as the role of standards and the changing of school mathematics. (Author/VN) ENC-001451



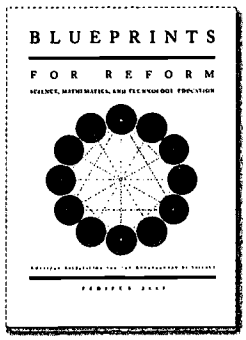
Blueprints for Reform

Grades K-12
1998
Author: AAAS Project 2061

Ordering Information:
Oxford University Press
2001 Evans Road
Cary, NC 27513
Telephone: (919) 677-0977
Fax: (919) 677-1303
Toll-free: (800)451-7556
Email: custserv@oup-usa.org
$17.95 per book (paperback)
Note: Add $3.00 S &H for first book, $1.00 for each additional. NC and CA add sales tax.

Standards: Project 2061 (1985)

This book summarizes reports on a dozen areas of education and serves as a starting point for exploring the educational system and its response to reform. This study views education as a system and educational reform as systemic reform. It provides an overview of topics such as equity, assessment, teacher preparation, community involvement, school organization, higher education, and technology. Topics are grouped according to the foundation for education, including societal aspects of the educational process; the school context, including curricula, technology, and assessment; and the support structure, teacher education and community involvement. The book includes a detailed list of resources and contacts. A companion web document provides access to more detailed information as well as an interactive forum for educators, policymakers, and parents. (Author/RMK) ENC-013390



Blueprints On-Line

http://project2061.aaas.org/tools/bluepol/blpframe.html

Grades K-12
Author: Project 2061 staff and commissioned experts
Standards: Project 2061 (1985)

The electronic version of the document described at left, this web site provides a detailed list of resources and contacts complete with a brief description, hyperlinked online accessibility, and contact addresses and phone numbers. An online forum is maintained for parents, educators, and policymakers to discuss the Blueprints and their implications. The discussion forum is organized by question, such as: How can changes in school organization simplify an already complex system and make it even more effective? A search engine allows users to search the Blueprints for particular words and phrases. (Author/RMK) ENC-013373

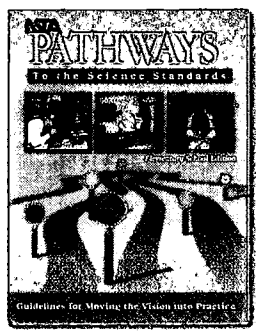
NSTA Pathways to the Science Standards: Guidelines for Moving the Vision into Practice

Grades K-6
1997
Author: editor, Lawrence F. Lowery

Ordering Information:
National Science Teachers Association
NSTA Science Store
1840 Wilson Boulevard
Arlington, VA 22201-3000
Fax: (703) 522-6091
Toll-free: (800) 722-6782
$31.46 per book (NSTA member price)
$34.95 non- member price
Order # PB124X

Standards: National Science Education Standards (December 1995)

Elementary teachers can read this guidebook for a variety of suggestions to help them implement the National Science Education Standards (1995). The first three and the last two chapters of the book discuss the standards that apply to teachers of all grade levels: teaching, professional development, assessment, program, and system standards. Each of these chapters provides a discussion of the standards, followed by a list of pertinent articles—most of them from *Science and Children* and *Science Scope*. The fourth chapter examines the science goals for elementary students as outlined in the content standards. This chapter includes a general discussion about the learning capabilities of students in various grade levels, followed by discussions of each content area and practical suggestions for assessment and for bringing the content area into the classroom. Vignettes are presented as examples of how some standards might be implemented. The appendices provide a list of the National Science Education Standards, recommendations for setting up an elementary science facility, and a list of addresses for elementary science programs. (Author/LCT) ENC-012124



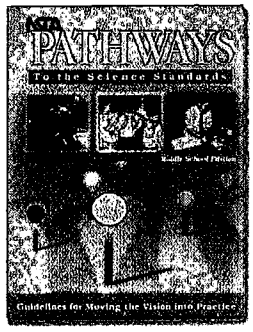
NSTA Pathways to the Science Standards: Guidelines for Moving the Vision into Practice

Grades 5-8
1998
Author: editor, Steven J. Rakow

Ordering Information:
National Science Teachers Association
NSTA Science Store
1840 Wilson Boulevard
Arlington, VA 22201-3000
Fax: (703) 522-6091
Toll-free: (800) 722-6782
$31.46 per book (NSTA member price)
$34.95 non-member price
Order # PB125X

Standards: National Science Education Standards (December 1995)

The first three chapters of this book, the companion volume to the one described on page 52, discuss the teaching, professional development and content standards that apply to all K-12 teachers. These initial chapters also provide examples specific to the middle school teacher. Each chapter features a chart highlighting the shifts in emphasis envisioned by the standards, as well as practical discussions about each standard and a bibliography of relevant articles. The fourth chapter covers the science content outlined in the NSES for students in grades 5 to 8. For each discipline, the book includes examples of inquiry, science and technology, personal and social perspectives, and history and nature of science. The text also contains vignettes from exemplary programs. The last two chapters discuss national standards for the science program and the educational system. A brief history and an outline of the NSES are provided in the appendices. (Author/LCT) ENC-014471

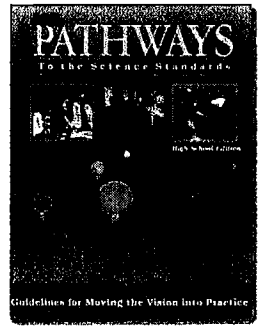


NSTA Pathways to the Science Standards: Guidelines for Moving the Vision into Practice

Grades 9-12
1996
Author: editors, Juliana Texley and Ann Wild

Ordering Information:
National Science Teachers Association
NSTA Science Store
1840 Wilson Boulevard
Arlington, VA 22201-3000
Fax: (703) 522-6091
Toll-free: (800) 722-6782
$31.46 per book (NSTA member price)
$34.95 non-member price
Order # PB126X

Also part of the series described in the previous two records, this book is designed to help high school science teachers implement the National Science Education Standards (NSES) in the classroom. The first three chapters discuss the teaching, professional development and content standards that apply to all K to 12 teachers, and provide examples specific to the high school teacher. The fourth chapter covers the science content outlined in the NSES for students in grades 9-12. For each discipline, the book includes examples of inquiry, science and technology, personal and social perspectives, and history and nature of science, integrating them within the disciplines rather than devoting separate sections to them. The text also contains vignettes from exemplary programs. The last two chapters discuss national standards for the science program and the educational system. (Author/LCT) ENC-004853



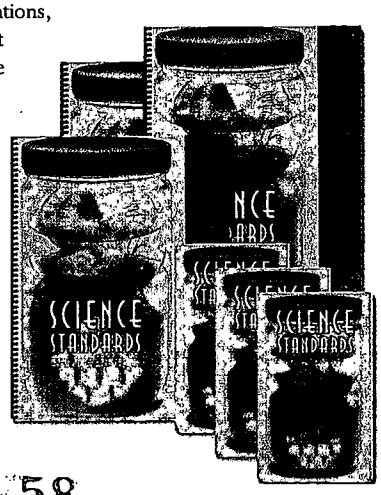
Science Standards: Making Them Work for You

Grades K-6
1996
Author: produced and directed by Judy Farnellette and Loraine Corfield Voros

Ordering Information:
Association for Supervision and Curriculum Development
1703 North Beauregard Street
Alexandria, VA 22311-1714
(703) 578-9600 / Fax: (703) 575-5400
Toll-free: (800) 933-2723
Email: member@ascd.org
http://www.ascd.org/
$680.00 for 3 videos and 3 guides (ASCD member price)
$780.00 non-member price
Order # 495241L84

Standards: Benchmarks for Science Literacy (1993); National Science Education Standards (December 1995)

The nine classroom examples in this video series offer ideas for active, hands-on science lessons based on the National Science Education Standards (1995) and the Benchmarks for Science Literacy (1993). The series comprises three videos and three facilitator's guides. Each video shows three teachers in spontaneous classroom situations, with video footnotes that highlight the standards-based practices. Tape one focuses on the primary grades (K to 2), tape two on grades 3 and 4, and tape three on grades 5 and 6. The authors recommend that participants view and discuss all tapes to understand the developmental flow of scientific concepts and skills, as well as issues such as curricular integration, authentic assessment, and constructivism. In a sample lesson, a second-grade teacher uses students' natural fascination with dinosaurs to teach the relationship between form and function. Children learn about predator-prey relationships and animal adaptations for defense with the help of Defenseless Denny, a cut-out animal with no defenses against a hungry Tyrannosaurus rex. In one form of embedded assessment, the teacher walks around the room, observing the children and listening to the questions they ask each other. Students are offered a choice of extension activities that address a variety of learning styles. The facilitator's guides provide information on conducting hands-on workshops that include lists of materials, sources of materials, and handouts. (Author/LCT) ENC-015149



CHANGING TEACHERS, CHANGING SCHOOLS: GENERAL

In this section you will find stories told by teachers in the process of transforming their practice—their struggles, their successes, and the lessons they learned from failure. You will find material, too, on why and how to revitalize classrooms. We have also included illustrations, through narrative and video, of what such classrooms could look like. What we offer here are insights brought from the field by professionals "in the trenches" and reflections on what they have taught us about facing the reality of change.

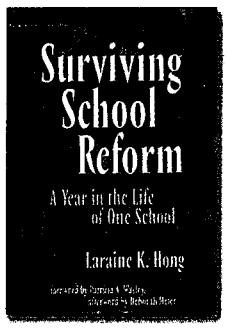
Surviving School Reform: A Year in the Life of One School

Series on School Reform

Grades K-6
1996
Author: Laraine K. Hong

Ordering Information:
Teachers College Press
PO Box 20
Williston, VT 05495-0020
Fax: (802) 864-7626
Toll-free: (800)575-6566
Email: tcp.orders@aidcvt.com
http://tc-press.tc.columbia.edu/
$21.95 per book

A small community in the western United States is the setting for the portrait of institutional change given in this book. The story transforms educational theory into the everyday struggle currently preoccupying teachers, parents, and principals across the country. Author Laraine Hong traces the developments at a 500-student K-5 elementary school for one year on issues of multiage classes, cooperative learning, whole language, hands-on math, and site-based management. These issues converge in critical episodes, including the principal's decision not to extend the contract of a new teacher. This detailed portrait demonstrates the interrelatedness of curriculum, the nature of decision making, the roles of teachers and principal, parent involvement, and school culture. The author believes school reform is necessary because of the changing nature of society and the need to help students think creatively, make decisions, and work together. Hong concludes that this is a story of hope and possibilities, showing a typical school and community that is flourishing in the aftermath of the conflict created by school reform. References are included. (Author/JRS) ENC-013389



JUMP ONLINE

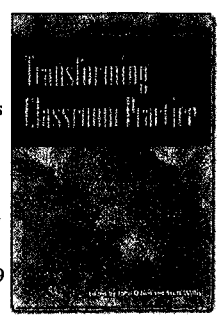
The resources featured in this issue are only a small sampling of the many materials we have in our collection of more than 14,000 curriculum materials. If you are interested in finding more resources that deal with the theme of change, you might try searching ENC's online database using subject words such as reform, instructional issues, teaching methods, teachers, educational improvement, and professional development. Or you might try conducting a search using the words "case studies" and "inquiry teaching".

Transforming Classroom Practice: The Best of ASCD's Update Newsletters

Grades K-12
1998
Author: editors, John O'Neil and Scott Willis

Ordering Information:
Association for Supervision and Curriculum Development
1703 North Beauregard Street
Alexandria, VA 22311-1714
(703) 578-9600 / Fax: (703) 575-5400
Toll-free: (800) 933-2723
Email: member@ascd.org
http://www.ascd.org/
$16.95 per book (ASCD member price)
$20.95 non-member price
Order # 198052

This collection of articles from ASCD's newsletters highlights ideas, schools, and programs that are working to meet the diverse and changing needs of students. Article topics include bilingual education, constructivism, integrating the curriculum, multiple intelligences, and preparing students for the workplace. In a set of articles on constructivism, there is a discussion of the differences between behaviorist and constructivist approaches to learning, with an in-depth look at constructivist applications in one school district. Related articles explore problem-based learning and the educational value of making connections between the classroom and the real world. Included with many articles are listings of related resources and specific ideas for implementation. (Author/JRS) ENC-013049

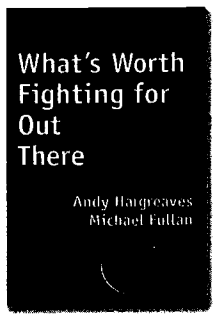


What's Worth Fighting for Out There?

Grades K-12
1998
Author: Andy Hargreaves and Michael Fullan

Ordering Information:
Teachers College Press
PO Box 20
Williston, VT 05495-0020
Fax: (802) 864-7626
Toll-free: (800)575-6566
Email: tcp.orders@aidcvt.com
http://tc-press.tc.columbia.edu/
$9.95 per book

In this book, authors Hargreaves and Fullan explore the need for educators to create interactive connections with communities beyond the schools in order for significant improvements in teaching and learning to occur. Also considered is the need for educators to consider the purpose, the emotion, and the hope that are at the heart of good teaching. The book is part of the What's Worth Fighting For? trilogy that promotes action for change while addressing the complexity of the current education environment with insight and practicality. In this book, separate guidelines for teachers, principals, governments, and parents are presented that focus on the challenge of establishing education as a vital force for individual and societal development. These guidelines are based on the beliefs that teachers make the difference in education and that a positively engaged teaching force is vital to educational change. The teacher guidelines offer ideas for making students and parents partners in education and for becoming involved in the evolution of the teaching profession. The parent guidelines challenge parents to acknowledge that the schooling that will be best for their children will be very different from their own schooling. References are included. (Author/JRS) ENC-013409



What's Worth Fighting for in Your School?

Grades K-12
1996
Author: Michael Fullan and Andy Hargreaves

Ordering Information:
Teachers College Press
PO Box 20
Williston, VT 05495-0020
Fax: (802) 864-7626
Toll-free: (800)575-6566
Email: tcp.orders@aidcvt.com
http://tc-press.tc.columbia.edu/
$9.95 per book

Part of the trilogy described above, this professional development book examines the need for individual responsibility and a collaborative culture in schools. It provides guidelines and encouragement for teachers and principals working for school reform. This book addresses questions such as: How can teachers build an authentic collaborative culture with collegiality as opposed to congeniality? How can professional development be intrinsic to the work of improving the school? And, perhaps most importantly: How can teachers work for improvement and still have time for their personal lives? After developing the issues, separate guidelines for teachers, principals, and school systems are presented that focus on the challenge of continuous school improvement leading to gains in student achievement. The teacher guidelines promote the development of an interactive professionalism in schools where teachers have greater decision-making ability on behalf of their students; where they make decisions in a collaborative culture of help and support; and where they are more fundamentally accountable as they engage in dialogue, action, and assessment of their work with other adults inside and outside their schools. A bibliography is included. (Author/JRS) ENC-013410

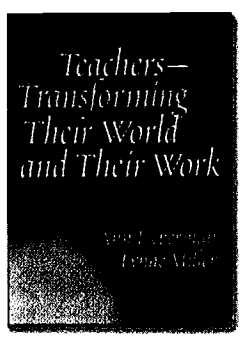
Teachers Transforming Their World and Their Work

Series on School Reform

Grades K-12
1999
Author: Ann Lieberman and Lynne Miller

Ordering Information:
Association for Supervision and Curriculum Development
1703 North Beauregard Street
Alexandria, VA 22311-1714
(703) 578-9600 / Fax: (703) 575-5400
Toll-free: (800) 933-2723
Email: member@ascd.org
http://www.ascd.org/
$13.95 per book (ASCD member price)
$16.95 non-member price
Order # 199217S25

Focusing on both the constraints and the possibilities embedded in teaching practice, this book addresses the contemporary realities of schools and teaching, using examples of the reform process in four schools. The words and experiences of teachers and principals illustrate what growth and change look like from the inside. A teacher's perspective is offered on what change requires, how differences in context and personnel are accommodated, what people learn as they change, and what it feels like in the process. Change is characterized as the collective involvement of teachers in school goals that become larger than their own classroom goals. Central to school change is the ability of principals and teachers to transition from isolated schools to schools that offer a rich, supportive environment for students and adults. Included are observations of practitioners involved in building professional communities in their schools, communities that demonstrate how teaching practices influence values and how reflection helps clarify beliefs. This book concludes with eight new insights about transforming teaching and schooling, such as ways to protect and nurture hope, passion, and commitment in teachers. References are included. (Author/JRS) ENC-015102

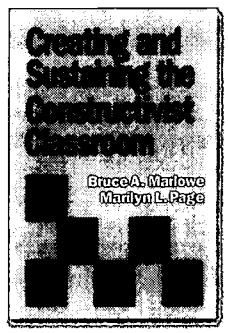


Creating and Sustaining the Constructivist Classroom

Grades K-12
1998
Author: Bruce A. Marlowe and Marilyn L. Page

Ordering Information:
Corwin Press, Inc.
2455 Teller Road
Thousand Oaks, CA 91320-2218
(805) 499-9774 / Fax: (800) 4172466
Email: order@corwinpress.com
http://www.corwinpress.com/
$24.95 per book
Order # 81272

Intended as a practical guide to constructivism for both preservice and inservice teachers, this book includes firsthand experiences of practicing teachers in student-created learning classrooms. The book explores the foundations of constructivism and practical issues related to its use in the classroom. Drawing from their own experiences, authors Marlowe and Page share their beliefs that while constructivist propositions can seem simple, they are not easy for teachers to implement. They address questions that concern teachers: What does it means to have students construct their own knowledge? How is understanding different from recalling? and What does past experience have to do with learning? Teachers then ask: How can I change my classroom when the rest of the school stays the same? and How can I sustain a vision if the school board and community do not understand it? The book offers teacher support, including checklists, guidelines, practical tips, and models designed to help teachers implement constructivist changes at any grade level. References and suggested readings are included. (Author/JRS) ENC-014898



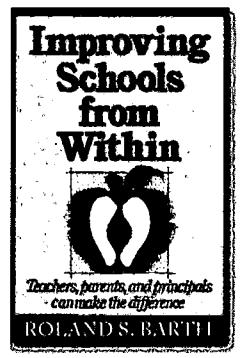
Improving Schools from Within: Teachers, Parents, and Principals Can Make the Difference

Jossey-Bass Education Series

Grades K-12
1990
Author: Roland S. Barth

Ordering Information:
Jossey-Bass, Inc., Publishers
350 Sansome St 5th floor
San Francisco, CA 94104
(415) 433-1740 / Fax: (800) 605-2665
Toll-free: (800) 956-7739
http://www.josseybass.com/
$19.00 per book

Based on his extensive personal experience as a teacher, principal, and university educator, the author of this book believes that America's schools are capable of improving themselves and that only changes from within are likely to bring lasting improvements. Barth focuses on the need for communication, collegiality, and risk-taking among adults in schools to create an atmosphere of learning. The book discusses the crisis of self-confidence among teachers who may no longer believe they are engaged in a vital cause, as well as problems in teacher-principal relationships. Also presented are ideas for creating schools that function as communities of learners. Barth defines the role of the principal in creating a positive learning environment for the school community, including ideas for implementing change such as setting clear expectations and empowering teachers with responsibilities that break down isolation. The author concludes with his personal vision of a good school, in which a community of learners enjoys a recommitment of adults to learning, time to philosophize about the teaching process, respect for diversity, low anxiety, high standards, and a sense of humor. A reference list is included. (Author/JRS) ENC-012398



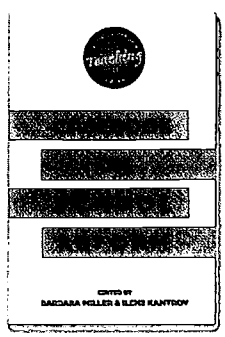
Casebook on School Reform

School Reform Teaching Cases Series

Grades K-12
1998
Author: editors, Barbara Miller and Ilene Kantrov

Ordering Information:
Greenwood Publishing/Heinemann Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$18.50 per book

These six case studies investigate different aspects of school reform and the process of change. Each case is set in a different location, such as the classroom, the school, or the district, with a distinct cast of characters that offers the views of teachers, parents, and administrators. In a sample case, All Aboard?, three teachers describe how they developed effective strategies for working with Limited English Proficiency students and how they faced the challenge of engaging their principal and colleagues. In other cases, teachers, administrators and parents face the complexity of creating school-based curriculum change; teachers in one district encounter system-wide ripples resulting from their changes in their instructional practices; and educators and state personnel experience the challenges of sustaining innovation and extending work to new sites. Each case narrative is accompanied by materials that include an introduction describing the genesis of the case, its original purpose, and any terms that may be unfamiliar to the reader. Each set of materials concludes with a facilitator's guide that offers background information, major issues, and activities for guiding the case discussion. (Author/LCT) ENC-015154

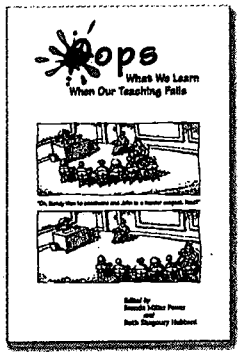


Oops! What We Learn When Our Teaching Fails

Grade K and up
1996
Author: coeditors, Brenda Miller Power and Ruth Shagoury Hubbard

Ordering Information:
Stenhouse Publishers
PO Box 1929
Columbus, OH 43216-1929
Fax: (614) 487-2272
Toll-free: (800) 988-9812
$17.00 per book
Order # K-0027

Written for less-than-perfect classroom teachers, this collection of 47 stories shares the experiences of veteran teachers coping with the failure of a new method, philosophy, or activity. The book acknowledges gaps between theory and practice in elementary through college settings and in a variety of disciplines. Some of the failures are embarrassing, such as when male high school students in grass skirts surprised the class with a dance illustrating their notions of a jungle tribe. In another story, a chemistry teacher shares how she dealt with learning that students in all four of her sections had copied one person's homework. Other essays address issues of race, economics, under-supplied classrooms, and bureaucracy. Each essay begins with a description of the classroom and students, the events, and the author's analysis of the situation. Some authors remain unresolved in terms of their learning from the experience, and others present insights that may be hard to face, such as the hurt feelings of colleagues or the conclusion that a particular activity seems to work in any classroom but theirs. Biographical information about the authors is also provided. (Author/LCT) ENC-015121

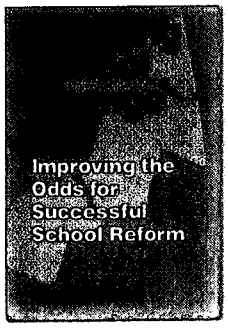


Charting School Change: Improving the Odds for Successful School Reform

Grades K-12
1998
Author: Barbara Stanford

Ordering Information:
Corwin Press, Inc.
2455 Teller Road
Thousand Oaks, CA 91320-2218
(805) 499-9774 / Fax: (800) 4172466
Email: order@corwinpress.com
http://www.corwinpress.com/
$19.95 per book
Order # 80066

In this book, readers will find a usable conceptual framework, or map, for understanding the need for and the process of school change. This map is supported with background information from fields such as educational research, systems theory, and conflict management. The book draws on the author's experiences in teaching humanities and in her participation in a 10-year experiment in school change. She includes practical ideas for ways educators can create successful change and deal with the forces that resist change. Part I explains the need for a new conceptual framework, introduces the basic concepts of self-organizing systems, and shows how these concepts help interpret common phenomena in school reform. Part II is a practical handbook for applying the concepts of self-organizing systems to specific dimensions of school change. Each chapter looks at a specific part of the change process from a self-organizing system perspective and offers practical suggestions. References are included. (Author/JRS) ENC-014901



Rethinking Educational Change with Heart and Mind

ASCD Yearbook Series

Grades K-12
1997
Author: editor, Andy Hargreaves

Ordering Information:
Association for Supervision and Curriculum Development
1703 North Beauregard Street
Alexandria, VA 22311-1714
(703) 578-9600 / Fax: (703) 575-5400
Toll-free: (800) 933-2723
Email: member@ascd.org
http://www.ascd.org/
$19.95 per book (ASCD member price)
$23.95 non-member price
Order # 197000

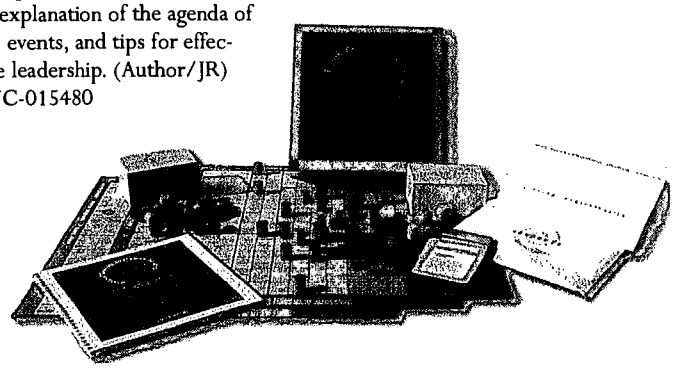
This yearbook is a collection of writings about positive change for school success. The editor and contributing authors seek to move the dialogue about change beyond the technical aspects to three areas of teaching, learning, and leadership that have received limited attention: the passion, purpose, and politics of change. Some of the questions addressed in this book include: What role should parents, students, and the community play in change efforts? How can educators overcome the tyranny of time? How can they set clear, measurable goals? And what about the issues of assessment and accountability? In other chapters, the authors examine the role of collaboration among educators in school reform, and the place of emotion in educational change. (Author/LCT) ENC-011622

Systems Thinking, Systems Changing: A Simulation Game for Transforming Organizations

Grades K-12
1999
Author: developers, Susan Mundry and Carol Bershad
Publisher: The Network, Inc.

Ordering Information:
ST & C Associates
25 Hammond Road
Natick, MA 01760-1101
(508) 652-9954 / Fax: (978) 465-9365
$475.00 per game
Note: Add $10.00 S/H. Please make checks or purchase orders payable to The NETWORK, Inc.

The board game and facilitator's guide in this kit are designed to help educators understand and gain experience in planning and leading organizational change in educational systems. The game simulates a school community whose members are learning to use systems thinking to make positive changes. The facilitator's guide describes systems thinking as a tool to help people identify problems, learn from best practices, and take steps to effect change. Game participants develop ideas and skills associated with working in groups to create learning organizations. They also learn strategies, processes, and models of organizational change. Teams develop strategies to accomplish specific goals involved in change. The game has built-in obstacles that hinder the teams from accomplishing their goals easily. The facilitator's guide provides background information about the game, an explanation of the agenda of the events, and tips for effective leadership. (Author/JR) ENC-015480



This section is specifically dedicated to professional development resources for science educators. In it you will find materials on ways in which students learn science, themes of science education reform, and practical advice on incorporating inquiry-based science—for both teachers and students—in the classroom.

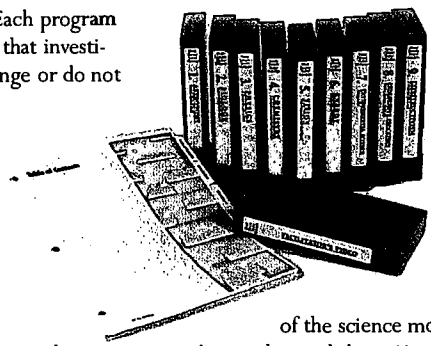
Private Universe Teacher Workshops

Private Universe Teacher Workshop Series

Grades 1-12
1995
Author: series executive producer, Matthew H. Schneps

Ordering Information:
Annenberg/Corporation for Public Broadcasting (CPB)
PO Box 2345
South Burlington, VT 05407-2345
Fax: (802) 864-9846
Toll-free: (800) 965-7373
http://www.learner.org/
$295.00 per series (10 videos + workshop guide)
$25.00 per workshop guide
$39.95 per video
Note: Specify title when ordering.

The nine sessions of this video workshop, edited versions of interactive teleconferences broadcast in the fall of 1994, examine current research on how students learn science and the implications of that research for the classroom. All discussions are built around footage of college graduates discussing their ideas and the question of how students assimilate scientific concepts. Each program is structured as an experiment that investigates how a student's ideas change or do not change in response to a given teaching strategy. Through interviews with high school students and teachers and scenes of classroom activities, the workshop demonstrates how a student's preconceived notions and ideas can pose critical barriers to learning science. Each workshop explores a particular educational theme by showing classroom examples from a specific grade level and posing a broad question within a specific science discipline. Also included in each workshop is classroom teaching that illustrates the science education issues being discussed, a presentation of current science education research, and studio and remote discussions of the science education issues raised in the video clips. The specific science concepts under exploration are explained and examples are given of feedback from previous workshops. Activities to be completed during the workshop are also included. Workshop One, for example, asks: What causes the changing seasons? The program opens with a segment in which new Harvard graduates, dressed in caps and gowns, discuss their theories for the causes of the seasons. The Harvard grads speak eloquently about their ideas—which are, for the most part, erroneous. From there, viewers go to a ninth grade astronomy class to see how teachers can elicit student ideas about the seasons. The series is accompanied by a teacher's guide that gives a synopsis of each program, a review of the science model, and activities to be done prior to and during the workshop. (Author/LCT) ENC-012564



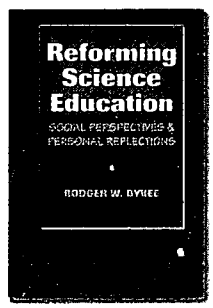
Reforming Science Education: Social Perspectives and Personal Reflections

Ways of Knowing in Science Series

Grade K and up
1993
Author: Rodger W. Bybee

Ordering Information:
Teachers College Press
PO Box 20
Williston, VT 05495-0020
Fax: (802) 864-7626
Toll-free: (800) 575-6566
Email: tcp.orders@aidcvt.com
http://tc-press.tc.columbia.edu/
$19.95 per book
Order # 3260-5

The author of these essays develops several major themes on reforming science education and the goals of science, including the need for curriculum to reflect the accelerating pace of scientific research and discovery. Other themes include the increasing irrelevance of the traditional boundaries among the sciences and the significant changes to civilization brought about by scientific advancement. The author draws on his 15 years of reforming science education and points out that today's global economy, which is based upon the production and use of science and technology, creates the necessity of scientific and technological literacy for all citizens. The book is divided into four parts. Part I provides a historical perspective on the transformation of science education and the changes in goals and curricula. This section identifies a multi-phased reform strategy and recommends a social perspective that should influence the transformation. Part II asks the question, What should the scientifically and technologically literate person know, value, and do as a citizen? It also discusses the science technology society (STS) theme of science education and explores the connections between scientific literacy and STS. Part III addresses the contemporary challenge of reform and the lack of change in various aspects of science education. One chapter in this section uses uses evolution as a metaphor for the process of change in teachers and teaching, while the second chapter addresses the failure of science educators to adequately respond to the current global crisis. The final essay in this section presents a critical analysis of STS. Part IV discusses the role of leadership and responsibility for bringing about reform in science education. Bibliographic references are included. (Author/LCT) ENC-013576

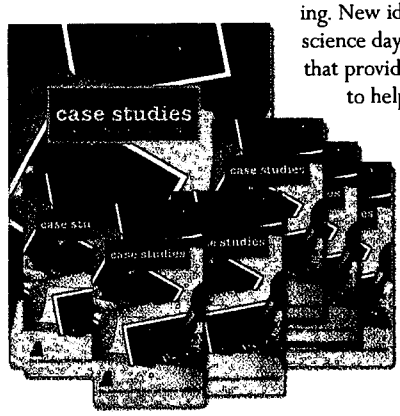


Case Studies in Science Education

Grades K-8
1997
Author: Harvard Smithsonian Center for Astrophysics

Ordering Information:
Annenberg/Corporation for Public Broadcasting (CPB)
PO Box 2345
South Burlington, VT 05407-2345
Fax: (802) 864-9846
Toll-free: (800) 965-7373
http://www.learner.org/
$325.00 per series
$199.00 per elementary package (tapes 1, 2, and 3 + facilitator's guide)
$199.00 per middle school package (tapes 4, 5, and 6 + facilitator's guide)
$20.00 per facilitator's guide

The Harvard Smithsonian Center for Astrophysics created this series of professional development videos to address issues in science education reform that concern K-8 science teachers. Each of the six videos contains case studies featuring interactions between teacher and students to illustrate how that teacher approaches a problem. The teachers were chosen for the case studies because they are in the process of examining their teaching methods and are representative of teachers everywhere. The videos show the teachers conferring with a project advisor or strategist to develop plans that better implement reform ideas. Some of the issues discussed in the videos include dealing with diversity, increasing students' roles in their learning, and assessment. In one section, a pair of teachers used techniques they had learned to integrate math and science into cross-curricular teaching. New ideas that they tried were part of a family science day. The facilitator's guide contains tables that provide an overview of the series and models to help plan workshops. The guide also contains descriptions of the lessons the teachers used on the video and related questions for the viewers to answer. For example, workshop participants are asked to list the strengths and weaknesses of a geology activity and the problems that might occur when the teacher uses group presentations to assess individual student learning. Examples of teachers' handouts and student work are included.



(Author/JSR) ENC-015104

Lisa Nyberg; Jane Morton

PBS Scienceline: K-5 Professional Development Series

Grades K-5
1998
Author: producer, Bob Morris

Ordering Information:
Public Broadcasting Service
1320 Braddock Place
Alexandria, VA 22314-1698
(703) 739-5071 / Fax: (703) 739-7513
Toll-free: (800) 645-4727
Email: shopeducation@pbs.org
http://www.pbs.org/
$199.00 per set (6 videos + 1 teacher's guide)
Order # ESSP100-WEBSL
Note: Order under the title Scienceline. This is one of 6 videos in the set.

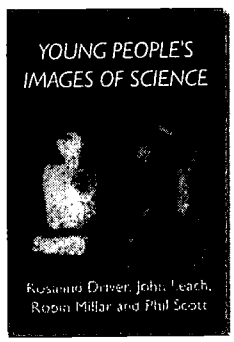
In this video, two classroom teachers are shown modeling specific aspects of standards-based instruction. The tape is part of a series designed to provide teachers with a forum in which they can get examples and ideas about implementing the National Science Education Standards. The first half-hour segment on this tape shows how a teacher uses guided inquiry to help students construct their knowledge and increase their joy in learning. The teacher uses demonstrations, hands-on activities, and the Internet to help her third and fourth grade students study sound. The students build different apparati to amplify sound, and they make connections between science and music when they investigate the construction characteristics of different instruments. The second segment highlights how a teacher uses outside community resources and interactions with scientific experts via email to supplement an investigation into mystery substances in a geology unit. The teacher leads discussion on topics such as time factors, educational benefits, and teamwork. The Scienceline web site priovides a place where teachers can discuss the topics covered in the videos with other teachers.
(Author/JSR) ENC-015132

Young People's Images of Science

Grades 4-11
1996
Author: Rosalind Driver, John Leach, Robin Millar, and Phil Scott

Ordering Information:
Taylor & Francis
47 Runway Road, Suite G
Levittown, PA 9057-4700
Fax: (215) 269-0363
Toll-free: (800) 821-8312
Email: bkorders@tandfpa.com
$28.95 per book (softcover)

This book describes the results of a major study of students' understanding of the nature of science. The authors argue that an understanding of science goes beyond learning the facts, laws, and theories of science; rather, it involves understanding the nature of scientific knowledge and the relationships between science and society. The study examines the ideas students form about science as a result of their experience in and out of school. It also explores how science teaching might develop a more scientifically literate society, and how students understand disputes about scientific issues. The results indicate that school science has limited success in promoting these understandings. The book concludes with a discussion of how the school science curriculum could be adapted to better equip students as future citizens in a scientific and technological society.
(Author/LCT) ENC-011670



They Don't Tell the Truth About the Wind: Hands-on Explorations in K to 3 Science

Grades K-3
1996
Author: Marilyn Fleer, Tim Hardy, Karen Baron, and Cliff Malcolm

Ordering Information:
Greenwood Publishing/Heinemann
Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$22.00 per book

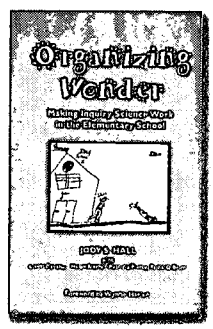
Designed to make a child's first attempt at scientific exploration both rewarding and relevant, this book provides teachers with hands-on explorations in science for K-3 students. The units in this book describe classroom techniques for discovering what ideas, experiences, and questions children already have about scientific concepts, and then to build from there. These units are designed to help children make sense of their experiences, create meaning, and take effective action in their world. The book includes ways to use stories, children's questions, and everyday situations as avenues for exploring scientific concepts. Teachers will also find a range of strategies for teaching, learning, and classroom management, as well as examples of student work. Activities include using kitchen materials to teach science; studying the cycles of life using tadpoles, frogs, and other life cycles; and studying heat and energy using vegetables. (Author/CCM) ENC-007281

Organizing Wonder: Making Inquiry Science Work in the Elementary School

Grades K-6
1998
Author: Jody S. Hall

Ordering Information:
Greenwood Publishing/Heinemann
Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$17.00 per book
Order # 00045-ENC

In this book, teachers will find a practical guide to structuring the inquiry science process that includes in-depth case studies and strategies for guiding students' inquiry without discouraging their excitement and curiosity. One chapter, Seven Steps for Organizing Wonder, explains a model for using exploration and investigation in the inquiry process. First, teachers identify key ideas and experiences on a topic, search for activities with potential for investigation, and introduce a series of initial explorations. The process continues with the transformation of the students' ideas into questions for investigation, an analysis of the problem for fair-test potential, and, finally, student implementation and interpretation of their investigations. Subsequent chapters describe the use of this process to investigate waves, bouncing balls, and light. The book concludes with the thought that time is needed to teach effectively with the inquiry science model, but that it should be seen as time well spent. References are included. (Author/JRS) ENC-013621



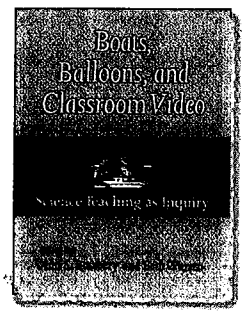
Boats, Balloons & Classroom Video: Science Teaching as Inquiry

Sense Making in Science Video Series

Grades K-6
1998
Author: editors, Ann S. Rosebery and Beth Warren

Ordering Information:
Greenwood Publishing/Heinemann
Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$21.00 per book (paperback)
Order # 000336-ENC1

This collection of essays describes the experiences of a group of elementary teachers as they collaborated with educational researchers to conduct their own scientific investigations and to explore their students' scientific learning in the classroom. The teachers actively engaged in constructing their own knowledge in science and reflecting on how they might create similar experiences for their students. The essays in this book describe some of the important discoveries the teachers made doing science for themselves and the profound effect this kind of experience had on their teaching practice. In one sample essay, Exploring Rust, Talking Science, a grade 4 teacher describes how she came to understand the importance of having her students talk about scientific ideas. The students' talks about science helped them learn science and helped the teacher better understand student thinking. The class study of rust began with a discussion to find out what the students knew about rust from previous experiences. The students then used their knowledge to create a list of variables and to build and test theories about the origins of rust. This investigative approach helped the class understand the processes and skills that scientists use when they attempt to solve complex problems. The model of professional development in this book places teachers' own questions, theories, and analyses at its core, so as to illustrate how the practice of scientific inquiry can be used as a tool for professional growth. (Author/JRS) ENC-013620

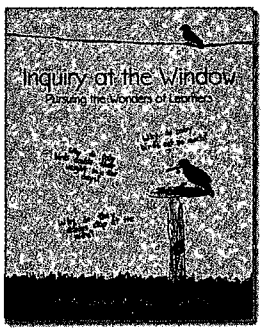


Inquiry at the Window: Pursuing the Wonders of Learners

Grades K-6
1997
Author: Phyllis Whitin and David J. Whitin

Ordering Information:
Greenwood Publishing/Heinemann Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$21.00 per book

Teachers can read about this year-long study of inquiry learning in which a fourth grade class observed and recorded the daily activities of birds. In the introduction, the authors present their model for an inquiry cycle of observing, questioning, theorizing, and more observing. The first chapter describes how they decided that watching the birds would enable students to engage in first-hand scientific investigation and writing. Chapter two documents how the children became critical readers of resources such as field guides, general reference books, and letters from relatives. The students used these resources to raise questions, make personal connections, and construct theories. Chapter three examines the importance of exploratory conversations in supporting inquiry, describing how the teacher and the students came to appreciate the benefits of generating multiple theories about their observations and readings. In chapter four, the authors reveal how they managed to focus student attention on a particular topic. The fifth chapter discusses the importance of collaborative learning communities in supporting scientific inquiry. In the concluding chapter, the authors reflect on how the study changed their visions of the nature of science and inquiry. The book is illustrated with black and white photographs, line drawings, and samples of student work. The appendices contain samples of self-evaluation worksheets, a project proposal form, and other handouts and rubrics. Bibliographic references are also provided. (Author/LCT) ENC-015147

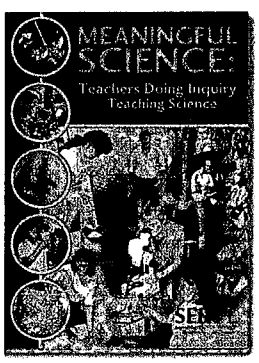


Meaningful Science: Teachers Doing Inquiry Plus Teaching Science

Grades K-8
1999
Author: editors, Terrie L. Kielbom and Penny J. Gilmer

Ordering Information:
SouthEastern Regional Vision for Education (SERVE)
1203 Governors Square Boulevard
Suite 400
Tallahassee, FL 32301
(850) 671-6033 / Fax: (850) 671-6010
Toll-free: (800) 352-6001
http://www.serve.org/
FREE

In this monograph, seven K-8 teachers describe their participation in a doctoral cohort group in science education, during which they each engaged in a different real-world scientific research project. The goal was to immerse teachers in scientific research so that they could experience inquiry in science and become part of the discourse of science through contextual learning experiences. The teachers chose environmental research projects that were relevant to their lives and those of their students. Sample topics include the olfactory structures of crustaceans, the development of a method to determine the cause of fish mortality by an algal toxin, and charting and observing the migration of birds. In their narratives, the teachers share their stories of working with scientists, working with each other, and using their experiences to change their classroom practice. (Author/LCT) ENC-015191



Creating a Context for Learning

Science of Teaching Science Series

Grades K-8
1997
Author: director, Kevin Lesniewicz

Ordering Information:
Annenberg/Corporation for Public Broadcasting (CPB)
PO Box 2345
South Burlington, VT 05407-2345
Fax: (802) 864-9846
Toll-free: (800) 965-7373
http://www.learner.org/
$199.00 per complete series (8 tapes + guide)
$24.95 per video

Hosted by Terez Waldock and content specialist Dr. Kathleen Fisher, this video investigates methods that can be used in a science classroom to set the stage for students to learn both scientific content and processes. The tape is part of the Science of Teaching Science series, designed to provide professional development suggestions and discussions with practicing teachers and content experts about science and math teaching. The series was originally broadcast as a live, interactive program on the Annenberg/CPB Channel. In this particular video, a panel of K-8 teachers investigates methods that can be used in a science classroom to facilitate student learning. Two teachers are highlighted to illustrate their methods of engaging students in scientific inquiry. Methods that they think are important are treating the students with respect, giving them multiple ways to express themselves, and having them generate their own questions. The students respond to the respectful treatment by behaving more responsibly and participating more fully in the activities. In the process of generating their own questions, students develop increased motivation and curiosity about their topics. In one classroom, for example, students learn about their five senses by experiencing sensations in many different situations. They are asked to write down their ideas, discuss them in groups, refine them using both fiction and nonfiction texts, and define a specific question about the five senses to use for further individual study. It is stressed that students need enough time to adequately study the topics and to satisfy their natural curiosity. The video suggests that these methods will engage students in the scientific process and help them remember the content. (Author/JSR) ENC-013827

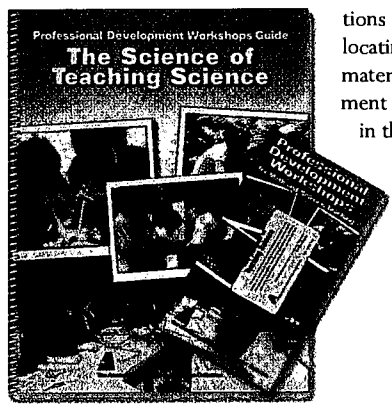
Preparing to Teach Science

Science of Teaching Science Series

Grades K-8
1997
Author: director, Kevin Lesniewicz

Ordering Information:
Annenberg/Corporation for Public Broadcasting (CPB)
PO Box 2345
South Burlington, VT 05407-2345
Fax: (802) 864-9846
Toll-free: (800) 965-7373
http://www.learner.org/
$24.95 per video
$199.00 per series (8 tapes + guide)

From the same series described on the preceding page, this video is designed to help elementary teachers with little or no science background prepare to teach new topics with confidence. The first segment, excerpted from Audrey Sturgis' middle school science class, shows how she uses a variety of skills and strategies to teach a science topic when she is lacking content knowledge. This segment ends with a panel discussion that examines Audrey's strategies. The second segment focuses on the discussion about the balance between scientific content and scientific process. The video ends with suggestions about preparing to teach a science topic and locating related resources or new curriculum materials. The content guide presents an assignment to do in preparation for the next workshop in the series. It also includes information about the featured teachers and their classrooms, a list of the guest teachers, and questions for thought that are to be answered in a journal. (Author/YK/JSR) ENC-013825



CHANGING TEACHERS, CHANGING SCHOOLS: MATHEMATICS

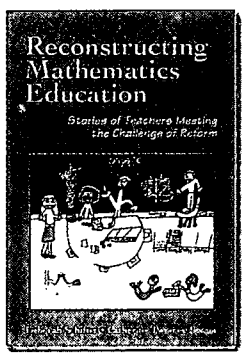
This section focuses on professional development resources for mathematics educators. You will find a selection of videos, essay collections, and other books on topics such as Cognitively Guided Instruction (CGI), problem-centered learning, and practitioner-based inquiry. Read how other teachers have struggled with and learned from the challenge of getting their students to think and engage actively in mathematical learning.

Reconstructing Mathematics Education: Stories of Teachers Meeting the Challenge of Reform

Grades K-12
1993
Author: Deborah Schifter, Catherine Twomey Fosnot

Ordering Information:
Teachers College Press
PO Box 20
Williston, VT 05495-0020
Fax: (802) 864-7626
Toll-free: (800) 575-6566
Email: tcp.orders@aidcvt.com
http://tc-press.tc.columbia.edu/
$18.95 per book (softcover)

Participants in the SummerMath for Teachers program at Mount Holyoke College wrote these narrative case studies of teachers who, guided by evolving constructivist understandings of mathematics learning, work to bring this view into their daily practice. Their stories detail the process of individual teacher change and offer glimpses of what is possible with the new mathematics pedagogy. In sample vignettes, descriptions are given of second grade students who hypothesize about odd and even numbers, third graders who demonstrate the commutativity of multiplication, and sixth graders who puzzle over the mysteries of fractions. Excerpts from teacher journals discuss the teacher's intentions in designing the activity, the instructional decisions she makes as the children engage in it, and her reflections afterward. The journal entries also offer opportunities to understand the demands of change, such as the personal resources required, the time needed, and the complexity of inventing new teaching practices. The teacher development program described in this book has a threefold commitment: helping teachers construct an understanding of the learning process, offering teachers opportunities for new and deeper understanding of the mathematics they teach, and supporting teachers as they develop a classroom practice guided by these understandings. References are included. (Author/JRS) ENC-013448



Fractions, Decimals, Ratios, & Percents: Hard to Teach and Hard to Learn?

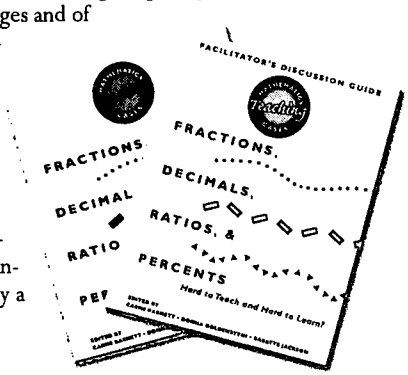
Mathematics Teaching Cases Series

Grades 1-12
1994
Author: editors, Carne Barnett, Donna Goldenstein, Babette Jackson

Ordering Information:
Greenwood Publishing/Heinemann Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$23.00 per casebook
$25.00 per facilitator's guide

Standards: NCTM Curriculum and Evaluation Standards (1989); NCTM Professional Standards (1991)

Written by and for teachers of grades 4-8, this collection of mathematics teaching cases is intended to encourage improvement of curriculum and instruction specific to fractions, decimals, ratios, and percents. These short cases are designed to stimulate discussion and collaborative reflection. Each case describes the events that created a problem, the classroom context, and the teacher's attempts to resolve the problem. The accompanying facilitator's discussion guide contains suggestions for structuring a teacher study group, as well as questions and issues raised by each case. For example, in How Can 100% of Something Be Just One Thing?, a grade 5 teacher addresses the importance of figuring out percentages and of conceptual understanding. She recognizes that her students need additional experiences with the concept of 100% but is unsure as to how to proceed. Issues raised in the discussion guide include the differences between conceptual understanding and procedural knowledge and the colloquial use of one hundred percent. Each case is followed by a list of suggested readings. (Author/CMS) ENC-009003



Algebra: It Begins in Kindergarten

Mathematics: What's the Big Idea? Series

Grades K-8
1997
Author: director, Lisa Friedman

Ordering Information:
Annenberg/Corporation for Public Broadcasting (CPB)
PO Box 2345
South Burlington, VT 05407-2345
Fax: (802) 864-9846
Toll-free: (800) 965-7373
http://www.learner.org/
$24.95 per video
$199.00 per series (8 tapes + guide)

Standards: NCTM Curriculum and Evaluation Standards (1989)

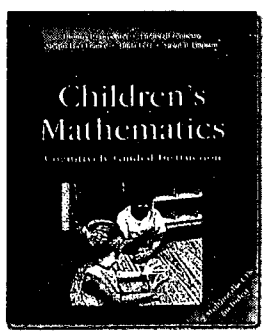
The seventh video in the Mathematics: What's the Big Idea? Series, explores algebra as being more than meaningless abstraction or symbolic manipulation. Fundamental algebraic activities, such as using variables and exploring multiple representations, are described in ways that can be developed in the primary and intermediate grades. The series comprises eight programs in a workshop format designed to help teachers learn mathematics in new and exciting ways. It suggests how to teach mathematics in these ways and shows classrooms that are changing, so that viewers can learn from observing the teachers in these classrooms. The videos include guest teachers engaging in group discussion and activities, questions for the viewer to discuss, and suggested classroom activities for students. In this video, classroom clips show primary students creating pictorial representations for simple equations. In another segment, intermediate grade students investigate surface area and volume using Cuisenaire rods. Guest teachers discuss ways to approach algebra as the study of relationships that can be represented in multiple forms: pictorial, verbal, tabular, and symbolic. A series guide contains outlines of the themes, activities, and supplies needed for active participation in the video workshop. Each workshop is correlated with specific NCTM standards (1989). (Author/JRS) ENC-014209

Children's Mathematics: Cognitively Guided Instruction

Grades K-2
1999
Author: Thomas P. Carpenter, Elizabeth Fennema, Megan Loef Franke, Linda Levi, Susan B. Empson

Ordering Information:
Greenwood Publishing/Heinemann Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$23.00 per book (with accompanying CD-ROMs)
Contact vendor for equipment specifications.

This research-based book portrays the development of children's understanding of basic number concepts and illustrates how Cognitively Guided Instruction (CGI) builds upon children's early mathematical thinking. The theory of CGI posits that children enter school with a great deal of informal mathematics knowledge. Without direct instruction on specific number facts, algorithms, or procedures, children can construct viable solutions to a variety of problems. The basic number operations can be defined in terms of these intuitive problem-solving processes; symbolic procedures can then be developed as extensions of the processes. In the CGI classroom, children come to rely on number facts, but the learning of these facts is more than a rote skill. It is built upon an understanding of number relations and is supported by a foundation of number sense developed through using modeling and counting strategies. This book presents classification schemes for describing important differences among addition and subtraction problems and multiplication and division problems. There are explanations and examples of problem solving and computational processes most children use as their numerical thinking develops. Discussion also covers the development of base-ten number concepts and multidigit algorithms, along with ways CGI can be used in the classroom. Two CDs provide short video segments showing students and teachers implementing the teaching and learning strategies described in the text. The appendix describes the research basis for CGI. (Author/JRS) ENC-015133



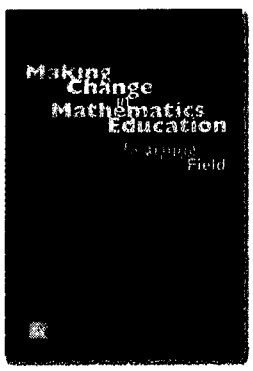
Making Change in Mathematics Education: Learning from the Field

Grades K-12
1998
Author: editors, Joan Ferrini-Mundy, Karen Graham, Loren Johnson, Geoffrey Mills

Ordering Information:
National Council of Teachers of Mathematics, Inc.
1906 Association Drive Drawer A
Reston, VA 20191-1593
(703) 620-9840 / Fax: (703) 476-2970
Toll-free: (800) 235-7566
Email: orders@nctm.org
http://www.nctm.org/
$9.56 per book (NCTM member price)
$11.95 non-member price

Standards: NCTM Curriculum and Evaluation Standards (1989); NCTM Professional Standards (1991); NCTM Assessment Standards (1995)

Teachers, curriculum developers, community members, administrators, and policy makers can use this book as a tool in the implementation of the NCTM standards (1989). Each chapter addresses questions that surface for practitioners seeking to change and improve mathematics education. The book draws heavily on material gathered for the Recognizing and Recording Reform in Mathematics Education project (R-cubed) initiated in 1992 by NCTM. The R-cubed database, case studies, and scenarios are used to illustrate the issues described in this book. One chapter explores the meanings of implementation of the standards at the state framework level, at the district guide level, and in the classroom. Another chapter looks at the variety of approaches to professional development, funding, and choosing curriculum materials used to initiate and sustain mathematics reform efforts. The book includes references and background descriptions of the schools researched for the R-cubed project. (Author/JRS) ENC-015134



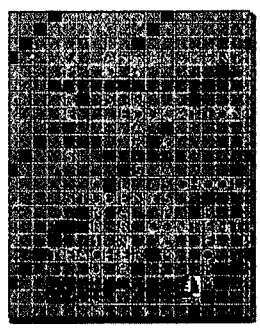
Mathematics in the Middle

Grades 5-8
1998
Author: editor, Larry Leutzinger

Ordering Information:
National Council of Teachers of Mathematics, Inc.
1906 Association Drive Drawer A
Reston, VA 20191-1593
(703) 620-9840 / Fax: (703) 476-2970
Toll-free: (800) 235-7566
Email: orders@nctm.org
http://www.nctm.org/
$22.00 per book (NCTM member price)
$27.50 non-member price
Order # 682

Standards: NCTM Curriculum and Evaluation Standards (1989)

The articles in this book reflect the experiences of grade 6-9 teachers as they try to bridge the gap between elementary school and high school for students. Included are ways to facilitate student learning in thinking hypothetically, grasping cause and effect, and thinking more expansively. The book also explores the effect of the NCTM standards (1989) on the reality of middle school mathematics. Part One describes some important issues for middle grade students, schools, and programs, such as student-centered versus content-centered classrooms. Part Two presents descriptions of five standards-based middle grades curricula. This part closes with an article that traces one teacher's journey in search of a curriculum that captivates her students. Part Three presents projects, activities, and programs that are actively implementing some of the NCTM's recommendations for middle school classrooms. Each article concludes with a list of references. (Author/JRS) ENC-014739



Learning Through Problems: Number Sense and Computational Strategies: A Resource for Primary Teachers

Grades 1-3

1999
Author: Paul R. Trafton and Diane Thiessen

Ordering Information:
Greenwood Publishing/Heinemann Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
Telephone: (603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$14.00 per book

Problem-centered learning is an approach to mathematics instruction that honors children's thinking and sense-making ability. The approach weaves elementary mathematics topics—including addition, subtraction, place value, and problem solving—into a variety of contexts that allow for genuine mathematical exploration. The first part of this book demonstrates this approach through classroom activities and outcomes from a specific story, the Pizza Problem Story. Students are asked to use problem-solving skills to find how many eight-slice pizzas are needed for a class party during which each person eats two slices. Descriptions of the activities include pictures of student presentations and oral and recorded examples of student work. The Pizza Problem Story illustrates what the authors call the four characteristics of a good problem: challenging nature, accessibility for all students, existence of a variety of solution strategies, and worthwhile mathematical ideas. The next section of the book addresses planning, implementation, and instructional issues related to problem-centered learning. Classroom examples show how number sense and computation skills can both be learned within a problem-centered framework. Additional sections contain information about the development of children's mathematical thinking, teacher reflections on classroom experiences with problem-centered learning, and ideas for assessing student learning. References include articles and reports offering the theoretical foundation of problem-based learning as well as curriculum resources and children's literature suggestions. (Author/JRS) ENC-014532

Teaching Math: A Video Library, K to 4

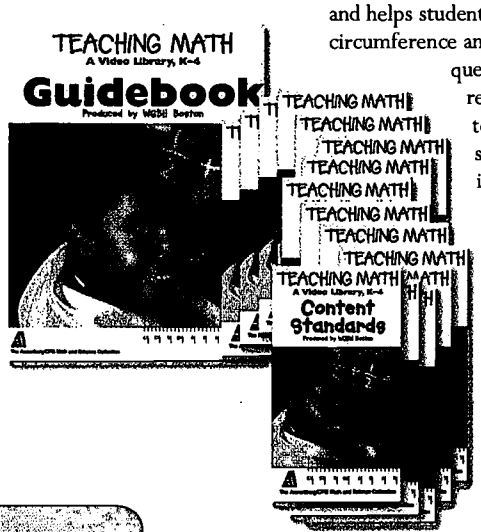
Teaching Math Series

Grades K-4
1995
Author: WGBH Educational Foundation

Ordering Information:
Annenberg/Corporation for Public Broadcasting (CPB)
PO Box 2345
South Burlington, VT 05407-2345
Fax: (802) 864-9846
Toll-free: (800) 965-7373
http://www.learner.org/
$375.00 per video library (24 tapes, 1 guidebook)
$25.00 per guidebook
Note: Additional ordering options available.

Standards: NCTM Curriculum and Evaluation Standards (1989); NCTM Professional Standards (1991)

This video library began when the Annenberg/CPB Math and Science Project issued a call for visual examples of dynamic classroom teaching that illustrates the curriculum content and process areas outlined in the NCTM standards (1989). The collection of 24 tapes includes an introductory video; 18 tapes presenting real, unscripted lesson segments; four videos that focus on NCTM process standards; and one video that shows two teachers using the standards in several lessons over one year. Viewers can observe a wide range of teacher-created lessons from various curricula in diversified educational settings. Each video ends with analysis questions intended to spark discussion and reflection. In one content area video, a California teacher conducts a small-group activity on circles with grade 4 students. After reviewing some definitions, groups of students find circular items around the room and record the their diameters and circumferences on a chart. Each group selects one item to discuss with the entire class. The teacher records measurements on the overhead projector and helps students to determine the relationship between circumference and diameter. Each video ends with analysis questions intended to spark discussion and reflection. An analysis question asks what techniques the teacher used to encourage students to explore the relationship. Also included with the videos is a guidebook of individual units to accompany each lesson. Each unit presents an overview of the lesson and an exploration activity for teacher workshops, as well as information on the classroom and a list of discussion ideas. (Author/KFR) ENC-009486



Teaching Math: A Video Library, 5 to 8

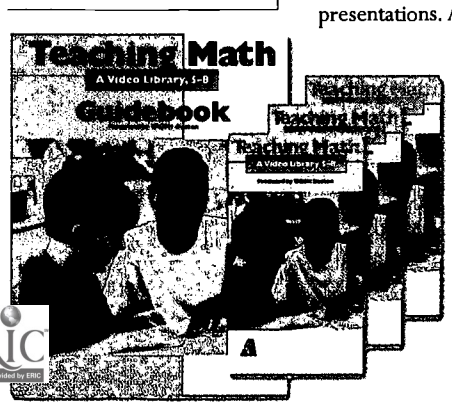
Teaching Math Series

Grades 5 -8
1996
Author: WGBH Educational Foundation

Ordering Information:
Annenberg/Corporation for Public Broadcasting (CPB)
PO Box 2345
South Burlington, VT 05407-2345
Fax: (802) 864-9846
Toll-free: (800) 965-7373
http://www.learner.org/
$125.00 per library (3 videos + guidebook)
$17.00 per guidebook

Standards: NCTM Curriculum and Evaluation Standards (1989); NCTM Professional Standards (1991)

Part of the series described above, this video library is designed for use in preservice and inservice workshops, by individual teachers, in parent-teacher association meetings, and by school administrators. The collection of three tapes contains six real, unscripted lessons focusing on different content areas. Different lessons include applications to real-life situations, technology use, and problems with more than one correct solution. In one lesson, for example, a teacher from a San Diego middle school conducts a small-group activity in which groups of students calculate the volume and surface area of rafts made up of different numbers of rods. At the end of class, a few groups make brief presentations. After the lesson, one analysis question asks how to help students learn to generalize patterns into formulas. A guidebook of individual units is included with the library. (Author/KFR) ENC-009489



Teaching Math: A Video Library, 9 to 12

Teaching Math Series

Grades 9-12
1996
Author: WGBH Educational Foundation

Ordering Information:
Annenberg/Corporation for Public Broadcasting (CPB)
PO Box 2345
South Burlington, VT 05407-2345
Fax: (802) 884-9846
Toll-free: (800) 965-7373
http://www.learner.org/
$250.00 per video library (10 videos + guidebook)
$25.00 per guidebook

Standards: NCTM Curriculum and Evaluation Standards (1989); NCTM Professional Standards (1991)

Part of the series described above, this collection of 10 videos includes an introductory video, five tapes containing unscripted lessons, and four videos that focus on communication, reasoning, connections, and problem solving. In one content area video, a teacher from a Boston high school conducts a small-group activity with ninth graders. Groups of students try to find a pattern that tells how many blocks are needed to make different-sized staircases. Each group uses paper squares to build several staircase models, records their data on a large piece of paper, and writes down questions that they encounter. After the activity, one analysis question asks how the teacher's questions encouraged reasoning. Selected videos include interviews that give students' reactions to the classroom activities. Also included is a guidebook compiled of individual units that contain a list of NCTM standards featured in the lesson, a summary of the video, and an exploration activity. (Author/KFR) ENC-009487

Thinking Through Mathematics: Fostering Inquiry and Communication in Mathematics Classrooms

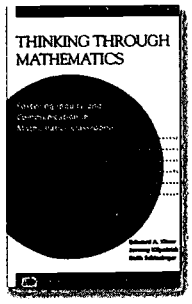
Thinking Series

Grades 9-12
1990
Author: Edward A. Silver, Jeremy Kilpatrick, Beth Schlesinger

Ordering Information:
The College Board
Department G6012345678
PO Box 1100
Two College Way
Forrester Center, WV 25438
Fax: (800) 525-5562
Toll-free: (800) 323-7155
http://www.collegeboard.org
$14.95 per book
Note: Plus $4.00 S&H

Standards: NCTM Curriculum and Evaluation Standards (1989)

The Thinking Series was initiated by the College Board's Educational EQuality Project, a 10-year effort to improve the quality of secondary education and to ensure equal access to college for all students. The books address teaching all students how to become competent thinkers and how teachers are modifying their practice to encourage students to think. Each book draws on both cognitive research and actual classroom practice. Using a problem-solving approach, the authors of this book propose ways that teachers can connect thinking and mathematics. Beginning with an explanation of the changing perspectives on learning and doing mathematics, the book explores how these perspectives can be incorporated into the teaching of secondary mathematics. The authors use examples of problems or tasks to stimulate teachers to find, construct, and invent their own activities and problem situations. Example problems in the book are drawn from newspapers, everyday experience, and textbooks. Vignettes of actual teachers' experiences illustrate how teachers have modified their practice to incorporate thinking activities. Considerable emphasis is placed on changing the nature of discourse in the classroom, including providing students with opportunities and encouragement to make conjectures and to reflect upon, refine, discuss, and amend their conjectures. (Author/GMM) ENC-007428



What's Happening in Math Class? Volumes 1 and 2

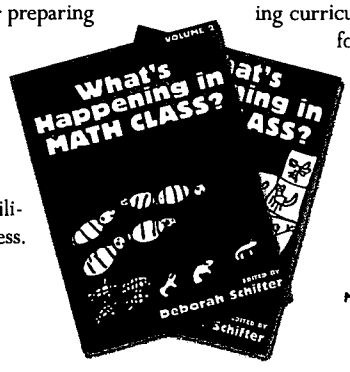
Series on School Reform

Grades 1-12
1996
Author: editor, Deborah Schifter

Ordering Information:
Teachers College Press
PO Box 20
Williston, VT 05495-0020
Fax: (802) 864-7626
Toll-free: (800)575-6566
Email: tcp.orders@aidcvt.com
http://tc-press.tc.columbia.edu/
$18.95 per volume
Order # 3481-0 for vol. 1,
Order # 3483-7 for vol. 2

Standards: NCTM Curriculum and Evaluation Standards (1989); NCTM Professional Standards (1991)

Written by teacher educators and teachers, this two-volume collection of essays is intended for use by preservice and inservice teacher groups interested in practitioner-based inquiry. Participants in the Mathematics Process Writing Project (MPWP), conducted by SummerMath for Teachers, produced detailed, reflective first-person narratives exploring their own classroom processes, instructional goals, and decision making, as well as their own changing professional identities in light of constructivist reform efforts. Each chapter comprises two to three teacher narratives, followed by an essay by a teacher educator addressing some of the broader issues in mathematics education that are embedded in the narratives. For example, some issues addressed in the narratives are the implications of using constructivism, concerns about mathematics content, and strategies for preparing students for a new classroom culture. Volume 1, *Envisioning New Practices Through Teacher Narratives,* addresses grade-specific mathematical content and issues that classroom teachers are likely to face as they engage in the new mathematics pedagogy. Volume 2, *Reconstructing Professional Identities,* contains essays that explore pedagogical issues such as redefining responsibilities for student learning and monitoring student progress. (Author/CMS) ENC-009073



Living and Learning Mathematics: Stories and Strategies for Supporting Mathematical Literacy

Grade 1
1990
Author: David J. Whitin, Heidi Mills, Timothy O'Keefe

Ordering Information:
Greenwood Publishing/Heinemann
Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$19.00 per book

The stories and strategies in this book document how mathematical literacy, or the ability to think in mathematics, was developed in a first-grade classroom. The authors use pictures and samples of student work to illustrate the mathematical activities of this class of 20 students. Students are shown devising strategies for problem solving and thinking mathematically as they use numbers in meaningful ways. The children create stories, discuss strategies, and assemble their own numerical information as they measure plants, classify dinosaurs, and count new and missing teeth. This book is organized around significant issues that include how literature fits into the mathematics classroom and how to make graphs meaningful. Children's interests, questions, and observations are used by the teacher to guide the mathematical discovery process and to shape the curriculum. The resulting curriculum invites children to use mathematics and language as tools for learning in an environment supportive of mathematical literacy. References are included. (Author/JRS) ENC-015101

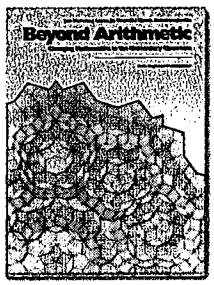
Beyond Arithmetic: Changing Mathematics in the Elementary Classroom

Grades K-5
1995
Author: Jan Mokros, Susan Jo Russell, Karen Economopoulos

Ordering Information:
Cuisenaire Dale Seymour Publications
10 Bank Street
PO Box 5026
White Plains, NY 10602-5026
Fax: (914) 328-5487
Toll-free: (800) 872-1100
http://www.cuisenaire-dsp.com/
$13.95 per book
Order # EN501-21259

Standards: NCTM Curriculum and Evaluation Standards (1989); NCTM Professional Standards (1991)

This book discusses why the NCTM, in its Professional Standards for Teaching Mathematics (1991), called for a shift in mathematics teaching. The book describes and illustrates how that shift is reflected in curriculum materials, in assessment, and in the everyday workings of the mathematics classroom. Beginning with an inquiry into why change is needed, the book offers a philosophical framework linking the NCTM goals to what actually happens in classrooms. For example, the authors note that emphasizing problem solving and reasoning requires focusing on getting students to think, explain, justify, and demonstrate. After examining the role of curriculum and considering how it should be redefined as a tool for both teacher and student learning, the book presents a glimpse of how young students look and sound when they are thinking and reasoning mathematically. Remaining chapters address questions teachers commonly ask about mathematics reform, describe approaches to assessing mathematical understanding, and discuss issues teachers face in creating a school climate in which students are active mathematical learners. (Author/LDR) ENC-004715



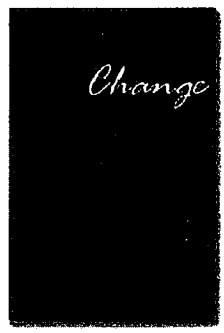
Wrestling With Change: The Dilemmas of Teaching Real Mathematics

Grades K-12
1994
Author: Lew Romagnano

Ordering Information:
Greenwood Publishing/Heinemann Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$23.00 per book
Order # 08342

Standards: NCTM Curriculum and Evaluation Standards (1989)

In the research project described in this book, a researcher and a classroom teacher openly and regularly examined their teaching strategies with two general mathematics classes of mixed-grade, at-risk students. The teacher, certified to teach secondary science, was struggling to make the math classes interesting while ensuring that students mastered the basic skills. The researcher offered to plan the classes and teach the material first, with the teacher observing and then teaching the other class the next day. What the researcher wanted to change was what—and how—material was being taught, while learning about issues mathematics teachers confront when making instructional changes. The initial chapters provide a literature review on teacher change and a research framework, while the remaining chapters each begin with a vignette depicting the everyday classroom interactions that led to changes in instructional practice. (Author/LDR) ENC-007750



Putting It Together: Middle School Math in Transition

Grades 5-8
1994
Author: Gary Tsuruda

Ordering Information:
Greenwood Publishing/Heinemann Educational Books Inc.
88 Post Road West
PO Box 5007
Westport, CT 06881-5007
(603) 431-7894 / Fax: (800) 203-1502
Toll-free: (800) 225-5800
Email: custserv@heinemann.com
http://www.greenwood.com/
$18.00 per book
Order # 08355

Standards: NCTM Curriculum and Evaluation Standards (1989)

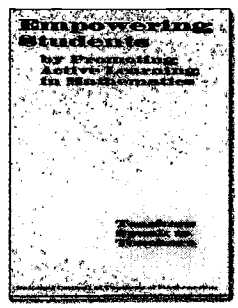
The author of this book on implementing reform in the classroom is a middle school mathematics teacher who begins by discussing how his personal beliefs about learning have changed significantly over the years. He describes the bits of evidence that gradually made it apparent to him that traditional methods were not working. He then details how he began to bring new techniques into his middle school mathematics classroom. The book includes sections on essays, journals, and other forms of writing in the math classroom; assessment alternatives, such as portfolios; problem solving and problems of the day; and grouping practices. It is designed to help teachers who are trying to meet the objectives of the NCTM standards (1989). (Author/KFR) ENC-007761

Empowering Students by Promoting Active Learning in Mathematics: Teachers Speak to Teachers

Grades K-12
1994
Author: editor, Dorothy Buerk

Ordering Information:
National Council of Teachers of Mathematics, Inc.
1906 Association Drive Drawer A
Reston, VA 20191-1593
Telephone: (703) 620-9840 / Fax: (703) 476-2970
Toll-free: (800) 2357566
Email: orders@nctm.org
http://www.nctm.org/
$6.00 per book
Order # 553E1
Note: 20% discount for NCTM members

In this publication, five full-time mathematics teachers detail their successful efforts to empower their students mathematically and to implement the standards outlined in NCTM's standards (1989). Each chapter is written by a different teacher, each of whom describes experiences and strategies for transforming students' conceptions of mathematics. The chapters offer anecdotes, advice, and suggestions for implementing active learning practices such as cooperative learning and student writing. (Author/KFR) ENC-007840



ONLINE PROFESSIONAL DEVELOPMENT

The online resources in this section include web sites where teachers can communicate with others about the change process, resources where teachers can find opportunities to support their professional development, and information on the reform effort in both mathematics and science.

The Millennium Project, from Debate to Understanding: The Evolving Role of Technology in Learning

http://millennium.aed.org/

Grades K-12
Author: National Demonstration Laboratory for Interactive Information Technologies

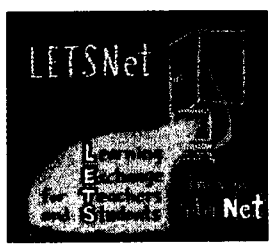
Maintained by the Academy for Educational Development's (AED) National Demonstration Laboratory, this web site provides a sustained forum in which informed participants can discuss, respond to, debate, and synthesize a wide range of opinions, research, and expertise about educational technology issues. Every three months, AED staff select five topics that can accommodate a wide range of opinions and experiences. Nationally recognized experts offer brief introductory opinions on the topics, and the international community then discusses and debates them for three months. After that, the discussions are archived, where they can be continued. The site also provides biographical information about the expert panel, an online library, and regular surveys and contests. Current topics include Technology and Teacher Professional Development, Technology Efficacy, Distance Learning in Higher Education, Technology and Educational Reform, and Technology as a Cognitive Tool. Winner, ENC Digital Dozen, September 1998. (Author/LCT) ENC-012958

LETSNet: Learning Exchange for Teachers and Students Through Internet

http://commtechlab.msu.edu/sites/letsnet/

Grades K-12
Author: Michigan State University College of Education and Michigan State University Communication Technology Laboratory

This web site, maintained by Michigan State University College of Education, is dedicated to helping K-12 teachers experience the value of the World Wide Web in the classroom by providing examples of how real teachers are using the web in everyday activities. Organized around teachers' stories of their successes and struggles with incorporating the Internet, the site includes lesson plans, curriculum standards, pointers to email discussion lists, and links to other Internet materials. In the Ten Big Ideas section, there are virtual field trips, visualizations of architecture and molecular behavior, and a kid's corner with a virtual bug collection. Another section contains lessons organized under seven subject headings. A sample science lesson, Worm Bin, lets students in grades 3 or 4 use the Internet to collaborate with another school to learn about the decomposition of waste and the life cycles of worms. A math lesson that could be adapted for any grade incorporates statistical research and a plan for action with collecting trash on Earth Day. Winner, ENC Digital Dozen, March 1998. (Author/JRS) ENC-011807



MCI Worldcom Marcopolo: Internet Content for the Classroom, Teacher Training Kit

http://www.wcom.com/marcopolo/training/index.shtml

Grades K-12
Author: MCI WorldCom, American Association for the Advancement of Science, National Council on Economic Education, National Council of Teachers of Mathematics, National Endowment for the Humanities/Council of the Great City Schools, and National Geographic Society

MarcoPolo is an Internet-based learning initiative sponsored by MCI and partnered with the American Association for the Advancement of Science (AAAS), the National Endowment for the Humanities, the National Council on Economic Education, and the National Geographic Society. The professional development training program introduced at this site is designed to help teachers integrate the Internet into their curriculum. The workshop materials are designed for educators who already know how to use a computer. All materials can be downloaded and include a leader's guide with directions for implementing the program, presentation notes, a PowerPoint presentation, and reproducible handouts. Additional resources include five Internet sites for science, mathematics, geography, humanities, and economics. One of them, Science Netlinks, provides science teachers with resources such as links to the national standards organizations and standards-based lesson plans. The Illuminations site for mathematics is under construction, but will provide extended examples to help teachers apply the updated NCTM standards. Other sites include Xpeditions for K-12 geography; Edsitement for teachers of literature, history, social studies, foreign languages, and art history; and Econedlink for adding economic insight to the social studies, mathematics, geography, business, language arts, and science curricula. Winner, ENC Digital Dozen, June 1999. (Author/LCT) ENC-014837

Teacher2Teacher

http://forum.swarthmore.edu/t2t/

Grades K-12
Author: The Math Forum and The Council of Presidential Awardees in Mathematics

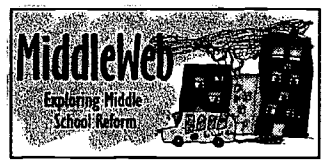
K-12 teachers can visit this site to find answers to questions about teaching mathematics, and parents can find ways their children are learning mathematics. The site is divided into two sections: help finding ideas and a forum for asking questions. A panel of teaching professionals, the Presidential Awardees for Excellence in Mathematics Teaching, is available to answer questions. Topics range from classroom teaching techniques to finding good Internet resources for professional development. Visitors to the site can conduct searches by grade levels or by topic. There are topic references for learning multiplication tables, teaching elapsed time, and questions on Advanced Placement Calculus. Some replies to questions include suggestions for using technology with advanced middle schoolers, information about mathematics in the workplace, and factoring trinomials. In addition, the site contains links to many other sites related to the teaching and learning of mathematics. Winner, ENC Digital Dozen, December 1998. (Author/JRS) ENC-013002

Middleweb: Exploring Middle School Reform 1998

http://www.middleweb.com/

Grades 5-8
Author: editor, John Norton

Maintained by the Focused Reporting Project, this award-winning web site provides resources for schools, districts, educators, parents, and public school advocates working to raise achievement for all middle grade students. In addition to a wealth of reform-oriented materials, the site offers hundreds of articles and links about curriculum, teaching strategies, teacher professional development, parent involvement, and classroom assessment. Other features include daily teaching diaries from two middle school teachers and the online editions of the Changing Schools newspapers, which report on the efforts of the Long Beach, California and the Louisville, Kentucky school systems to implement standards-based reform. Winner, ENC Digital Dozen, January 1999. (Author/LCT) ENC-013649

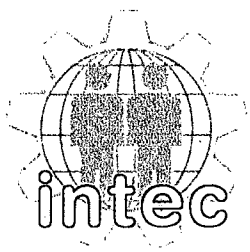


INTEC

http://intec.concord.org/

Grades 5-12
Author: educational director, Raymond M. Rose
Standards: Benchmarks for Science Literacy; National Science Education Standards (December 1995)

The International Netcourse Teacher Enhancement Coalition (INTEC) offers online professional development courses to help teachers develop inquiry-based teaching and learning in math and science classrooms at the middle and high school levels. The INTEC design requires the participation of a cross-disciplinary, site-based team of science and math teachers and an administrator from schools or districts committed to educational reform. Exemplary curricula, primarily selected from NSF-funded inquiry-based projects, provide the content core. The intent is to challenge the participants through curricula that include examination of recent discoveries or revisiting of older concepts represented and explored in novel ways. NetCourses combine face-to-face discussion with moderated online discourse through a graphical browser. Also available is a field expert in each project curriculum who has already used it in a classroom. A course is offered over one academic year, starting September 1998, for a minimum of 125 contact hours, and another is available during the summer. Winner, ENC Digital Dozen, April 1999. (Author/GMM) ENC-014664



Pathways to School Improvement

http://www.ncrel.org/sdrs/pathways.htm

Grades K-12
Author: North Central Regional Educational Laboratory in cooperation with the Regional Educational Laboratory Network

Pathways, an award-winning site, addresses critical issues identified by educators, researchers, and community leaders. National leaders in each area provide practical, research-based solutions to these issues. Contributions come from America's leading educational research centers and universities. Mathematics and science topics include: locating, using, and integrating Internet-based materials; providing hands-on and authentic learning experiences; implementing curriculum, instruction, and assessment standards for math and science education; and ensuring equity and excellence in mathematics and science. Other topics include assessment, professional development, and school-to-work transitions. Pathways contains a variety of articles, graphics, movies, and sound files, as well as many links to other exemplary Internet resources for education. Winner, ENC Digital Dozen, August 1995. (Author/DEB) ENC-002454

WWW.4teachers

http://www.4teachers.org/

Grades K-12
Author: South Central Regional Technology in Education Consortium

This free, web-based monthly publication provides a place where educators and others interested in K-12 education can encounter new ideas about technology's role in education. At this site, visitors can express their opinions, share experiences, and be inspired and educated by other teachers' narratives about using technology in educational settings. The site features interviews, web lessons, and surveys, as well as online lesson plans that guide students through an annotated set of sites on such subjects as language arts, science, mathematics, and research in teaching. Winner, ENC Digital Dozen, November 1997. (Author/LCT) ENC-010903

Teacher Change: Improving K-12 Mathematics

http://change.enc.org/

Grades K-12
Author: Eisenhower National Clearinghouse (ENC)
Standards: NCTM Curriculum and Evaluation Standards (1989); NCTM Professional Standards (1991)

The collection of materials at this site is intended to facilitate discussion, reading, reflection, learning, and change related to improving mathematics education. The materials include essays on teacher change, cases and stories about teaching practices in the US and other countries, professional development activities, and descriptions of curriculum materials that support changes in classroom practices. Data and resources from the Third International Mathematics and Science Study (TIMSS) are integrated throughout this project and provide the backdrop for the dialogue about change in mathematics classrooms. Some files require Adobe Acrobat Reader for viewing. Winner, ENC Digital Dozen, May 1999. (Author/GMM) ENC-014838

Teacher Change Improving K-12 Mathematics

The Guidebook of Federal Resources for K-12 Mathematics and Science

http://www.enc.org/guidebook/index.htm

Grades K-12
Author: Eisenhower National Clearinghouse (ENC)

This electronic document is the online version of a comprehensive directory of federal offices, programs, and facilities supporting K-12 math and science education. The purpose of *The Guidebook* is to improve awareness of the federal government's extensive commitment to mathematics and science education. The Federal Agencies section describes the 16 government agencies, highlighting each agency's involvement in math and science education and the national programs it sponsors. Each program is briefly described, and contact information is provided. The Regional Consortia section contains information about the 10 Eisenhower Consortia, which provide educational services to all regions of the United States. The State Resources section takes visitors directly to the state or territory of their choice to find federally funded programs. (Author/LCT) ENC-015103

Suggested Readings

For the full text of excellent journal articles for educators exploring change, go to ENC Online's Teacher Change: Improving K-12 Mathematics http://change.enc.org/. Click on Resources for Change and then Suggested Readings.

Titles include "Shhhhh, the Dragon Is Asleep and Its Name Is Resistance," which includes scenarios that illustrate how resistance can undermine progress and ideas for positive action in managing resistance; and "Getting Reform Right: What Works and What Doesn't," which details seven interwoven reasons why typical approaches to change do not work and offers seven propositions that could lead to substantial educational improvement.

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How do you generally access the Internet?

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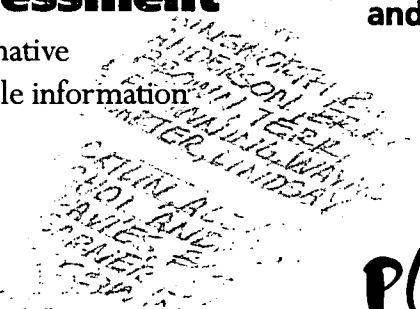

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