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ABSTRACT

This issue, intended for classroom teachers, provides a collection of essays organized around the theme of mathematics and science across the curriculum as well as a guide to instructional materials related to the theme. Topics addressed in the essays include experiencing mathematics through nature; connecting science, fiction, and real life; exploring science and human health; and learning daily from everyday problems. Sections include: (1) "What Does Learning Look Like?" (Annette Thorson); (2) "National Science Foundation" (Kimberly S. Roempler); (3) "Blinded by Technology?" (Joyce Kasman Valenza); (4) "The Power of Convergent Learning" (Carol Damian); (5) "Dream Houses; A Floor Plan for Mathematical Success" (Robert E. Freeman); (6) "Physics Fun" (Louise Stivers); (7) "Making Connections with the Vedic Square" (Thomasenia Lott Adams); (8) "ENC Has Across-the-Curriculum Ideas for You!" (Scott Bartley and Gordon Baugh); (9) "Beyond Numbers: Communicating in Math Class" (David K. Pugalee); (10) "Writing To Learn Mathematics" (Joan Countryman); (11) "Island Hopping Across the Curriculum" (Mary Hindelang); (12) "Experiencing Math through Nature" (Colleen Niemi); (13) "Batty about Bats" (Elizabeth Grenke); (14) "Technology Education Enters the Classroom" (Wes Perusek); (15) "Basketsful of Math and Science Learning" (Susan Cox); (16) "Investigating 'Stretchy' Benchmarks" (Janice VanCleave); (17) "We Need More Earthworms!" (Francine Plotycia); (18) "Learning Every Day from Everyday Problems" (Melanie Shreffler); (19) "Independent Thinking in the Chemistry Lab" (Mark Benvenuto); (20) "Connecting Science, Fiction, and Real Life" (Carolyn Sue Gardiner); (21) "Go off the Subject for Math Fun and Learning!" (Rhonda D. Cummins); (22) "Exploring Science and Human Health" (Cynthia Delgado); and (23) "Math, Science, and So Much More: Making the Cross-Curriculum Connection" (Carol Damian and Terese Herrera). (MM)

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Volume 9, Number 2, 2002

Mathematics and Science Across the Curriculum

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Theme for this issue:

Mathematics and Science Across the Curriculum

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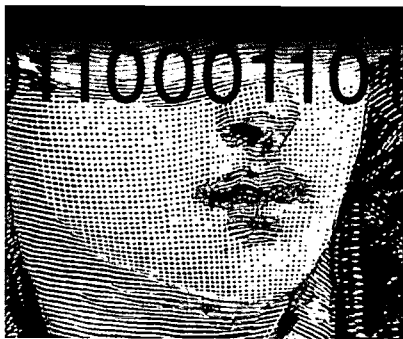
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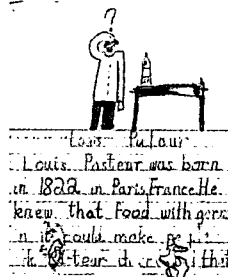
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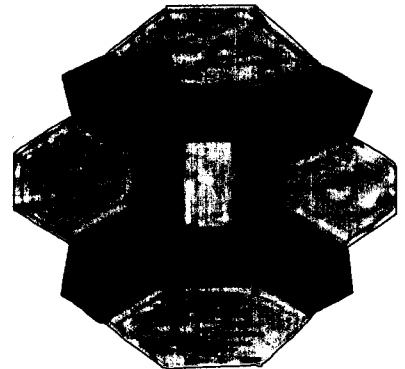
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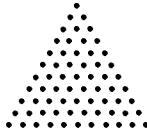
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Update...

Around the Clearinghouse and the Nation

This section features columns, essays, and news of interest to classroom innovators.

What is the Eisenhower National Clearinghouse?

Funded through a contract with the Office of Educational Research and Improvement of the U.S. Department of Education, ENC was created in 1992 to collect and catalog curriculum resources for K-12 mathematics and science educators and to disseminate information about federally funded educational programs. Our products and services have evolved to include a web site, ENC Online (enc.org); *ENC Focus*, a free quarterly magazine; and numerous other publications and services. For more information on ENC's vast collection of curriculum resources, see page 56.

Editorial

What Does Learning Look Like?

by Annette Thorson, ENC Publishing

66 **W**hat process do you use to select the topics for *ENC Focus*?" This is an FAQ we get from people who apparently assume that, since we serve mathematics and science teachers, we must have one tried-and-true, mathematical or scientific way to choose *Focus* topics. At the other extreme, a casual observer might think that our "process" resembles the legend of the discovery of penicillin—we leave our petri dish open and see what falls in and starts to grow.

It is true that the germ of an idea might come from any number of sources. Among our most trusted are ENC's Mathematics and Science Advisory Boards—see page 1 of this magazine for the list of these distinguished educators. Or a topic might spring from the group of local math and science teachers who come to ENC about once a month to share dinner and talk about their lives in the classroom.

Often, a topic might be selected because it is simply too important for us to ignore. This is true of two upcoming topics: *Success in the Urban Classroom* (scheduled for October 2002) and *Special-Needs Students in the Mathematics and Science Classroom* (scheduled for April 2003).

Regardless of the origin of a particular idea, our purpose in choosing topics is to cover a broad spectrum of issues that are important to mathematics and science teachers.

After the topic is selected, the next task is to refine our definition of the topic. This is hammered out by a relatively small group of mathematics and science content specialists and editors. This group turns broad topics such as technology or assessment into well-defined themes such as *Integrating Technology in the Classroom* and *Assessment That Informs Practice*.

Normally, the task of defining the topic is one of the most challenging parts of planning an issue of the magazine. But this time, for the topic *Mathematics and Science Across the Curriculum*, everyone seemed much more relaxed than usual. After all, since this topic is about curriculum, it really touches the core of the mission of ENC. We all agree on what this topic means—right?

To test that assumption, group members agreed to try something new. Rather than brainstorming verbally in our usual way, people paired up and used colored pencils, crayons, chalk, or markers to draw a mock cover for this issue.

Two teams drew images of a bridge on their *Focus* covers—a natural metaphor for across the curriculum. Another team sketched a huge pot of alphabet soup with all the different subject areas spelled out like a crossword puzzle inside. One cover was devoted to a concept map; another showed the tributaries of science, math, art, literature, history, and music flowing together to form the river of knowledge.

In the middle of all of the drawing and discussing, we realized we were grappling with the question: what does learning look like? We hope this issue of *Focus* provides some answers.

We begin with a vision from ENC's science education specialist, Carol Damian, who provides examples of the powerful learning that occurs when students use knowledge from every discipline to solve real-life problems (page 12). The problem-based learning approach drives the entire curriculum in a school district in Illinois (page 47); in California, Louise Stivers takes her

second graders out of the classroom to experience the machines they built and used in their physics unit (page 19); in North Carolina, Robert Freeman's middle schoolers build models of their dream houses (page 16).

Students are getting their hands dirty: Francine Plotyia's first graders dig for earthworms in Maryland (page 45). Teachers are getting their hands dirty, too: Mary Hindelang tells of a summer professional development program at Michigan Technological University in which teachers from every discipline live in the wilderness and learn how they can integrate nature into their curricula (page 32). Program participants Colleen Niemi and Elizabeth Grenke describe exactly how it is done (pages 34 and 36).

Other teachers give other specific examples of the convergence of disciplines in their classrooms. Thomasenia Lott Adams describes how she uses the Hindu Vedic square and Islamic art to illuminate mathematics (page 22), while Mark Benvenuto's chemistry students raise and study tropical fish (page 48). David Pugalee and Joan Countryman each provide examples of the power of writing in learning mathematics (pages 29 and 31).

The use of literature is a favorite way to make connections across the curriculum. Picture books help Susan Cox teach mathematics to kindergarteners (page 42), and Carolyn Sue Gardiner describes works of fiction that pique middle school students' interest in science (page 51).

We encourage you to join these teachers in telling *Focus* readers what learning looks like in your classroom. See the boxes on this page for upcoming topics and other guidelines.

In addition to her background as an editor of educational magazines, Annette Thorson has taught in classrooms ranging from kindergarten through college. She encourages readers to contact her with comments. Email: athorson@enc.org

Writers' Guidelines for *ENC Focus*

Detailed Writers' Guidelines are available online at

enc.org/focus/write

Here are Guideline highlights:

Articles submitted for consideration should be grounded in the national educational standards while being short (500 to 2,000 words) and compelling. It is essential that articles promote educational equity and advance the principle of "education for all." 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 chosen references or a brief reading list. All content must be original, and all quotations must be properly cited. ENC is not interested in publishing articles that have the main goal of promoting commercial products.

Photos or other illustrations add interest, and good illustrations increase your chances for publication. Students in laboratory settings must be shown following appropriate safety guidelines and wearing proper safety attire, including eye protection. Please note that we can use photos of children under 18 years of age only if we receive written permission signed by a parent or guardian.

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to *ENC Focus: A Magazine for Classroom Innovators.*

ENC invites readers to contribute articles

Join in the Dialogue! *Write for ENC Focus*

Topics and Deadlines:

Data-Driven Decision Making - Submissions due June 1, 2002

Special-Needs Students in the Mathematics and Science Classroom - Submissions due September 1, 2002

Collaborating with Colleagues to Improve Practice - Submissions due December 1, 2002

Topics and deadlines subject to change without notice.

See Writers' Guidelines on this page.

National Science Foundation

ENC is working with NSF to create a national digital library for science, mathematics, engineering, and technology education.

by Kimberly S. Roempler,
ENC Instructional Resources

Since 1996, the National Science Foundation has studied the development of a national digital library for science, technology, engineering, and mathematics (STEM) education. From this beginning, NSF funded the National STEM Education Digital Library (NSDL) Initiative, a collective effort to build a national digital library of high-quality educational materials for students and teachers at all levels, in both formal and informal settings. The national impact of the NSDL will be to improve the quality of science, mathematics, engineering, and technology education and to increase access to information in these fields.

The NSF program accepts grant proposals in four tracks: Core Integration, Collections, Service, and Targeted Research.

- The Core Integration collaborative group is focusing on the coordination and management of the library's core collections and services. It also is developing the library's central portal.
- The Collections projects, of which there are 31, cover a variety of topics and serve many audiences. Collection providers are experts in their fields. They are expected to manage a subset of the NSDL content within a coherent theme or specialty. Each of these collections can be searched as a stand-alone entity, but the portal being developed by the Core Integration group will allow for all the collections to be searched as a whole. Eventually, NSF hopes the individ-



What is a Digital Library?

Digital libraries are accessible via the Internet. They provide instant, round-the-clock access to complete versions of electronic resources including text, video, audio, and software. All these materials are cataloged to a very fine level of detail so that highly specific searches are possible.

For more information about how digital libraries function, see the *ENC Focus* article "Digital Libraries for You" (enc.org/focus/horizons).

For details about the NSF Digital Libraries projects, visit the web site (www.ehr.nsf.ehe.nsf.gov/ehr/DUE/programs/nsdl).

Link to these and all web sites in this magazine by visiting the online version of this issue (enc.org/focus/curriculum).

ual collections will encompass the wealth of STEM education information.

- The Service projects are expected to support users, collection providers, and the Core Integration effort. Service projects will also enhance the impact, efficiency, and value of the NSDL as a whole.
- The Targeted Research projects are expected to explore specific topics that have immediate applicability to one of the other three tracks.

ENC has been very successful in working with NSF and other organizations in developing Collections projects. We have also worked with the Core Integration groups at University of California, Berkeley (smete.org) and at Cornell (nsdlib.nsdlib.cornell.edu).

Here are brief descriptions of the four Collections projects with which ENC is currently involved.

The Learning MATRIX **The Learning Matrix** (thelearningmatrix.enc.com)

ENC's first NSDL project is The Learning Matrix, a collection of resources to improve the preparation of math and science teachers by supporting faculty who teach

mathematics and science courses in two- and four-year colleges. The web site (thelearningmatrix.enc.org) contains information about and examples of best practices in undergraduate teaching.

The project is focusing particular attention on web resources with challenging mathematics and science content, course descriptions, syllabi, and lesson plans. Links to electronic communities and professional organizations are included. The site will offer peer-reviewed materials, such as projects and assessments, as well as video clips that illustrate standards-based teaching on the college level.

Another important component of The Learning Matrix will be an enriched web-based learning environment where visitors interact with their colleagues' materials to gain deeper understanding of the substance and context in both research and practice.



The Gender and Science Digital Library (GSDL)

GSDL is a collaborative project between the Gender and Diversities Institute at the Education Development Center (EDC) and ENC. The initiative will serve as a dissemination outlet for a high-quality, interactive library of gender and science resources for use in K-12 schools, higher education, women's studies, and teacher preparation. Another goal of the project is to assist educators in promoting and implementing gender-equitable science education in both formal and informal settings.

The web site (www.gsdl.org) will help link science teachers and gender equity specialists to mentors and other experts in cross-disciplinary examinations of gender and science. The active involvement of the educators, scientists, and technology design experts promises to provide a much-needed "self-guided professional development system" and online community focused on improving outcomes for all students in science.



Innovative Curriculum Online Network (ICON)

The International Technology Education Association (ITEA), in partnership with ENC, is developing a comprehensive digital library collection to promote K-12 technological literacy. The first step in the project is to build, monitor, and maintain the digital library collection.

To provide an accessible virtual environment for the collection, the project will create an electronic roadmap to connect users with technological literacy resources. Another key effort will involve promoting digital library tools and services to relevant professional communities.

PREL The Ethnomathematics Digital Library (EDL)

The EDL project is designed to preserve and affirm the rich cultural and mathematical heritage of indigenous cultures and to ensure worldwide access to this heritage. The Pacific Ethnomathematics Collections Network (PECN) will develop the collection. PECN is made up of representatives from the University of Guam, the University of Hawaii, the University of the South Pacific, the Australian Academy of Science, and the Pacific Resources for Education and Learning (PREL). ENC will provide technical assistance and on-going support to PECN.

One of the first tasks of the EDL will be to identify, collect, catalog, and organize high-quality ethnomathematics curriculum and instruction materials, research articles, and other professional resources of interest to the K-12 community, curriculum developers, researchers,

and members of institutions of higher education. The project will also establish a virtual curriculum and research exchange network to inform future research directions and foster the development of culturally sensitive mathematics curriculum.

Kimberly S. Roempler is ENC's associate director of Instructional Resources and director of the NSDL programs at ENC. Email: roempler@enc.org

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Blinded by Technology?

When they're doing research, students are often dazzled by lightning-fast search engines and hundreds of listings from the World Wide Web. It's up to teachers to alert them to the blind spots.

by Joyce Kasman Valenza, Springfield High School,
Erdenheim, Pennsylvania

Last spring, I sat on a panel that heard one of our brightest seniors present an intriguing thesis: "Hitler's personality was primarily responsible for his rise to power." Her paper cited several online journal articles and web sites. It was well written, but her research had glaring holes. She missed Hitler's political manifesto *Mein*

Kampf, and she missed William L. Shirer's *The Rise and Fall of the Third Reich*. She missed all the biographies on the shelves in our library and many other thoughtful studies available in bookstores and larger libraries.

Although she and I had been in the habit of consulting on research throughout the year, she did much of the research for this paper at home. With the new independence offered by the Internet, students lose a critical element in the research process—human consultation. And they often neglect important sources.

Just recently, another student, who was at the end of his research rope, needed information on the history of breakdancing. He'd spent a full weekend searching the Internet and found lots of personal pages devoted to "moves." When he finally asked me for help, we considered the time period when breakdancing was at its peak. We dusted off a few *Readers' Guide to Periodical Literature* editions from the early 1980s. We retrieved articles from *Time*, *Newsweek*, and *U.S. News and World Report*.

"Does anyone else know about this?" he asked me in amazement.

After that, we hit our school's online subscription services, where we found journal articles that linked breakdance historically to hip hop, explored breakdancing as a form of self-affirmation for inner-city youth, and related it to the poetry of the streets. None of this was available from the search engines and sites students can access without paying subscription fees, what I call the "free web." When students are researching the Kent State University killings, the *Challenger* disaster, the war in Vietnam, the Middle Ages, or the Renaissance, they do themselves a great disservice by limiting their exploration to the free web.

Certainly, they will find material on the web. But for all these topics, they will miss hundreds of nonfiction titles written by authors who may have spent years developing expertise in a particular area.

For areas of modern history that occurred B.E.D. (before the era of instant digitization), that is before 1994, students miss a wealth of contemporary reporting and analysis. When they're researching the Civil War, they will discover that Mathew Brady's extraordinary photographs are on the web. What they might not discover is that Bruce Catton's thoughtful commentary is not. Children need both. And we need to let them know.

The fact is, while there are many generous people, government organizations, museums, and universities sharing their knowledge on the web, the vast majority of authors and publishers are still in the business of making money, and they just aren't giving their work away. Though more magazines and newspapers draw

Making Information Technology Available to All

by Laura K. Brendon, ENC Information Services

Many states and cities provide research tools similar to ACCESS-Pennsylvania, offering their citizens web access to magazine indexes and electronic journals as well as statewide borrowing privileges. To find what is available in your state or city, contact your public library or your state's education agency (enc.org/professional/guide/learn/providers). The following are a few examples of statewide services:

- Alabama Virtual Library (www.avl.lib.al.us) was featured in the January 2001 issue of *Computers in Libraries*. AVL provides access to several standard reference works, subscription databases, and journals and maintains a database of lessons and activities.
- AccessMichigan (accessmichigan.org) offers access to books online (ebooks) in addition to journals and subject databases.
- Colorado Virtual Library (www.aclin.org) focuses on providing access to web-based materials by subject, collections of digitized images (which may be viewed online), and searches of member libraries' catalogs.
- INSPIRE (Indiana Virtual Library) (www.inspire.net) offers access to many indexes and journals as well as a database of information about trees commonly found in the Midwestern United States.

readers to their sites by providing online excerpts from current and past issues, if you want access to the full content of the archive, you will have to buy it.

So beware: If you are doing serious research, you won't find much of the material you'd find in a library's reference, nonfiction, or modern-fiction collections among the no-charge web offerings.

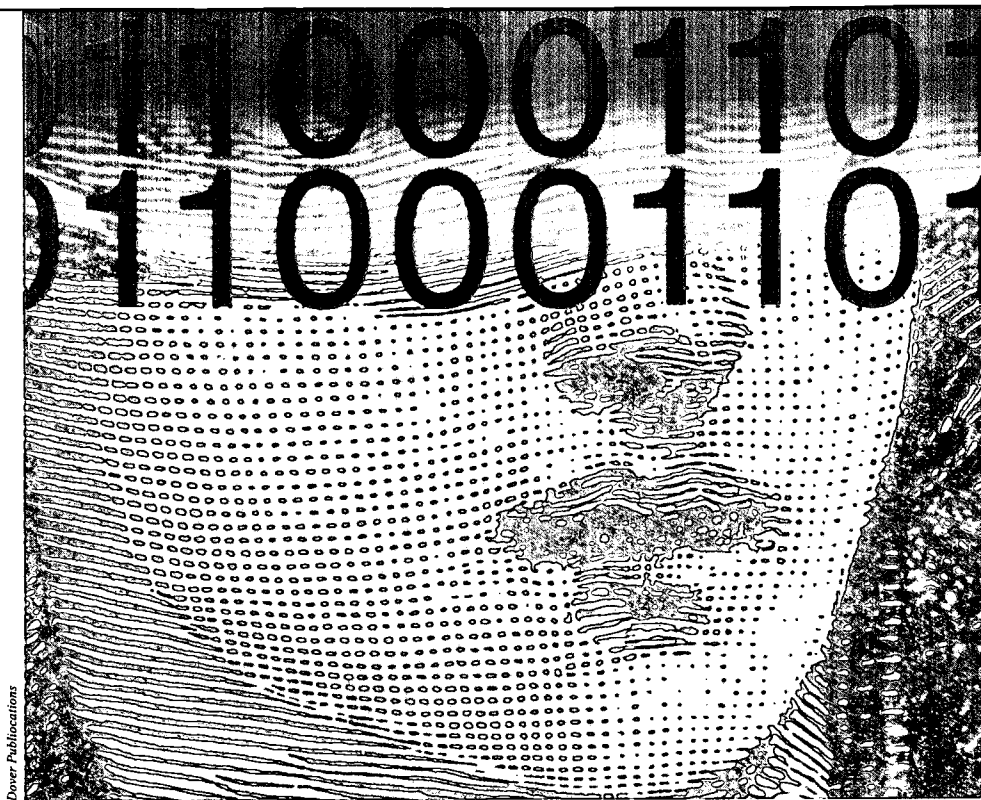
Here's the general rule of thumb for what you won't find:

- High-quality reference books (other than some almanacs, dictionaries, and encyclopedias that are not particularly threatened by loss of sales, or titles that have found some alternative revenue through their web presence).
- Full-text nonfiction books—this includes those richly illustrated titles that draw young people into new areas of knowledge, such as biographies, literary criticism, and scholarly works.
- Any book—fiction or nonfiction—that is still under copyright, and generally any book written by an author who is alive or by one who has been dead less than 75 years.
- Comprehensive journal, magazine, and newspaper indexes and the full text to support them.

You'll notice I've been careful to note the limitations of the free web offerings. On the other side of the web, the subscription side, students can access full-text journal literature and high-quality reference materials.

And that brings to mind a curious phenomenon: Many students who have access to the materials provided by the subscription services of the web may not recognize their value. Students are either unaware or they choose not to exploit these rich services. Instead, they mechanically travel to the one or two web search tools whose addresses they remember, often bypassing their best sources. Teachers and parents should be aware that students often have access to much more than the well-known, popular sites such as Yahoo!, AOL Search, or Excite. We should encourage students to look further in their searches, and we should check bibliographies early and often for quality, scope, and evidence of scholarship.

In my state, the ACCESS-Pennsylvania database (www.accesspa.state.pa.us) offers a suite of subscription services that can be accessed at home. The offerings



Dover Publications

include the EBSCO periodicals and reference database, SIRS Discoverer full-text newspaper and magazine articles, Associated Press Photo Archive, and other sources of literary and scientific articles. Your state likely provides access to subscription-only databases through public libraries or its education agency (see box on p. 8).

The vast and powerful web still has its limitations. But you don't have to take my word for it. I asked my friend and colleague, Internet education guru Kathy Schrock, at school.discovery.com/schrockguide/, what she found lacking on the web. She responded: "What is not often found on the free web is material that cites its source. The only way to tell if you have found quality information on the web is to first conduct research in the traditional way—in your library, in reference books and print materials—to allow yourself to create your knowledge base on your topic. Only then can you decide if what you find on the web is worth using and whether it supplements, complements, or disputes your research!"

Joyce Kasman Valenza is the librarian at Springfield High School in Erdenheim, Pennsylvania. She writes a weekly column for The Philadelphia News about technology and education. This article is adapted from the column that appeared in the January 2001 issue. Email: joyce.valenza@phillynews.com

A version of this article also appeared in Learning & Leading with Technology, vol. 29, no. 1. © 2001, ISTE (International Society for Technology in Education). Toll free: (800)336.5191; email: iste@iste.org; web site: www.iste.org.

EISENHOWER NETWORK

ENC is part of the National Network of Eisenhower Regional Consortia and Clearinghouse, a nationwide collaboration that provides support to mathematics and science educators across the country. In addition to ENC, the Eisenhower Network includes ten Eisenhower Regional Consortia that work toward these goals:

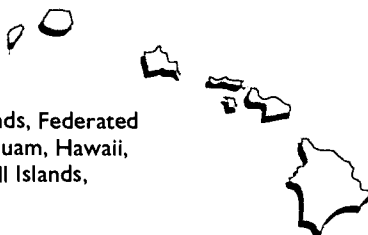
- To identify and disseminate exemplary mathematics and science instructional materials;
- To provide technical assistance to educators in implementing teaching methods and assessment tools;
- To collaborate with local, state, regional, and national organizations engaged in educational improvement.

Also part of the Eisenhower Network are 12 ENC Demonstration Sites—one in each region, one at ENC on The Ohio State University campus in Columbus, Ohio, and one at The George Washington University in Washington D.C. These sites provide visitors with the opportunity to access ENC services electronically and to pick up free publications.

In recent years, the Eisenhower Network has spread even further with the creation of ENC Access Centers. Located throughout the country, these volunteer centers are staffed to distribute ENC publications and to teach local educators about the Eisenhower Network. There are already 125 Access Centers, with more added each month.

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 Eisenhower Mathematics and Science Regional Consortium at PREL

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Honolulu, HI 96813
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Fax: (808) 441-1385
Email: askmathsci@prel.org
URL: www.prel.org

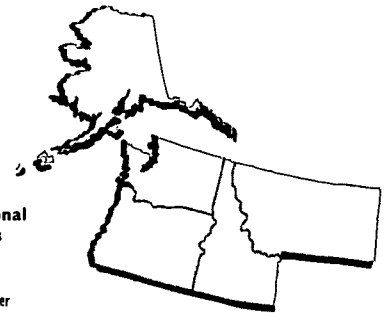
demo site

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

Northwest Region

Alaska, Idaho, Montana,
Oregon, Washington



Consortium

Northwest Eisenhower Regional Consortium for Mathematics and Science at NWREL

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demo site

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Far West Region

Arizona, California,
Nevada, Utah



Consortium

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Eisenhower National Clearinghouse for Mathematics and Science Education
Columbus, Ohio

demo site

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North Central Region

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



Consortium

North Central Eisenhower Mathematics and Science Consortium at NCREL

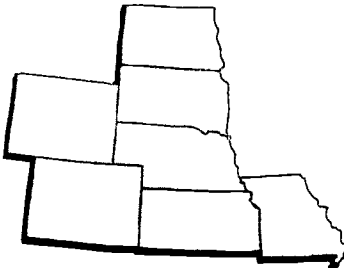
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Mid-continent Region

Colorado, Kansas, Missouri,
Nebraska, North Dakota,
South Dakota, Wyoming



Consortium

McREL Eisenhower Regional Consortium for Mathematics and Science

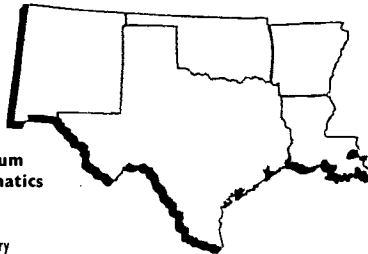
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Southwest Region

Arkansas, Louisiana, New
Mexico, Oklahoma, Texas



Consortium

Eisenhower Southwest Consortium for the Improvement of Mathematics and Science Teaching at SEDL

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ENC Capital Collection & Demonstration Site

Washington, DC

demo site

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URL: www.gwu.edu/~immcl



Northeast and Islands Region

Connecticut, Maine, Massachusetts,
New Hampshire, New York, Rhode
Island, Vermont, Puerto Rico, Virgin
Islands



Consortium

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Mid-Atlantic Region

Delaware, District of Columbia,
Maryland, New Jersey, Pennsylvania



Consortium

Mid-Atlantic Eisenhower Consortium for Mathematics and Science Education at RBS

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Appalachia Region

Kentucky, Tennessee, Virginia,
West Virginia



Consortium

Eisenhower Regional Consortium for Mathematics and Science Education at AEL

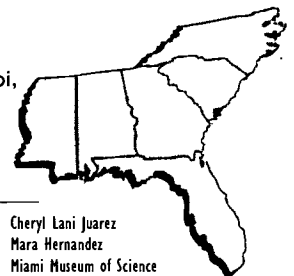
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Southeast Region

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



Consortium

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Focus on

Mathematics and Science Across the Curriculum

This section
presents articles
on the theme
of this issue.

Themes for *ENC Focus*

Each issue of *ENC Focus* presents articles on a topic of concern to classroom innovators. Previous issues have covered topics such as Teaching in the Standards-Based Classroom, Making Schools Work for Every Child, Mathematics & Science in the Real World, Assessment That Informs Practice, Integrating Technology in the Classroom, and Inquiry & Problem Solving. The online version of *ENC Focus* (enc.org/focus) provides the full text of all issues.

The best source of new ideas and helpful tips for improving science and mathematics education is the classroom teacher. We invite you to join the community of *ENC Focus* writers. Check page 5 for upcoming themes. Our guidelines for writers also appear on that page and online (enc.org/focus/write).

The Power

Students who have cross-curricular learning experiences are better prepared for standardized tests—and for life!

by Carol Damian, ENC Instructional Resources

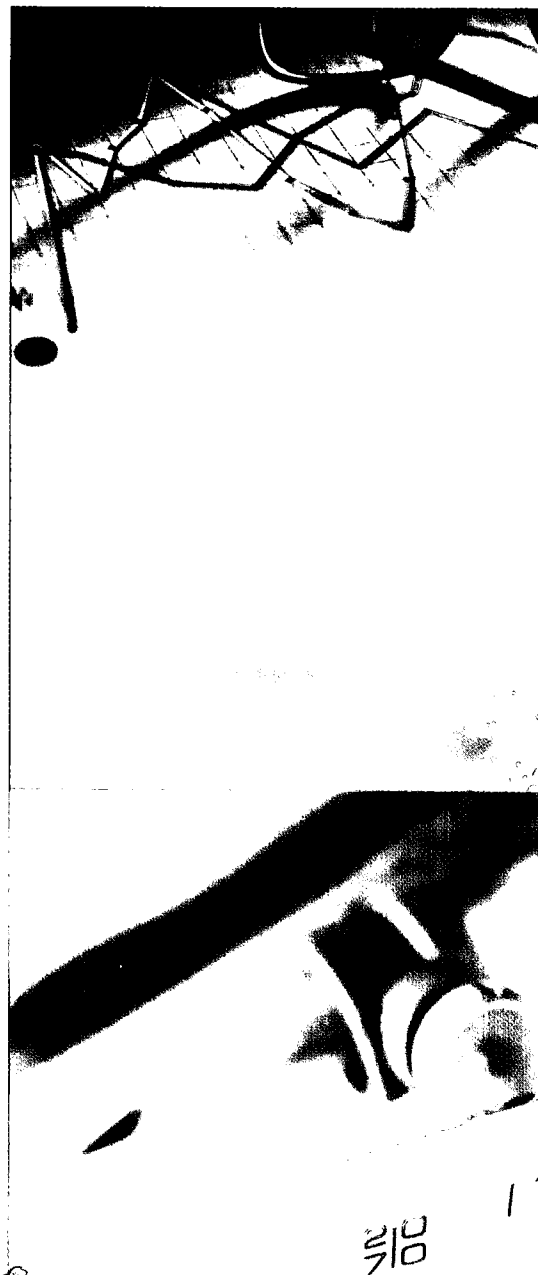
Several years ago in my school neighborhood there was a great deal of discussion about the urgent need for additional water for new homes and businesses. Supplying sufficient water required a tall, high-capacity water tank. Everybody wanted the water, but, for aesthetic reasons, no one wanted the tower built near their homes.

The tower became quite an issue. The students in my physics class were studying the principles of water pressure, volume, flow rates, supply sources, and related topics, so we took on the water tower question. We wanted to know more about factors affecting our own and our neighbors' immediate needs. We designed an investigative project together. Students volunteered or were assigned to accomplish specific tasks and then to share their findings.

We found ourselves seeking information from the city water division, city and county engineers' offices, the department of natural resources, our neighbors (including a number of businesses), financial experts, engineering consultants, historical archives, legal advisors, geologists, and others. We attended public hearings. The students went to several local sites to learn more about our water sources and the infrastructure for delivering water.

As we wrapped up the project, students presented their findings in the form of maps, charts, models, graphs, letters to city officials, financial reports, calculations, and drawings about water pressure, flow, distribution, and use. We could not make the political decision, but we all certainly learned how physics touches our daily lives.

Today, a new water tower stands in our community, and many young adults have an understanding of what it takes to assess needs and to



of Convergent Learning

design and build a tower. To gain this understanding, the students' skills and knowledge from all their academic studies were employed. Their curriculum converged to meet a "need to know."

A friend of mine who teaches biology was not satisfied with his students' understanding of the needs for survival and reproduction probability of living organisms. He was aware of his students' questions about in-the-news topics such as selective breeding, genetic engineering, and food supply-and-demand. So he and his students designed a unit to investigate the principles of survival, heredity, and reproduction. Part of the project required each student to

visit a nearby farmer to learn what is actually practiced to obtain the best crops and livestock.

My friend reports that student involvement and interest have increased, and the farmers enjoy sharing their expertise in agribusiness with the youngsters. Students learn about selective breeding, genetically altered seed crops, population studies, costs of operation, land use, marketing, labor issues, community laws, and waste disposal procedures.

At the conclusion of the project, the students wrap their findings into reports, presentations, and actual input to the community. They use every type of knowledge



and skill that they have achieved in their schooling to accomplish this project. It is truly cross-curricular—the academic subject areas converge in their work.

A math teacher I know has his students do a study of per-kilometer gas consumption of different types of cars and SUVs. They investigate mileage reported by the manufacturer, actual rates from car owners, differences in long-haul and city driving, comparisons of weights of the cars and types of engines in the various models, and related matters.

Kids love cars! Since interest is high, students quickly learn investigative processes as they collect, calculate, compare, and report data in a variety of forms. The reports and end-products from this endeavor are wide in scope. The project not only converges the curriculum but also illustrates the value of lifelong learning as students help their parents make decisions about vehicle purchases.

The above examples reveal the power of curriculum convergence in helping students learn about topics that are important and useful. The examples show how mathematics and science can work across the curriculum in ways that are natural and meaningful, rather than artificial or contrived.

Overcoming Roadblocks

Sometimes we find ourselves trying to integrate subjects by having students study a specific topic in each of their classes. For example, if the topic is the effect of disease on human population, biology classes might study the mechanism behind bubonic plague. Math classes could investigate and graph the effects of the plague on human population over the centuries. History classes could study how the population decline brought on by the plague affected the politics and economics of the times. English classes could read literary works about the human impact of the plague.

This kind of integration requires complicated planning. It seems to work best in self-contained elementary classrooms or in middle schools where teachers of different subject areas work in teams to serve the same student groups. It is very difficult in large high schools that have multiple electives and course sections.

No matter the grade level, teachers know the roadblocks of multiple-class studies. There are problems of scheduling teacher and student time and accommodating days for standardized and in-class testing. How can teachers work together to assure that grading is fair, standards are met, topics are synchronized, and relevancy is maintained? Challenges go beyond the question: “Do all the teachers have the same students?” Planners must also ask: “Do all the teachers understand the content well enough to integrate the topic into their curricula?”

All of these difficulties can be overcome, but often not easily and not in all schools. In situations where integration seems impractical, another way of encouraging

students to use all of their resources is to plan in-class projects where the different subject areas naturally converge—as in the opening examples.

Convergence Is Fundamental

If our goal in education is to produce fully literate citizens, then convergence of subject content is fundamental. The idea is not new. As early as 1916, John Dewey cautioned that isolation in all forms should be avoided, and we should strive for connectedness (Dewey 1916, 1936). Recent brain research tells us that long-term memory depends upon learning experiences that make sense and are relevant to the learner (Wolfe, 2001, p. 48). We now know that without making connections among the subjects, students struggle to understand unrelated topics and to memorize isolated facts.

Convergence is also integral to meeting the national standards in mathematics and science (see sidebar on page 15). In standards-based teaching, teachers plan learning experiences in which the students are solving real problems. As students puzzle through the problems, they make connections and look at alternatives. Student curiosity and inventiveness are nurtured: it’s acceptable to take risks. Integrating across the curriculum is not the only way to meet the standards, but it is a sound approach.

Still more voices are reinforcing the need for convergence. The Glenn Commission report, *Before It’s Too Late* (National Commission on Mathematics and Science Teaching, 2000), gives four reasons why students should become competent in math, science, and technology. These reasons can be summarized as:

1. Rapid change in the global economy: demands for skills in reasoning, researching, and problem-solving in the workplace are increasing.
2. Everyday decision-making: citizens need to understand and make reasonable decisions related to such matters as cloning, DNA evidence in legal cases, new drugs, global warming, ozone-layer destruction, and financial situations.
3. National security: the safety of our citizens and the preservation of our freedom is an ongoing national goal and responsibility.
4. Future progress: mathematics and science help us understand our world; they are the tools for improving our lives.

All these reasons relate to connecting mathematics and science with other subjects; it is clear that science, math, and technology cannot be separate entities.

These are lofty goals, but we are frequently asked a more immediate question: “What are you (teachers) doing that will assure that your students will pass the

required standardized tests?" I am finding—and testing statistics are revealing (Lustig, 1996, p. 62, and National Assessment Governing Board, 2000)—that students who participate in well-designed, cross-curricular projects are able to pass standardized tests. They are better prepared than students without that background because they have learned to think critically, apply their skills and knowledge, and use reason and logic to come to conclusions (Soos, 2001).

A Risk Worth Taking

I have found that when student interest is deeply engaged, they immerse themselves in learning. They recognize and apply the connections among science, mathematics, language, literature, history, economics, art, music, and cultural factors.

I've been pleased to see high levels of enthusiasm, learning, test results, and long-term interest when students are involved in across-the-curriculum math and science issues and topics of interest to them. It is my hope that the articles and suggested resources in this issue of *ENC Focus* will assist you and your colleagues in your development of curriculum-converging learning experiences for you and your students.

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The National Standards: Convergence Is Essential

The national mathematics and science standards encourage the kind of cross-curricular learning described in the accompanying article.

National Science Education Standards (1996):

Inquiry is central to science learning. When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills. (p. 2)

Principles and Standards for School Mathematics (2000):

Students are expected to learn serious, substantive mathematics with an emphasis on thoughtful engagement and meaningful learning (p. 213). Mathematical reasoning develops in classrooms where students are encouraged to put forth their own ideas for examination (p. 189). ... students should formulate questions and design experiments, [investigations], or surveys to collect relevant data, organize the data, and represent sets of data (p. 249). When students can see the connections across content areas, they develop a view of mathematics as an integrated whole (p. 355).

ENC is hosting an online discussion of this article!
Join other educators talking about:

- How you or your school can make mathematics and science converge with other subject areas.
- How you can maintain high-quality mathematics or science instruction when you blend these subjects with other content areas.

Visit enc.org/focus/discuss/damian

DISCUSS

Dream Houses: A Floor Plan for Mathematical Success

In this math classroom, students build mathematical skills and real-world knowledge as they create the homes of their dreams.

by Robert E. Freeman, Public Schools of Robeson County,
Lumberton, North Carolina

Using this component approach, I was able to connect math to multiple content areas, align components to my school's standard course of study, incorporate multiple learning modalities, promote higher-order thinking skills, and formulate projects that used the national teaching standards as their basis. I

Most educators would agree that students must go beyond memorizing rules and facts—they need to know how the content presented in class applies to their world.

As a sixth-grade math teacher, I have found that merging students' mathematical skills and knowledge with real-world problem solving increases their success.

Dream Houses, a problem-solving unit I developed, had a two-fold objective. First, it connected mathematical concepts to real-world applications. Second, it created a learning environment that motivated and challenged students to excel. The yearlong interdisciplinary unit, with math as its core content area, allowed students to apply the concepts that they were learning in math class to the real-world concept of home architecture; my students used math skills to design and build the homes of their dreams.

Project Components

The unit was broken down into 13 components (see page 17) that would culminate at the end of the year in a final presentation. Students were required to complete 10 of the components. Six components were required, and the students were able to choose the four other components according to their individual interests. As the students learned new math skills, they applied their knowledge to the Dream Houses components.



Sam:

When I first heard about the Dream House project, I really didn't understand how or what this had to do with math. But from the first I learned about area and square feet and how houses are not all the same. It was really neat when my parents and I were driving around town and I would estimate how many square feet were in each house. My parents were amazed.

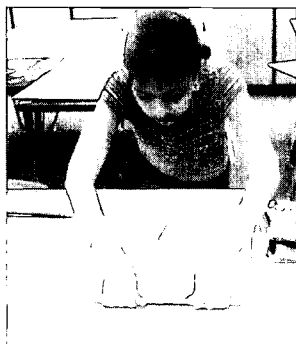
They were really shocked when I was able to talk to them about mortgages. I have decided that I need a really good job, like a doctor or lawyer, to build the house I designed. I also want a 15-year mortgage, so that I can get it paid for quicker and pay less interest. When I told my dad that, he laughed and said, "Finally you're in the real world, son."

I wanted the class to last longer. Our classes are an hour and a half long, but Mr. Freeman's class never seem to last long enough.

worked with other teachers in my school on many of the cross-curricular components. I also developed rubrics for each component. These rubrics were given to the students before the components were started so that expectations were clear.

Community Involvement

Connecting Dream Houses to the real world was essential for my students to understand the implications of their learning. Before students designed their floor plans, a builder visited the class to discuss the process of building a house and the average price per square foot of a new home. A real estate agent discussed the price of land, and how the neighborhood in which one chooses to live affects the cost of building a home.



Bonnie:

Frank Lloyd Wright was my favorite architect. He not only built office buildings but houses that fit into their environment. Can you believe that I learned this in my math class?

Since Mr. Freeman's class, my career thoughts have changed. I have always wanted to be an interior designer, and most people think that's a great job for a girl. But what I learned in math this year is that I am also good at designing things like homes. I have decided to become an architect/interior designer. Mr. Freeman made me believe in my math skills and told me to go for it. Lots of teachers tell you that you can do it, but Dream Houses showed me that I could do it.

The Dream House Project

Math Components:

- **Required:** First, the students designed their dream house. The school's art teacher introduced mechanical drawing, design format, and function. Using the concepts of length, width, and area, students created the floor plans for their home, which were limited to 2,500 square feet. The math content used in this component included the addition, subtraction, multiplication, and division of whole numbers and fractions. The students used scale and proportion principles to convert their floor plan from feet to inches (the scale for the floor plan was 1/2 inch equals 1 foot).
- **Required:** After the students had drafted their floor plans, the next component required them to record the square footage of each room using the formula $\text{length} \times \text{width} = \text{area}$.
- Next the students took the length, width, and area of each room and converted those into an order-of-operations expression. For example, if a room was $12 \times 12 = 144$, then the student would convert this area equation into an order-of-operations equation such as $(3 \times 4) \times (3 \times 4) = 144$.
- The next component asked the students to convert each room's area equation into an algebraic expression using at least one variable. So the original expression of $12 \times 12 = 144$ was converted into an algebraic expression such as $b = 2$ then $(6 \times b) \times (3 \times b \times b) = 144$.
- Then students applied an x- and y-axis to their floor plans. They recorded the ordered pairs of at least four rooms in their house. This process helped them to understand the significance of correct ordering in relation to location and placement principles.

Writing Components:

- **Required:** The students wrote descriptive papers focusing on either the interior or exterior (or both) of their homes. The students were asked to be as creative as possible in giving the reader a clear and distinct view into their new home.
- **Required:** Students researched and wrote reports on careers that they might wish to pursue as adults.

This component developed the students' understanding that to be able to afford the house they were designing, they would need a well-paying job.

- Another writing component gave the students the opportunity to compare and contrast American homes with homes in a foreign country of their choice.

Technology Components:

- **Required:** Technology was incorporated within the graphing component of the unit. Students compared the square footage of each room to the overall square footage of the house and created bar graphs and circle graphs to show the relationships. This component required students to create graphs using percentages and decimals. The students used Microsoft Excel to record and create their graphs.
- Students were encouraged to use the Internet to research homes in foreign countries, to search out house plans on the Internet, and to research careers for the writing components. Students had to cite and document at least five sources from the Internet.
- For the final presentation, students were given the option of using Microsoft PowerPoint to describe the multiple components of the project.

Economics and Design Components:

- **Required:** Making a foam board model of their homes was by far the most popular component. According to the students, this was the most interesting and fun part of the whole process. Students drafted their floor plan on a foam board base and then built their houses using 1/4-inch foam board. The original floor plan had used a scale of 1/2 inch = 1 foot, but this was too small for the model. Converting the original floor plan to a larger scale of 5/8 inch = 1 foot made the models easier to work with.
- Furnishing and creating a cost analysis for at least one room in their house were enjoyable activities for most students. They considered carpet samples, furnishings, appliances, fixtures, and decorations when collecting information for this component.



Jeff:

Our Dream House project was just like a real job in several ways. First you had to actually design your own house. I really liked taking the square footage and turning it into algebraic expressions. I was able to understand using variables a lot better after that.

My dad, who also does some building, couldn't believe what we were doing in math class. He and I started measuring our house so that I could get some ideas about designing my home. He took me to a hardware store and we talked about lumber and other cool stuff.

The students learned a lot from a banker who talked about how banks lend money and the requirements for getting a home loan. The banker explained payment terms and loan amounts. The students also completed a loan application and discussed with the loan officer how credit reports are analyzed for approval.

As Dream Houses progressed to the furnishing and cost analysis of a room, an interior designer talked to the students about decorating their home. Students were given ideas about appliances and what furnishings and colors might go best with their designs. A trip to a building supply store gave students the chance to price many of the fixtures that would go into their home.

Equally important to designing the house was the future career that would enable students to afford the home of their dreams. Community members, including a doctor, teacher, psychologist, lawyer, banker, and college professor, vis-



Jennifer:

I realize now that it takes hard work and effort to have a nice home, and that math is important in building and keeping your home. I think when I grow up I want to be a banker and use the skills I learned in Mr. Freeman's class to help people build and buy the house of their dreams.

ited the classroom to give students insights into their professions and discussed the educational requirements of their fields. The students began to understand that to have a nice home requires more than a desire to have one; it takes a good job to pay for it.

The students in my class came from a variety of backgrounds, so the dream homes they built were different. Some were duplex apartments designed to accommodate grandparents, while some were large, single-family homes. I encouraged each student to design what he or she wanted.

Presentations

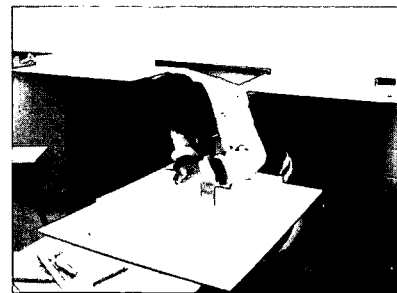
After the components of Dream Houses were completed, the students created 20-minute presentations to culminate the unit. The presentations had to incorporate each of the student's 10 components, but the format could vary.

Some students created traditional tri-fold presentations, while others chose to use Microsoft PowerPoint. Parents, school officials, and community members were invited to the students' presentations. The students demonstrated how the knowledge they had gained in math class was interconnected in the design, building, and financing of a home.

The central purpose of this unit was to give meaning and significance to mathematical knowledge and ensure long-term retention of those skills. Students realized the importance of math skills in their decisions about a future home. The class's 100 percent passing rate on the state's math proficiency test adds credibility to this interdisciplinary approach to teaching. In addition,

Dream Houses made math fun and interesting for my students. Their reflections, presented throughout this article, demonstrate their enthusiasm.

Robert E. Freeman is a Fulbright Scholar, Nationally Board Certified Teacher, and a recipient of the 2001 Milken Educator Award. He taught sixth-grade mathematics for six years at Carroll Middle School in Lumberton, North Carolina. Presently, he is employed as the Initially Licensed Teacher Coordinator for the Public Schools of Robeson County, North Carolina.



Nina:

Dream Houses is the most interesting class project that I have ever done. You are able to study math, like order of operations, algebraic expressions, and area, without doing all those math problems in the book. I really never understood area until we started measuring rooms to understand how big they were before we designed our floor plan. My friends and I didn't understand all the things involved in building a house, and we sure didn't realize all the math that was involved.

It was really neat having the banker come in and talk to us about how houses are financed. I didn't realize that most families pay for their homes over a 30-year period. It really gives you much more respect for your home when you understand all the money that it takes to pay for it.



Physics Fun

American Scientist

A second-grade class enjoys a cross-curricular unit including physical science, social studies, and art.

by Louise Stivers, Buchanan Math, Science Magnet Center, Los Angeles, California

Recently, while assessing my classroom practice, I realized that even though I did a good job of teaching my second graders life and earth science, I often neglected physical science. In part, I chalked this up to the science kits that were available in our school. Most were damaged or outdated. None paid much attention to physics.

When I brought up physics instruction in the teachers' lounge, my colleagues' remarks assured me that I was not the only one facing this dilemma. One frustrated teacher sighed, "Who has time for science?"

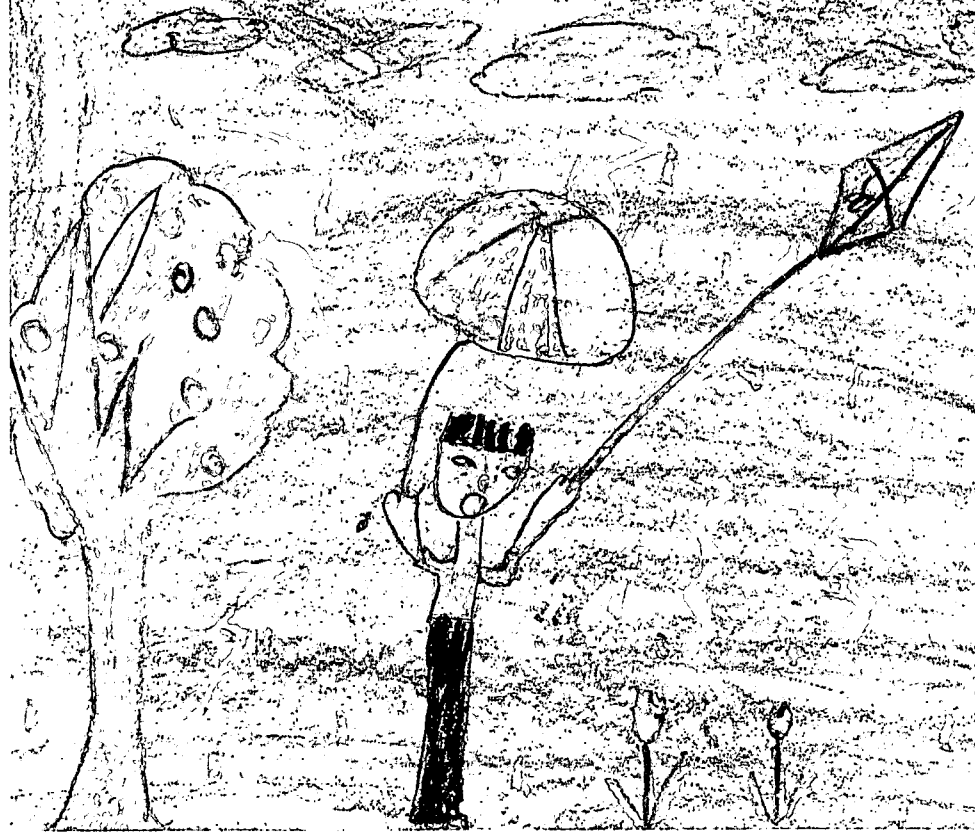
My search for answers led me to the National Science Teachers Association's web site (www.nsta.org) and, in turn, to the Toshiba Foundation, K-6 Teachers Grants. Supported by my principal, I applied for, and received, money to purchase equipment and supplies for a four-week physical science unit about simple machines and mechanical devices.

Cross-Curricular Connections

I started the unit by establishing a connection between the sciences and the humanities. I reasoned that such a bridge would link the mechanical devices we would study with the real world.

I began making this connection by introducing the class to the

Benjamin Franklin was born in 1706 and died in 1790. He was a very interesting and important person. One day he went out in the rain with his kite. He tied a key onto the kite. He got a shock from the lightning. This proved that lightning is made out of electricity.



lives of scientists exemplifying each of the last four centuries: Isaac Newton, Benjamin Franklin, Louis Pasteur, and Albert Einstein. When it became apparent that the students had only a vague understanding of the significance of the accomplishments of these scientists relative to the time in which they lived, I incorporated social studies into the unit.

Long periods of time, such as centuries, are often difficult for young children to grasp. Yet, my

second graders are expected to read and interpret a time line. By researching, writing, and illustrating short biographies of scientists for each century, the class was able to construct a time line of biographic information that allowed them to trace both the progression of time and the advancement of science.

To further help students understand what life was like in different time periods, I selected two or three paintings to illustrate life in each

What I Learned About Isaac Newton

Isaac Newton is a very famous scientist. Newton lived in England. He was born in 1642 and he died in 1727. Newton discovered gravity. These are the Laws of Motion that he wrote. When something is moving, it stays moving until some force acts on it. Conservation of energy means energy can be changed but it is never lost. For every action, there is a reaction.



century. For example, Rembrandt's *The Polish Rider* (c 1655) displays typical seventeenth-century clothing and a horse as a mode of transportation. Ernest Narjot's *Santa Monica* (1889) and Henry Chapman Ford's *Mission Santa Barbara* (1884) both depict locations that some of my students have visited. These paintings made it clear just how much the local landscape had changed in the last 100 years.

On our time line, the twenty-first century was left open. Students were encouraged to "think out of the box" and imagine their world 50 years from now. After looking at works by Jackson Pollock and Pablo Picasso, they considered the question "What will your life be like in 2050?" Their work reflected both the naïve misunderstandings and optimism of seven year olds.

Hands-On Learning

Of course, science itself remained the cornerstone of the unit. We began by thinking about everyday mechanical devices and simple machines. We learned that all simple machines have one thing in common: they make it easier to do tasks that require strength. Whether the job is to lift a heavy object or pry the lid off a can of paint, the principles of work and energy need to be understood to grasp the concept of machines. However, since my second-grade students were not experienced enough to grasp the mathematical explanation of work and energy, I started the lesson by looking for ways to demonstrate these ideas conceptually rather than mathematically.

We began by studying a common mechanical device, the pendulum. As with each item we would explore, I introduced the pendulum using a wooden model. When asked if they had seen anything like the model before, some of the students spoke about visiting a pendulum clock at a local observatory, others talked about grandfather clocks, and one boy related a playground tetherball to a pendulum. Taking our exploration to the next level, we used craft sticks, thread, and the pull-tab from a soda can or a wooden ring to create a model of a pendulum.

Next we explored the lever, a simple machine with many everyday applications. Though traditionally the seesaw was the most accessible example of this simple machine, most of my students only knew of seesaws from books and pictures, rather than experience. In fact, there has not been a

seesaw on our playground for at least 30 years!

Without a seesaw handy, I turned again to wooden models. As my students freely explored the model, I explained the principles of the machine and how the pivot point was called the fulcrum. Again, once I felt that the students were comfortable with the model, we began to construct levers of our own, first with wooden rulers and triangular prisms and, when these materials proved difficult to work with, a cardboard tube cut in half and a strip of stiff cardboard. With this repeated exposure, students really seemed to understand how a lever works.

Next stop: pulleys. Again, students were introduced to this simple machine by exploring a wooden model. As my students showed an understanding of the model, I explained that, like any other simple machine, pulleys reduce the force we must apply by extending the work of lifting or pulling over a greater distance.



Photo by Louise Silver

Now that my students had a grasp of these three common devices, we set out to make an actual machine that would do work. I devised a lesson in which we would construct a windmill or pinwheel, and then add a pulley to it so that work, in the scientific sense, would actually be done. We constructed a simple pinwheel and added a cork to which we attached a string. When students blew on the windmill, it turned the pulley (the cork), and a stick attached to a string was raised.

In considering ways to assess student learning, I planned to assign a series of mock tasks and then ask the students to select the appropriate machine to complete each job. However, as the time for assessment drew near, I was concerned that there was still a gap between exploring the materials and building models and truly understanding the processes.

To bridge that gap, we went on a "machine hunt" around our campus looking for applications of the principles we were studying. I was pleased when two students immediately identified the rope assembly on the flagpole as a pulley and another eagerly pointed out that a pull-down door handle was a good example of a lever.

The hunt a success, we headed back to the classroom. I was convinced that they had got it! That impression was confirmed later when the youngsters did very well on the formal assessment.



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National Science Teachers Association and the California Science Teachers Association.

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Louis Pasteur

Louis Pasteur was born in 1822 in Paris, France. He knew that food with germs in it could make people sick. Pasteur discovered that

Standards Met in This Unit

This unit was based on the following standards from the California State Framework for each curriculum area:

Science - Physical Science: What are machines, and what do they do? What principles govern their action?

History - Social Science: People from Many Cultures - Now and Long Ago. Through reading and listening to biographies, children can learn about the lives of those from many cultures who have made a difference.

Visual Arts Heritage - Historical and Cultural: Understand that art reflects, records, and shapes history and plays a role in every culture.

Making Connections with the Vedic Square

Mathematical principles from ancient India form the basis for cross-curricular—and multicultural—learning.

by **Thomasenia Lott Adams,**
University of Florida, Gainesville

I first became aware of the Vedic Square in the book *Multicultural Mathematics: Teaching Mathematics from a Global Perspective* (Nelson, Joseph, & Williams, 1993). I quickly became fascinated by all of the mathematical concepts (counting, addition, multiplication, number comparison) involved in creating the square and the concepts (patterns, geometry) illustrated in the square itself. (See sidebar on this page for directions for developing the Vedic Square.)

When I facilitated an exploration of the Vedic Square with preservice elementary school teachers in my mathematics methods course, they were delighted to finally have an application and extension for the traditional multiplication table. It was a “wow” moment for the entire class. Subsequently, they were able to use their new knowledge when teaching their own students.

Over time, my students and I have found applications for the Vedic Square in mathematics, art, social studies/history, and communications. As we make connections among school subjects, students find new meaning in their studies.

Connections in Mathematics

Besides the basic operations and number comparisons that are used to develop the Vedic Square, students can also search for numerical patterns on the rows, columns, and diagonals of the square and in groups of numbers in the square.

Developing the Vedic Square

To develop the Vedic Square, you need two blank multiplication tables. If you are making your own tables, be sure to use graph paper to achieve the square shape. You may choose to use the 0-9 facts or 1-9 facts for the initial experience. For this description and in my own instruction, I use the 0-9 facts. Follow the steps below to develop the Vedic Square.

1. Complete the traditional multiplication table as in Figure 1.
2. Examine each entry in the completed multiplication table.
3. If the entry has a value of 0-9, the entry remains the same and should be recorded as is in the appropriate cell in the blank table.
4. If the entry is greater than 9, that is 10 or greater, add

Figure 1
0-9 Multiplication Table

X	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9
2	0	2	4	6	8	10	12	14	16	18
3	0	3	6	9	12	15	18	21	24	27
4	0	4	8	12	16	20	24	28	32	36
5	0	5	10	15	20	25	30	35	40	45
6	0	6	12	18	24	30	36	42	48	54
7	0	7	14	21	28	35	42	49	56	63
8	0	8	16	24	32	40	48	56	64	72
9	0	9	18	27	36	45	54	63	72	81

Figure 2
0-9 Vedic Square

X	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9
2	0	2	4	6	8	1	3	5	7	9
3	0	3	6	9	3	6	9	3	6	9
4	0	4	8	3	7	2	6	1	5	9
5	0	5	1	6	2	7	3	8	4	9
6	0	6	3	9	6	3	9	6	3	9
7	0	7	5	3	1	8	6	4	2	9
8	0	8	7	6	5	4	3	2	1	9
9	0	9	9	9	9	9	9	9	9	9

the two digits of the entry. If this sum is 9 or less, place this sum in the original entry cell in the blank table. For example, $4 \times 8 = 32$ (down 4, over 8). Since 32 is greater than 9, add the two digits, 3 and 2. The sum is 5. So in the place of 32, record 5 in the blank table.

- If the sum in step 4 is still greater than 9, continue to add the digits until the sum is 9 or less and place this sum in the appropriate blank table cell. For example, $8 \times 6 = 48$ (down 8, over 6). Since 48 is greater than 9, add the two digits 4 and 8. The sum is 12. This sum is still greater than 9, so add the two digits of this sum, 1 and 2. This sum is 3. So in the place of 48, record 3 in the blank table.
- Repeat the steps as necessary until the Vedic Square is complete with 100 facts as in Figure 2.

For example, a simple pattern can be found for the rows and column of 6: 6 3 9 6 3 9 6 3 9. I encourage students to develop conjectures about why this and other patterns appear and how the numbers within the patterns are related. The search for numerical patterns creates an opportunity for extensions and long-term exploration of the Vedic Square over the school year.

Another mathematics topic that can be addressed through the Vedic Square is plane geometry and the study of shapes. "An implied premise in the use of the Vedic Square is that numbers have 'shapes,' just as objects" have shapes (Nelson, Joseph, & Williams, 1993). To find the shape of a number 0-9, find the number's entries in the Vedic Square and connect the entries with line segments. The resulting plane figure and/or angle is the shape of that number. See examples in Figures 3 and 4.

Students often prefer to record the shapes on separate paper or another blank multiplication table so that the shapes can be examined without the numerals. Questions that we've explored include:

- What are the shapes of all the numbers 0-9?
- How can the shapes be categorized? (e.g., number of sides, regular, irregular)
- How many different shapes are there for the 0-9 Vedic Square?
- Are any shapes similar or congruent?
- How can concepts such as symmetry and rotation be used to examine the shapes of numbers?
- What seems to be special about shapes whose numbers have a sum of 9?
- What would happen to the shape if another fact family were added so that the table is 0-10?
- Which shapes tessellate (i.e., form a pattern that covers the entire plane—no gaps, no overlapping)?

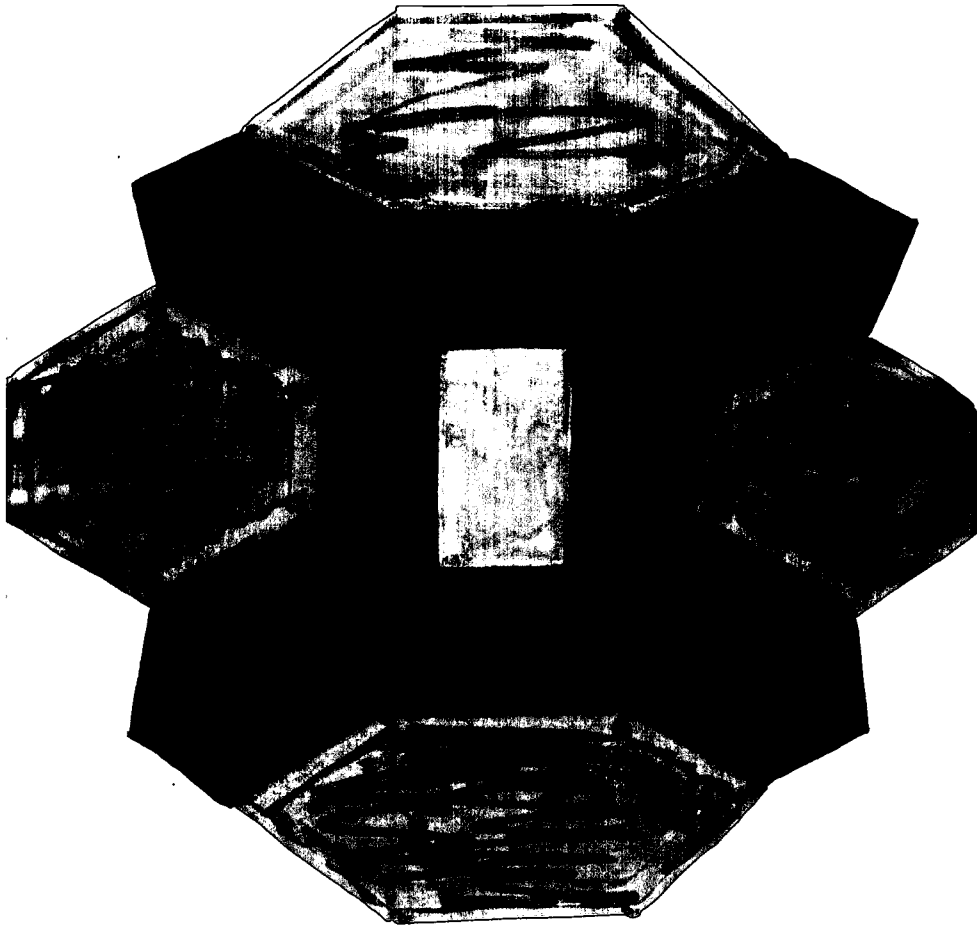
Figure 3
0-9 Vedic Square. The Shape of 2: Rectangle

X	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9
2	0	2	4	6	8	1	3	5	7	9
3	0	3	6	9	3	6	9	3	6	9
4	0	4	8	3	7	2	6	1	5	9
5	0	5	1	6	2	7	3	8	4	9
6	0	6	3	9	6	3	9	6	3	9
7	0	7	5	3	1	8	6	4	2	9
8	0	8	7	6	5	4	3	2	1	9
9	0	9	9	9	9	9	9	9	9	9

Figure 4
0-9 Vedic Square. The Shape of 4: Hexagon

X	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9
2	0	2	4	6	8	1	3	5	7	9
3	0	3	6	9	3	6	9	3	6	9
4	0	4	8	3	7	2	6	1	5	9
5	0	5	1	6	2	7	3	8	4	9
6	0	6	3	9	6	3	9	6	3	9
7	0	7	5	3	1	8	6	4	2	9
8	0	8	7	6	5	4	3	2	1	9
9	0	9	9	9	9	9	9	9	9	9

ENC graphics: Andy Ault



"Center of the Universe"

Work at this site shows an internal hexagon and smaller, outlining hexagons. The shapes of 4 and 5 in the Vedic Square are also hexagonal.

LotusArt, Gallery 3
(www.lotusart.com/gallery3_mstr.html)

The Kalimah artwork on this site shows the use of angles for the shape of 0 and 9. Also, the shape in its entirety suggests two squares (internal shape of 9) with one square rotated by 45 degrees.

I also engage students in using drawing and coloring tools to turn the shapes of numbers into intricate designs of their own. For the illustration on this page, the student used the shapes for 1 and 8 (green hexagon), 4 and 5 (black hexagon), 3 and 6 (dodecagon), and 2 and 7 (rectangle). The student's title for the drawing, "Center of the Universe," indicates her attempt to develop a design with horizontal and vertical symmetry.

This exercise reinforces the visual geometry concepts in the Vedic Square, and it provides a platform for the class to discuss mathematical concepts through art and

to discuss art concepts through mathematics. I have found that students who are particularly interested in art become motivated to explore other mathematical concepts, such as symmetry and rotation, that are related to art and design.

Connections in History and Social Studies

When I present the Vedic Square exploration, I encourage students to read more about Vedic mathematics. I guide them to web sites (www.ics.uci.edu/~rgupta/vedic.html and www.vedicmaths.org) that they can use to begin their research. Students can explore the discovery of the Veda, ancient Indian texts, and how Vedic mathematics fits into the timeline for the historical development of mathematics. This gives them insight into how different cultures have contributed to the field. Further exploration of the Veda gives a context for studying the people of India.

When I presented the Vedic Square exploration in one class, I found that one of the students was Muslim. He shared many details about his culture and religion with us

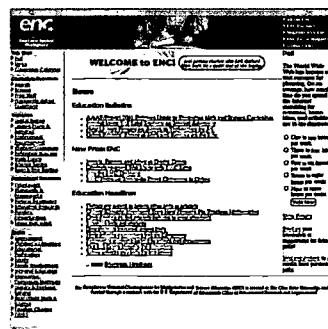
Connections in Art

Given that the Vedic Square allows one to explore the shape of numbers, it is a natural progression to then use those shapes for artistic representation. In fact, "some of the properties of the square led to the discovery of systems which formed the basis of the intricate patterns and designs which are now familiar to us as examples of Islamic Art" (Jones, 1989, p. 32).

Through Internet or library searches, students find that "In mosques and in the illuminated writing of Qur'an no decorations could depict people or animals so there developed a tradition in which geometrical and rhythmic patterns predominated...art in the Muslim religion" (Jones, 1989, p. 32).

I have found several web sites for exploring Islamic Art. Students look at the images and search for the shape of numbers in obvious, subtle, and curvature forms. Here are just two examples of what can be found on the web:

Muslim Student Association, State University of New York, Buffalo (wings.buffalo.edu/sa/muslim/img/isl/pages/decoratif2.html)



and described the artwork of buildings in Iran, his home country, that illustrated our study of the shape of numbers in art. Another Muslim student brought in his prayer rug to share the designs containing shapes of numbers. These experiences encouraged students to look for mathematics in places that they had not considered before these classmates shared their culture.

Connections in Communication (Reading, Writing, Speaking)

The National Council of Teachers of Mathematics (NCTM) suggests that “communication can support students’ learning of new mathematical concepts as they... draw, use objects, give verbal accounts and explanations, use diagrams, write and use mathematical symbols” (2000, p. 61).

To facilitate mathematics learning from this perspective, I ask my students to use mathematical terms in oral and written descriptions of the Vedic art they create. Students review each other’s artwork and written descriptions and discuss how shapes of numbers are used for artistic expression.

In addition, I encourage students to find and discuss the shapes of numbers in their own environment. This perspective of numbers usually is different from finding the shapes of numbers in the Vedic Square, but the experience gives students an opportunity to develop a sense of mathematics as a part of their own lives.

Here are a few shapes of numbers that my students have suggested:

- Shape of 0: peephole, hoola-hoop, bracelet, sun
- Shape of 1: light pole, lightning rod, pencil
- Shape of 4: doorway, picture frame, window, computer monitor
- Shape of 5: outstretched hand
- Shape of 12: telephone button pad, dozen eggs



Thomasenia Lott Adams is an associate professor of mathematics education at the University of Florida. She teaches methods courses to undergraduate and graduate preservice elementary school teachers.

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ENC Online is designed to make the resources of the Eisenhower National Clearinghouse available to educators everywhere all the time. Here is a quick introduction to the site. We urge you to “jump online” and discover for yourself how helpful enc.org can be to you.

Curriculum Resources. In this area of the site, you can use two search formats to locate all types of teaching materials in ENC’s collection of more than 20,000 items. The searches allow you to choose particular subject words, grade level, cost, and type of material to find exactly what you need for your classroom.

Web Links. Check this category for ENC’s popular Digital Dozen feature, a monthly selection of exemplary math and science web sites. Web Links connect you to hundreds of sites with math and science lesson plans. A search feature helps you find Internet resources quickly and efficiently.

Professional Development. This portion of the site is designed as a teachers’ professional support system. *By Your Own Design: A Teacher’s Professional Learning Guide*, a joint project of ENC and the National Staff Development Council, is available here. This section also provides links to the national mathematics and science education standards, and state frameworks are listed conveniently by state. Federally funded resources and professional development strategies are also available in this section.

Topics. Hundreds of articles, teacher interviews, and selected curriculum resources are arranged thematically in this area. Topics include inquiry and problem solving, implementing technology, equity and diversity, and assessment. All of these topics provide content developed for *ENC Focus*, as well as useful web site and journal articles.

Register. By registering with ENC, you can participate in our newest feature: online discussions! You can also request free print products and sign up for email services such as the monthly Digital Dozen selection or periodic updates about ENC products and online offerings. To learn more, visit the registration area (enc.org/register).

ENC Online also has a quick way to get to the full text of each issue of *ENC Focus*—visit the ENC Focus Magazine area of the web site (enc.org/focus). In this area, you can also sign up for a free subscription to all future issues of the print magazine.

ENC Has Across-the-Curriculum Ideas for You!

Want to find music in mathematics?
How about physical education in physics?
Come to ENC's Classroom Calendar for
these and hundreds of other ideas and
resources.

by Scott Bartley and Gordon Baugh,
ENC Instructional Resources

If you're one of the many teachers interested in doing more to integrate web technology into your classroom, but don't have time to sort through the number of sites most search engines kick up, ENC's online feature Classroom Calendar (enc.org/thisweek/calendar) is a great resource. Classroom Calendar's user-friendly format allows you to search month-by-month and quickly peruse numerous date-appropriate topics that include biographies (Newton, Fermi), inventions (fireworks, bicycles), mathematics (Pi Day, math puzzles), and science (rainforests, Hurricane Hugo).

Classroom Calendar entries also can be accessed by category, because we know you might have reason to explore the physics of Frisbees on some day other than January 13—the day the disc was first produced by the Wham-O company (see page 28).

Once you select a topic, the real fun begins. Each Classroom Calendar entry includes an introduction that explains the relevance of the topic. Each introduction is written with a specific age group in mind, although most topics can be adapted for any classroom. You may even want to begin some activities by having your students read the introduction for themselves.

Most entries also include a Connections section that will help you create your own cross-curricular lessons. For example, an investigation of giant pandas (September 9) can lead to an organized debate about the pros and cons of working to save endangered species, letter writing campaigns, and geographic studies of the panda's habitat. You may be inspired to work with a fellow teacher to carry out some of these plans.

Classroom Calendar entries also include an extensive list of web resources. These web sites have been carefully researched and selected so that you can be confident in using them with students or when researching to increase

your own content knowledge. Finally, each Classroom Calendar entry ends with links to related resources in the ENC collection. These resources lists are so long that we cannot include them with the Classroom Calendar samples printed here. Visit ENC Online for the full versions!

Golden Mean Day

by Scott Bartley

There's Pi Day (March 14) and Mole Day (October 23), so it seems only right that the Golden Mean should have its own day. The Golden Mean, or Golden Ratio, is 1.6180339 rounded off to eight digits, or approximately 1.618. That makes August 13—the day that is 61.8 percent of way through the year—a fitting day to proclaim Golden Mean Day. (Of course, if you prefer to celebrate during the traditional school year, you could have students figure out what 61.8 percent of your school year would be, or 61.8 percent of a specific month.)

The Golden Mean represents an aesthetically pleasing proportion of height to width: 1 to 1.618 . . . Like pi, it's an irrational number. It's often represented by the Greek letter phi.

There's no clear evidence pointing to who gave it its 24-karat name. Some people think it was Johannes Kepler in the 1600s, and others think it was the ancient Greeks hundreds of years earlier. Certainly, the ancient Greeks recognized the existence of the Golden Mean and used the ratio in the design of one of the world's most beautiful structures—the Parthenon. The Golden Mean can also be found in paintings by artists as dissimilar as Leonardo da Vinci and Piet Mondrian.

The Golden Mean can be heard as well as seen! From Mozart and Bach to Faith Hill and Britney Spears, at 61.8 percent of the way through a piece, something special almost always happens. These "special somethings" can be a sudden or brief change in key, a guitar or drum solo, the introduction of bridge music (a musical transition between themes), the final recapitulation (restatement) of a theme, or even silence. And to segue from music to musical instruments, violins often contain examples of the Golden Mean: on many violins the length of the fingerboard compared with the length of the total instrument is equal to about 1:1.618.

The Golden Mean also occurs in nature. A nautilus shell with its sequentially larger chambers is one of the most striking examples. In the human body, the ratio of the “lub” to the “dub” of a heartbeat is equal to the Golden Mean—the dub is about 1.618 times longer than the lub.

Connections

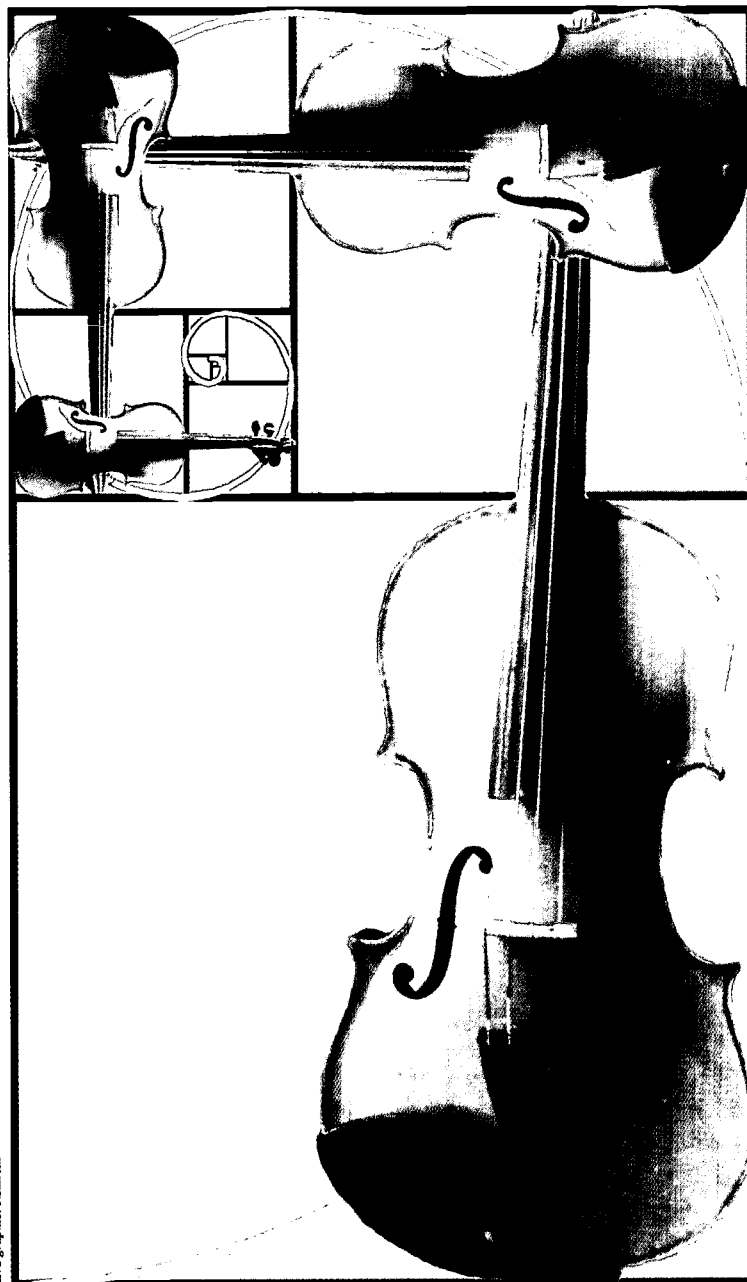
You might introduce the Golden Mean by drawing a large rectangle whose sides are 55 by 89 centimeters (about 1:1.618). Divide the rectangle into a 55-cm square and a rectangle. Ask the class to observe the similarity between the larger rectangle and the smaller one. Have the students predict what would occur if you divided the smaller rectangle into a square and a rectangle. Then have a student do it. The hope is that students will recognize that the proportions remain similar.

Connecting the Golden Mean to the Fibonacci series is a natural extension since the Golden Mean and Fibonacci numbers (1, 1, 2, 3, 5, 8, 13, 21, 34, . . .) are inextricably related. Have students calculate the ratios of neighboring numbers: $1/1$, $2/1$, $3/2$, $5/3$, $8/5$, $13/8$, $21/13$, $34/21$, These ratios steadily approach the Golden Mean as a limit.

In addition, you can extend the Golden Mean across the curriculum by studying Greek architecture or the works of artists such as da Vinci or composers such as Bela Bartok.

For an extension from music, have students test the hypothesis that something often “happens” in a musical composition about 61.8 percent through it. Ask students to choose a favorite song, multiply the number of seconds the song takes to play by 61.8 percent, and then listen to find out if any changes occur in the song around that time.

Another suggestion: Have students measure their full height and then measure their height



Visit Golden Mean Day online (enc.org/thisweek/calendar) for an extensive list of related web resources and materials selected from the ENC Collection.

just to their navels. Ask them to divide their total heights by their “navel” heights. The result should be a number close to the Golden Mean.

Finally, every new holiday needs some good PR work. Have students create Golden Mean Day posters and cards—or even songs and poems—to spread the word. And you might want to top off the celebration with a PC (proportionally correct) Golden Mean cake!

Frisbee as Science and More

by Gordon Baugh

January 13, 1957, marks the day that the Frisbee—the flying disc loved by dogs as well as people—was first produced by the Wham-O Company (now a division of



ENC graphic: Andy Ault

Mattel). At that time, the disc was called the Pluto Platter, and it had already been around for almost a decade.

The first plastic version of this flying disc was created in 1948 by two veterans of World War II—Walter Frederick Morrison and Warren Franscioni. They went into business together in southern California to produce the Flyin' Saucer. In a few years, Franscioni moved away, and Morrison reconfigured the disc, giving it the name Pluto Platter. He marketed his creation by demonstrating its capabilities on the beaches of California and, according to some accounts, in a parking lot in Los Angeles. It was there that the owners of Wham-O saw the whirling disc and became interested in buying it.

Although the plastic flying disc was a new invention, for years college students in the East had been sailing other flying discs—pie plates, the lids of cookie tins, and even paper plates—in impromptu games of catch. In particular, students were known to toss tins made by the Frisbie Pie Company, and to call out “Frisbie!” as a warning, like “fore!” in golf. On a trip to some college campuses in the East, one of the owners of the Wham-O Company heard students toss the term “Frisbie” and liked it. In 1958, Wham-O renamed

the disc Frisbee, taking the name, but not the spelling, from the students who went “Frisbie-ing.”

Over the years, Frisbees have become more and more popular and have been integrated into both physical education and physics courses. In physical education courses, students play Frisbee to exercise, and in physics courses, students learn why Frisbees can fly.

Connections

The Frisbee is a great teaching tool! It has a wide variety of curricular applications. Plus it is familiar to most students and is relatively inexpensive. Can you really combine physics and physical education? Why not? Use physics to explain what students do in physical education.

Take students to the gym or outdoors and have them toss balls and Frisbees. Encourage them to compare and contrast how each object moves using terms such as lift, Bernoulli's principle, and aerodynamics. Also, since students often have trouble identifying forces acting on an object, this is a perfect opportunity to practice drawing free-body diagrams. It is also an excellent time to clarify misconceptions about gravity and Newton's laws of motion.

Take this concept one step further. Have students consider what it would be like to repeat the activity on the moon. Ask students to diagram what the resultant pathway of motion would look like. This gives students the opportunity to recognize that without an appreciable atmosphere to supply aerodynamic lift, the Frisbee, in essence, is just another ball!

For a more quantitative activity, have students construct their own Frisbees and experiment with variables that affect flight. Students could work in groups, with each group focusing on a particular factor—mass, shape, amount of spin, angle of attack, and velocity. In this way, students can explore what happens to the range of the Frisbee by changing one variable at a time. Ask students to graph their data (range versus mass, for example). To conclude the activity, have students present their findings to the class.

To connect with technology, ask students to research how Frisbees progressed from idea to product. Or give Frisbees a communications spin by having students create a TV commercial or magazine advertisement that ties together what they have learned.

Happy Frisbee-ing!

Scott Bartley and Gordon Baugh serve the ENC Instructional Resources team as graduate students in mathematics and science education at The Ohio State University.



Visit Frisbee as Science and More online (enc.org/thisweek/calendar) for an extensive list of related web resources and materials selected from the ENC Collection.

Beyond Numbers: Communicating in Math Class

Communication skills enrich students' understanding of mathematical concepts both in the classroom and for the world beyond.

by David K. Pugalee, University of North Carolina at Charlotte

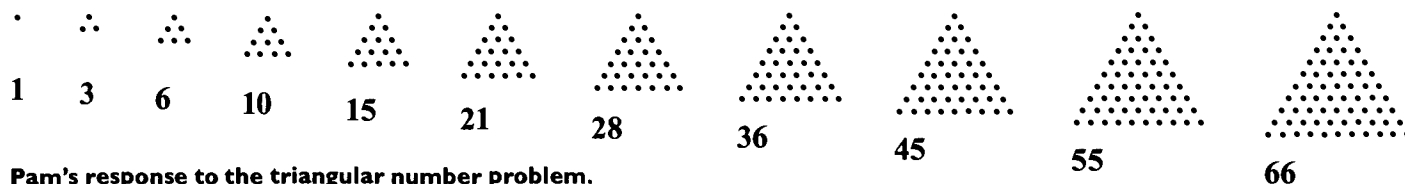
In an article titled "Never Say Anything a Kid Can Say!" teacher Steven C. Reinhart concluded that if his "students were to ever really learn mathematics, they would have to do the explaining, and *l*, the listening" (Reinhart, 2000, emphasis in original).

His words highlight how students' use of communication skills in the classroom can enrich their mathematical

while, at the same time, they are refining their own reasoning and applying their developing sense of "good" mathematical communication.

Think-pair-share is another strategy. After giving students time to consider a problem, have them form pairs and share their thinking. This strategy could be extended to small groups. Formal presentations can also become an outgrowth of a focus on communication. Students might also collaborate in producing a research paper, a poster, or an oral report. In *Writing Math Research Papers*, Robert Gerver (1997) offers a plan for developing reports and presentations.

Regardless of the communication methods used, it is important for students to have opportunities to share their work. Summarizing and reporting help students refine and reformulate their mathematical ideas, and thus



Pam's response to the triangular number problem.

I am not completely sure, but I think if you add on by going from 5 to 10, you will get the correct answer. For instance, $10 + 5 = 15$ and $15 + 6 = 21$, etc. I would think this would be correct by looking at the problem

alone. Your final result of the triangle would be the number 66. At first I thought you would multiply by 2, but that doesn't work out because $6 \times 2 = 12$. In the example of the triangle it is 6 then 10. So I changed my mind!

understanding. It is this understanding that the NCTM's standards call "essential to enable students to solve the new kinds of problems they will inevitably face in the future" (NCTM, 2000).

Modes of Communication

The teacher quoted in the opening paragraph gives us three golden rules: Never say anything a kid can say, ask good questions, and use more process questions than product questions.

This kind of classroom discourse can be promoted through four modes of communication: spoken language (speaking and listening), written language (reading and writing), graphic representation (diagrams, pictures, and graphs), and the active mode (performing, demonstrating, and physical involvement) (Griffiths & Cline, 1994).

How can we involve students in all of these modes, especially discussing and writing about mathematics in the classroom? Students could be asked to collaborate in writing a single response to a group effort. Group discussion can focus students on key mathematical ideas

improve their ability to communicate mathematically.

Consider how three students in a high school developmental algebra class described how they would find a solution to $18x^3 + 48x^2 = -32x$. Nine steps can be identified in the students' process.

First, we would transfer the $-32x$ to the other side which would make it a positive $32x$. Next, we could set it equal to zero. Now, we can look for what they have in common. Factoring out a $(2x)$. It ends up being $2x(3x+4)^2=0$. Can we break it down anymore? We set each part of the problem equal to 0 because one of them has to be equal to 0 because multiplying anything by zero gives 0. Finally, each factor set equal to zero gives $x = 0$ and $x = -4/3$.

This level of response is significant for several reasons. First, the writing demonstrates procedural proficiency in manipulating terms in an equation and illustrates the students' ability to factor a polynomial. Second, the students engaged in discussions and agreed on this process. Third, the writing shows the power of discourse when students are given opportunities to engage in meaningful classroom interaction (Pugalee, in press).

Students' reflective statements such as "Can we break it down anymore?" demonstrate the power of oral and written communication in supporting metacognitive behaviors. These students also demonstrate conceptual understanding of the zero product property in their explanation of why they set the factors equal to zero. This communication experience gave students an opportunity to solidify their understanding of a procedure and provide reasoning that underscored their conceptual understanding of the process.

Get It in Writing

Once students have practice discussing mathematics and writing as a group, they may be more comfortable writing independently. Writing supports mathematical reasoning and problem solving and helps students internalize the characteristics of effective communication. For example, Kathy, a sixth-grade student, worked a problem that asked how many people could be seated at eight tables placed end to end if a single table could seat four people. To solve the problem, Kathy wrote:

I would place eight tables together and figure out how many places could be placed at each table... You can put 18 places at the tables. The reason for this is, when you put the tables together you can only put two places on either side. You cannot put more places because the tables are joined. On each end table you can put three places instead of just two. So that gives us six tables in the middle part with two people and two tables on the ends with 3 people. That is 18 places at the tables.

Kathy's work shows how writing provides a mechanism for reflection. Writing also reveals the processes the student used to solve the problem. As another student pointed out, "Writing in math seems awkward and slows you down, but it makes you think about what you're doing."

Middle schooler Pamela's work on the triangular number problem (see page 29) reveals the power of writing in her reasoning about patterns. Given the first four numbers, Pamela was asked to find the tenth triangular number. At first, she thinks multiplying by two will continue the pattern, but then she discovers that multiplication doesn't work. She is engaging in verification of her thinking, which leads her to consider alternative approaches. Although Pamela doesn't fully describe the pattern in her writing, she does show her understanding that the triangular numbers increase by adding a row that is one greater than in the previous number.

Peer Evaluation

As students learn to communicate their thinking to others, they should also learn to analyze and evaluate the reasoning and strategies of others (NCTM, 2000).

Rubrics are one means of giving students criteria for evaluating their own communication as well as that of others.

The NAEP (National Assessment of Educational Progress) uses rubrics to evaluate constructed response or open-ended questions where students are required to describe their mathematical thinking. The NAEP scale goes from 0 for responses that are completely incorrect or irrelevant to 4 for responses that indicate a conceptual and procedural understanding of the problem. More information is available on the web site (nces.ed.gov/nationsreportcard/math).

Students will need help in learning to use rubrics for peer evaluation. Teachers should discuss criteria presented in the rubrics, provide examples of responses across the rating scale, and provide many opportunities for students to use the criteria in self and peer assessment.

Peer assessment is an opportunity for students to develop a sense of what constitutes effective communication. For example, students in an eighth-grade class were asked to describe for others their process for finding the dimensions of a pool with a perimeter of 18 meters and covering an area of 18 square meters. Then they rated each others' work on a scale of 0 to 3.

Jonathan wrote:

First of all, the pool has to be a rectangle because 18 cannot be divided by four. Therefore, one side must be longer than the other. In order to get the area of the pool, you must multiply the length by the width. You have to multiply two numbers to get 18. There is a choice of 6×3 , 18×1 , or 9×2 . Any of these would work. They would work because when multiplied, they all equal 18.

At the top of his paper, Jonathan drew a rectangle labeled with the dimensions 6m and 3m. $P=18m$ was written beside the diagram. Beside the drawing, he wrote the equation $6m \times 3m$ is equal to $18m^2$.

Jonathan's response shows remarkable logic in arguing that the pool must be rectangular. He contends that the perimeter of a square is divisible by four. His writing also details how he approached finding possible number combinations for the area.

In evaluating Jonathan's work, one of his peers gave him 2 on the 0 to 3 scale. This student justified his rating by pointing out that Jonathan "forgot to include how he got the perimeter." (This work gave the teacher an opportunity to discuss the role of diagrams in effective communication. That is, diagrams should be integrated into explanations.)

On the same problem, another student received a rating of 2 because the paper, in the words of his peer, "needed more detail. Make it clearer how you found your answer. Why don't any other numbers work?"

Another student provided this rationale for rating a paper 3:

continued on page 32

Writing to Learn Mathematics

Youngsters' thought processes and misconceptions are revealed when students learn to write about mathematics.

by Joan Countryman, Lincoln School,
Providence, Rhode Island

“Does your answer make sense?” I asked an algebra student who had come to me for extra help with his homework. The question seemed to startle him. We looked at each other, the tenth grader and the first-year math teacher, and his eyes told me that it had not occurred to him that any of it should make sense.

That moment was to shape my career as a teacher of mathematics. It challenged me to find ways to help students see the meaning in the math that they were learning. Writing about the homework, explaining the graphs and functions, making up word problems, and producing biographies of important mathematicians proved to be powerful tools. I began to collect examples of student work: journals, essays, word problems, letters.

Over the years, as the collection grew and I shared choice pieces with colleagues, I searched for a way to encourage a wider circle of math teachers to try writing in their classrooms. *Writing to Learn Mathematics* was published in 1992, and now, ten years later, continues to receive considerably more attention than I expected it would. Teachers, both preservice and experienced practitioners, tell me that they especially appreciate the samples of student writing and the insights gained about what students understand, or do not understand, about math. The following excerpt from page 18 of the book presents one of my favorite examples of a seventh grader writing about his struggle with his own mathematical sensemaking:

POSITIVES AND NEGATIVES

In class we have been using + and -. They are very hard to understand (especially subtraction of + and -). When you are adding the same signs together $+6 + +8 = +14$ it is easy, you just do normal adding, keeping the signs the same. If, however, the signs are different, $-4 + +6 = +2$, you just subtract and the higher number's sign dominates. I'm very clear on adding. On subtracting I'm not so good although I am clear on how to do it. When you are subtracting two of the same signs $+10 - +6 = +4$, all you do is subtract. When the signs are different $-6 - +2 = -8$ it is just adding and the higher number's sign dominates. But a hard one to solve is when the signs are different and the first digit is less than the second ($+4 - -7 = +11$). The first digit's sign will be the sign in the answer then you just add. When the digits are the same signs but the number in front



is smaller ($-3 - -7 = +4$) you just subtract but you take the sign that is opposite from the problem's signs—for example if the problem's signs are - the answer sign will be +. I don't understand why but I know how to do it.

—Gary

You can almost hear Gary thinking as you read his description of what he has noticed about operations on integers. Since he indicated that addition was clear, I wrote him a note suggesting that he try changing a subtraction problem to an addition problem and using his rules for addition, for example $+4 - -7 = +4 + +7 = +11$. Of course, he will still need to think about why my rules works, but referring back to the colored tiles might help him see a connection between addition and subtraction. For [Gary and his classmates] the combination of writing and working with manipulatives contributed to their understanding operations on integers, a concept that for many students never makes any sense.

Joan Countryman is head of the Lincoln School in Providence, Rhode Island, and serves on ENC's Mathematics Advisory Board.

Editor's Note: For a complete description of *Writing to Learn Mathematics* as well as ordering information, see the Focus on the Collection section of this magazine (p. 84).

continued from page 30

Covered all criteria. You told why your answer worked and why you didn't choose any other sets of numbers. You indicated that you tried all possible factors.

These comments, recorded during a classroom session in which students were rating each others' work, show how skilled students can become in recognizing qualities of effective communication.

Mathematics in the Real World

NCTM (2000) posits that an increasing emphasis on the ability to convey mathematical ideas in both written and oral form is necessary to prepare our students for both higher education and the workplace, where teamwork, collaboration, and communication are demanded. In a communication-rich environment, students become "good critics and good self-critics" (NCTM, 2000).

Communication, then, isn't a by-product of being mathematically literate—it is a means to that end. Communication plays a critical and active role in developing the kind of thinking and reasoning skills that are necessary for individuals to use mathematics successfully in the real world.

David K. Pugalee is a member of the faculty in the Department of Middle, Secondary, and K-12 Education at the University of North Carolina, Charlotte. His writings on communication skills in the mathematics classroom and on mathematics literacy have appeared in other journals.

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Island Hopping

A week spent in the wilderness gives teachers a chance to reflect on their work and develop new units for their classrooms.

by Mary Hindelang, Michigan Technological University, Houghton, Michigan

Now in its fourth year, the Educators' Science and Mathematics Institute Series (ESMIS) at Michigan Technological University provides standards-based graduate level professional development courses for elementary, middle, and high school teachers. We hope participants will be inspired to create units for their classrooms based on the learning they gain for themselves. If teachers have an unforgettable experience, it is likely that they will communicate that learning to their students.

Many of the ESMIS courses take teachers out into the wilderness. One of the most successful courses is called The Ecology of Isle Royale. Preserved as a wilderness area, Isle Royale is the largest island in Lake Superior. It is home to a diversity of wildlife, including moose and gray wolves. Teachers camp in Isle Royale National Park, cooking their own meals, hiking, gathering data, and discussing their experiences with their fellow teachers and ESMIS faculty.

This institute is designed to explore basic ecological concepts regarding the interrelatedness of the plants, animals, geology, climate, and human influences on Isle Royale. The teachers observe and participate in research projects that are being conducted on the island. In addition, they read historical journals and nature writing based in Isle Royale and keep their own nature and scientific journals. All of the content of the institute is aligned with the Michigan Curriculum Framework Standards and Benchmarks (Michigan Department of Education, 2000).

The participants are selected for the institute based on their responses to questions about their current teaching philosophy and their plan for using the knowledge gained in their classrooms. The institute is funded by the Eisenhower Higher Education Grant Program and the National Science Foundation. Competitive fellowships are given to teachers from all grade levels and all disciplines. The



Photos by Mary Hindelang

Across the Curriculum

teachers are required to design a teaching unit for their classrooms that demonstrates scientific concepts and interdisciplinary ideas for their students.

See articles on pages 34 and 36 for two teachers' responses to their experiences and examples of units they created based on their ESMIS courses.

Over time we have made changes in our program to meet the needs of the participants. For example, participants suggested using a greater number of K-12 teachers as session leaders. As a result, we now offer sessions taught by teachers with expertise in particular areas, such as astronomy, physical science, and life science. We also have sessions throughout the institute in which each participant presents his or her best teaching idea to the other participants. This is a wonderful opportunity for teachers to showcase an idea they are proud of, and each participant goes away with 20 new ideas that have been tried out by another teacher.

We are also continually evaluating the efficacy of our ESMIS courses on participants' practice and on their students' improvement in science literacy. Our evaluation results indicate a positive impact on students whose teachers attended ESMIS and used their experience as the basis for teaching science, math, social sciences, and language arts concepts. The students showed significant improvement in tests related to the content taught and improved attitudes toward math and science in particular, and school in general. Teachers have reported increased confidence in their content knowledge and ability to engage and motivate students by effectively transferring the information and skills learned in the institutes.



Being a language arts teacher, I have learned a tremendous amount on this trip, which will help me inspire my students and increase my confidence in teaching the science curriculum in my classroom. I have a strong interest in science and feel further knowledge about the sciences helps me extend my students' reading and provide a purpose for reading.—ESMIS participant



I learned and experienced so many things—walks with the researchers were rewarding when sharing plant and animal identification. Each walk with another participant was a sharing of ideas, knowledge, and classroom experience—all valuable when making decisions about what to do and how to do it in my classroom.—ESMIS participant

Mary Hindelang is the project coordinator of the Educators' Science and Mathematics Institute Series and is a research assistant professor in the Department of Education at Michigan Technological University. She did her doctoral research in the Moose/Wolf Ecological Study in Isle Royale National Park.

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esmis/index.htm](http://www.ed.mtu.edu/esmis/index.htm)

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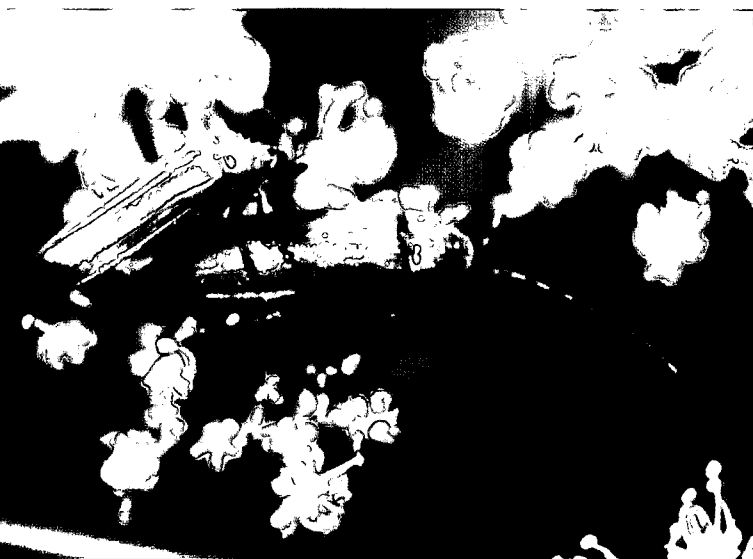
More teacher stories and lesson ideas from the Educators' Science and Mathematics Institute Series at Michigan Technological University were previously published in *ENC Focus* (volume 8, number 3) on the topic *Becoming Literate in Mathematics and Science*. Complete content of all issues of this magazine is available free online (enc.org/focus).

Experiencing Math Through Nature

High school students learn how mathematics helps us understand the natural world.

by Colleen Niemi, Jeffers High School,
Painesdale, Michigan

To help create a more positive attitude toward studying mathematics among high school juniors and seniors and to address their questions about its relevance, I developed lessons connecting mathematics and nature. The ideas came from a course in the Educators' Science and Mathematics Institute Series (ESMIS) at Michigan Technological University (see related article on page 32). The lesson described here is based on the



Photograph courtesy: Quoditch Moor Nature Reserve

capture/recapture technique, which naturalists use in estimating the number of a certain species in a given geographic area.

The lesson is successful with students because they are actively engaged in the collection of data outdoors rather than using textbook-generated samples of data. Students also develop their cooperative learning skills as they collect, analyze, and present their data.

The mathematical topics covered include ratios and proportions, percents, measurement, calculation of perimeter, circumference, area and volume, and random sampling. Throughout the activity, the students refine and demonstrate their knowledge of these mathematical concepts, as well as acquire new information and skills.

Capturing Candy

In Michigan, this activity must be implemented early in the fall because it is dependent on the presence of soldier beetles and goldenrod plants. Because using the capture/recapture method with the beetles is quite challenging, we begin with a brief activity in which individually wrapped caramel candies are used to represent the beetles.

Before class, I outline an area in an overgrown field and scatter caramels throughout the area. The goal for the students is to estimate the total number of caramels I distributed even though they cannot find all of the candies.

To begin, half of the students are designated naturalists. They have two minutes to search for and "capture" caramels. When they run out of time, they record the total number of captured caramels, mark each caramel with an X, and redistribute the marked caramels in the designated area.

The remaining students then become naturalists for two minutes. This time, some of the caramels they find will be marked and some will be unmarked. The students

Figure 1. Data Collection Sheet for Capturing/Recapturing Beetles

This same form is used for recording small group data and for recording combined data for the entire class.

Day 1: _____ (Date)

marked _____ (a)

Day 2: _____ (Date)

of (a) found _____

of unmarked _____ (b)

Day 3: _____ (Date)

of (a) found _____

of (b) found _____

of unmarked _____ (c)

Day 4: _____ (Date)

of (a) found _____

of (b) found _____

of (c) found _____

of unmarked _____

record the number of each. When that task is complete, the students search for the remaining caramels, knowing that all the candy will be eaten as we discuss our data.

For a large class, this activity could be expanded to several trials. Another option would be to have several different search sites.

Once we are back in the classroom, the students estimate the total number of caramels originally distributed using the following ratio:



ENC photograph: Andy Ault

$$\frac{\text{Number of marked caramels collected in 2nd search}}{\text{Total number collected in 2nd search}} = \frac{\text{Number marked in 1st search}}{\text{Total number initially distributed}}$$

Inputting the numbers from their searches and solving the proportion gives an estimate of the total number of caramels. This number is then compared to the actual value that I first distributed. The discrepancy between the two numbers gives students some idea of the difficulties faced by naturalists when they are searching for animals rather than candy. It also prepares them for the next activity.

Capturing Beetles

In their first experience with real collection of data from nature, students use the capture/recapture activity to determine the size of the population of soldier beetles on the property surrounding the school. The insect to be collected will depend on the species found near your school. I selected soldier beetles because goldenrod is abundant on the school property, and the beetles are attracted to the pollen of the goldenrod.

Before our actual data collection, the students determine the area of the school property (in square meters), and select several different sites to search. Each site must have

the same area, measured in square meters. Students are assigned to groups and each group is responsible for a site. Data are collected for four days before making a prediction.

While marking caramels is easy, marking soldier beetles is a little trickier. We have tried using different colors of fingernail polish. Each group of students goes out on day one with a bottle of red fingernail polish. When they find a soldier beetle, they mark its back with a tiny dot of fingernail polish. It is important not to get any polish on the wings, which would harm the beetles. The total number of beetles marked on day one is recorded.

For the next two days, the students go to their designated sites with different colors of fingernail polish. They record the number of marked and unmarked beetles they find and mark the unmarked ones with the color of the day.

On the fourth day, students go out again to gather data, but do not mark any beetles. They calculate the predicted population size each day using the same formula they used with the caramels, and make observations about how the size changes, if in fact it does. See Figures 1 and 2 for examples of the individual data sheet/class data sheet and prediction calculation sheet we used.

The activity concludes with discussion about the use of this type of sampling and population determination. This activity is even more meaningful if you can arrange to have a naturalist or a representative of the Department of Natural Resources visit the class to discuss how scientists use the capture/recapture method.

My students benefited from the cross-curriculum approach of this lesson and enjoyed learning about a method used in forestry and wildlife management and how it relates to mathematics.

Colleen Niemi is currently teaching mathematics at Jeffers High School in Painesdale, Michigan. This lesson was developed when she was teaching at Johannesburg-Lewiston High School in Johannesburg, Michigan.

Resource

Michigan Department of Education. (1998). *Michigan Curriculum Framework*.

The mathematical content of this unit addresses topics covered in the Data Analysis and Statistics Strand of the Michigan Curriculum Framework Project Mathematics Standards.

Acknowledgments

The author would like to thank Richard Bruot of Johannesburg, Michigan, and Kenneth Niemi of Atlantic Mine, Michigan, for their suggestions and ideas.

An experience with bats in the wild led this elementary teacher to develop a literature-based unit for her students.

by Elizabeth Grenke, Hancock Elementary School, Hancock, Michigan

As a teacher of primary students, each fall when Halloween rolled around, I would find myself pulling out bat-shaped patterns from my file. My students and I would talk a bit about the creatures, the type of habitats they live in, their anatomy, and what they eat. Then we'd usually move on to another project the next day. We'd always touch the surface, but never swoop into a more detailed study of this fascinating animal.

This changed completely after I participated in the Educators' Science and Mathematics Institute Series (ESMIS) at Michigan Technological University (see related article on page 32). With backpacks and boots, a group of 20 educators from various grade levels and subject areas spent a week on the North and South Manitou Islands in the Sleeping Bear Sand Dunes National Park. The week was filled with inquiry-based learning experiences, with the hope that our sense of wonder would transfer to our students when we returned to our classrooms.

My most memorable experience occurred during some dark hours I spent with two graduate students from Eastern Michigan University. They were mist-netting bats in hopes of learning which species inhabit or migrate through the islands. Mist-nets are often used for catching birds for study. The nets are made of extremely fine fibers and hang between two posts. Even to the human eye, they can be difficult to see. To catch bats, the mist-nets were hung between the sides of a narrow, wooded trail and were raised to the height of 15 feet. Within the nets are small pockets in which the bats fall upon striking the net. The night brought three red bats for us to observe.

It was a thrilling evening for an elementary teacher. This was the first time I was able to truly examine a bat; previously, I had only observed them behind glass in a zoo. The experience encouraged me to create a unit in which my primary-aged students could learn about bats in an exciting and multisensory way.

I built the unit around five pieces of literature geared for young children. Although all books tend to overlap with similar information on bats, each presents the information in a different form.

Figure 2. Formulas for Daily Prediction Totals

$$\begin{array}{l} \text{Day 2:} \\ \frac{(a) \text{ found}}{\text{total found on day 2}} = \frac{(a) \text{ marked}}{\text{total}} \\ \text{Day 3:} \\ \frac{(a)+(b) \text{ found}}{\text{total found on day 3}} = \frac{(a)+(b) \text{ marked}}{\text{total}} \\ \text{Day 4:} \\ \frac{(a)+(b)+(c) \text{ found}}{\text{total found on day 4}} = \frac{(a)+(b)+(c) \text{ marked}}{\text{total}} \end{array}$$

This simple proportion gives an estimate of the number of a particular species in a designated area. The percentage of the number of marked beetles found on the second day gives us an idea of what percent of the total population we marked the previous day.

Because this was our first experience with the capture/recapture method, we took data for four days and made comparisons of estimated population sizes. We used the data again when we were studying probability and statistics.

About Bats



Introduction Activity: *Stellaluna*

Stellaluna, written and illustrated by Janell Cannon, is one of the most beautiful science-based picture books I have come across as a teacher. Students fall into it. While relating to a wonderful story, they learn without even realizing learning is taking place. The book is about a young bat that is separated from its mother and raised in a nest full of fledgling birds. Later, the bat discovers its true identity.

The story may be used at many levels. For my students, who are five and six years of age, it serves as an introduction to the bat unit and encourages language development for the concepts of same and different. Students are encouraged to compare birds with bats using their own words.

Together we make two lists. What do we know about birds? What do we know about bats? Each list is written in a different color. Pictures can be drawn as aids to the words for young students.

Next, students are invited to come up and circle things from both lists that are the same using a similar color crayon or marker. A Venn diagram format would also work extremely well in this exercise.

Stellaluna creates an excellent opportunity for sensorimotor activities and special movement. Ask:

- Show me what your pointer finger (or body) looks like when it is straight up.
- What would it look like if it were upside down?
- How would a bat move flying at night through lots of trees?
- How would most birds look if they had to fly at night in the dark? (This can lead to a good discussion that a nocturnal owl can fly well at night.)

Activity Two: Hearing and Echolocation

Zippering, Zapping, Zooming Bats, written by Ann Earle and illustrated by Henry Cole, offers students a clear explanation of how bats use echolocation to make them good hunters (predators). *Batty Science*, an activity kit by Pace Products available through Scholastic Books, gives good examples of echolocation for students to try. Here are a few ideas:

- Give every student a small whistle and ask them to blow it gently while noticing what they hear. Then, ask the students to blow the whistle in the same way, while cupping their ears forward with their

hands. Discuss which time they could hear better and why. Older students could discuss the relationship between surface area and sound waves. For my young students, I found pictures of bats with ears twice as big as their head so the children could understand our experiment conclusion.

- Discuss how bats make squeaking noises. If something gets in the way of these sounds, the sound bounces off and comes back to the bat. Have students hold a book far out from their face and make some squeaking sounds of their own. Then, have students slowly move the book closer to their mouths. Discuss the difference in the sound as their voice sounds bounce off the book and echo back to their ears.
- I have seen a third activity in a variety of publications. I believe it initially comes from Project Wild. Students stand in a circle. The “bat” is given a film container containing a few beans and is blindfolded in the middle of the circle. Another student standing on the outside of the circle is also given a shaker. As the bat shakes the container, the circle member waits a few quiet seconds then shakes back to simulate sound waves bouncing back. Then, the bat tries to find its prey.

Activity Three: The Hand-Wing

Chapter One of Joanna Cole’s *The Magic School Bus Bat Fact Finder*, “What makes a bat a bat?” gives excellent diagrams of a bat’s anatomy. It also gives strong examples of the difference between a bat and a bird, making it a good follow-up to *Stellaluna*.

For my students, the more hands-on and active they can be, the more understanding they gain. The following activity gives students the feeling of what it would be like to have a hand-wing.

Students look at diagrams of the anatomy of a bat and compare and contrast their own structure to that of a bat. Ask:

- This is a bat’s upper arm. Where is your upper arm?
- This is a bat’s elbow. Where is your elbow?
- This is a bat’s thumb. Where is your thumb? (The same can be done for the first through fourth fingers. Have students verbalize the difference. What does a bat have that we don’t have?)

Next introduce the concept of the bat’s wing membrane. Using plastic-wrap, help students wrap their own hands, excluding the thumb, since that is a gripper for a

bat. Students can then experience what it feels like for fingers to be connected with wing membrane. Suggest students stretch their fingers out as far as they can and move their hands through the air. For safety, be sure to explain why students need to keep the plastic wrap away from their noses and mouths.

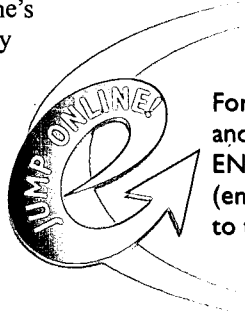
Activity Four: Bat Myths

Continuing with the *Magic School Bus Bat Fact Finder*, help students take apart bat myths. This can be done in a number of ways. A myth might be presented to the class with students giving thumbs up or thumbs down for yes or no. After they give reasons for their answers, information from the book is shared.

Another way to assess student thinking is by designating a “yes,” “no,” or “I’m not sure” section of the classroom. (Corners would work well.) With each new myth, students have to move themselves into place. In short, they “take a stand.” This could lead to positive discussion on making up one’s own mind, instead of simply following where others go.

Myths addressed in Chapter 7 include:

- Bats nest in human hair.
- Bats are blind.
- All bats have rabies.
- Vampire bats suck blood out of people.



For many more instructional ideas and resources about bats, visit ENC’s Classroom Calendar (enc.org/thisweek/calendar) and go to the October 31 entry.

The bat activities in this unit meet many goals of the Michigan Curriculum Framework. Students gain an understanding of bats and their ecosystems through exploring scientific knowledge in the life sciences. A take-off unit on caves and how they are formed would connect Earth science nicely. Students observe and construct scientific knowledge by

generating questions about the world around them with bats as the centerpiece. Students interpret pictures and text that represent scientific knowledge, and they apply their own prior knowledge and reasoning to what is presented to them. This unit also connects science with various other content areas, including the arts.

So much more can be done with the books and ideas presented here. Although these activities are geared for younger children, I would encourage teachers of all levels to adapt the unit for their own students.

Elizabeth Grenke teaches a transition classroom of five- and six-year-old students at Hancock Elementary School in Hancock, a town in Michigan’s Upper Peninsula.

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Activity Five: So Many Bats!

Bats, compiled by Carolyn MacLuchich for the Australian Museum, is a wonderful wrap-up book. Full of color photographs of many different species of bats, the book reviews topics already presented. The pictures are excellent, and viewing them together offers a good opportunity for students to discuss what they have learned.

Extension Activities

Here are a few activities to be used throughout the unit and for closure and assessment.

- Each day have students tell a neighbor one bat fact they’ve learned.
- Students can draw a picture of the species of bat they find most interesting. Encourage them to draw that bat’s habitat as well.
- Ask students to imagine becoming a bat for one night then tell or write a story about what it was like.

Technology Education Enters the Classroom

With newly developed K-12 standards, the International Technology Education Association hopes to clarify the image of technology education and help improve technological literacy.

by Wes Perusek, Ohio Space Grant Consortium, Ada, Ohio

First appearing in the English language in the 17th century, the word *technology* meant a discussion of the arts. By the 20th century, the word had come to mean the processes and ideas as well as the tools and machines that we use to change the natural world to serve human purposes.

Seemingly an all-purpose and ever-present word in the 21st century, the term technology causes some confusion in education. When we talk of educational technology, we mean the modern-day teaching tools derived from computers. Technology education is something else—it is the study of mankind's attempt to shape and form the world to serve human needs and wants. As such, it is at the core of human development and progress.

A few decades ago, schools began teaching "industrial arts" to prepare young people for the then-new industrial society. Today, many leaders are advocating a curriculum known as technology education to prepare young people for a highly sophisticated technological society.

The International Technology Education Association (ITEA) is an advocate for including course work in the

K-12 curriculum that will enable all students to become technologically literate. A membership organization representing some 6,000 educators in the United States, ITEA recently published standards for technological literacy content (see page 40). The content is integrated into thematic units at the elementary levels; technology education becomes courses at the middle and high school levels.

In developing these standards, ITEA was mindful of standards in other subject areas, such as the *National Science Education Standards* (1996), *Benchmarks for Science Literacy* (1993), *Curriculum and Evaluation Standards for School Mathematics* (1989), and *Principles and Standards for School Mathematics* (2000). Because technology education is interdisciplinary, it has the power to combine standards across subject areas.

The ITEA standards specify what every K-12 student should know and be able to do to be technologically literate. The publication, *Standards for Technological Literacy: Content for the Study of Technology* (2000), opens with a discussion of the importance of preparing all students to live in a technological world. Following an overview, the standards are presented in five categories with a chapter for each: The Nature of Technology, Technology and Society, Design, Abilities for a Technological World, and The Designed World. The final chapter is a call for people in the community to promote technological literacy for all students.

According to a survey conducted by the ITEA's Technology for All Americans Project, 30 states include technology education in their curriculum frameworks, which

continued on page 41

Americans' Technology Literacy Is Subject of Report

In January 2002, the National Academy of Engineering and the National Research Council released a report on their study of technology literacy in the United States. They found that neither the schools nor government policymakers have recognized the importance of technology literacy to the nation. Their report *Technically Speaking: Why All Americans Need to Know More About Technology* calls for a broad-based effort to increase technology literacy, beginning in the nation's kindergartens.

The connection between all subjects and technology literacy should be emphasized throughout a student's education, the report writers say. Federal agencies should provide incentives for publishers to include technology content in all text-

books, including nonscience subjects, and establish awards for innovative ways to improve student or public knowledge.

The writers note that technology literacy is a broader concept than being able to use technology tools such as computers. They suggest that the word *technology* should appear where appropriate in science education standards and materials. The study of technology literacy was sponsored by the National Science Foundation and Battelle Memorial Institute. *Technically Speaking* is available as an online electronic document at (www.nap.edu/catalog/10250.html?onpi_topnews_011702). It is available in print from the National Academy Press (\$19.95 paperback).

Standards for Technological Literacy

The International Technology Education Association (ITEA) established its Technology for All Americans Project in 1994. In the first two years, the project produced a statement of the reasons for and possible structure of classroom study of technology, *Technology for All Americans: A Rationale and Structure for the Study of Technology*. For the next four years, the project focused on developing standards for teaching technology literacy. The National Academy of Sciences was among the groups and individuals worldwide who reviewed the standards.

After the publication *Standards for Technological Literacy* was released in 2000, the association disseminated the standards in workshops and conferences, including 11 workshops at centers of the National Aeronautics and Space Administration. Currently ITEA is developing assessment and professional development standards, which are expected to be available in 2003.

The standards publication devotes a chapter to each standard and includes material applicable to all grade levels. Each grade level standard includes narratives that explain how the standard applies to that age group. Benchmarks explain what the student should be able to do as a result of meeting the standard. Vignettes show teachers in classroom and laboratory settings. (See box on page 41 for an example.)

For more information, visit the ITEA web site (www.itea.org). The 20 standards are listed below.

The Nature of Technology

Standard 1: Students will develop an understanding of the characteristics and scope of technology.

Standard 2: Students will develop an understanding of the core concepts of technology.

Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Technology and Society

Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.

Standard 5: Students will develop an understanding of the effects of technology on the environment.

Standard 6: Students will develop an understanding of the role of society in the development and use of technology.

Standard 7: Students will develop an understanding of the influence of technology on history.

Design

Standard 8: Students will develop an understanding of the attributes of design.

Standard 9: Students will develop an understanding of engineering design.

Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities of a Technological World

Standard 11: Students will develop abilities to apply the design process.

Standard 12: Students will develop abilities to use and maintain technological products and systems.

Standard 13: Students will develop abilities to assess the impact of products and systems.

The Designed World

Standard 14: Students will develop an understanding of and be able to select and use medical technologies.

Standard 15: Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.

Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.

Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.

Standard 18: Students will develop an understanding of and be able to select and use transportation technologies.

Standard 19: Students will develop an understanding of and be able to select and use manufacturing technologies.

Standard 20: Students will develop an understanding of and be able to select and use construction technologies.

Reprinted from *Standards for Technological Literacy: Content for the Study of Technology* (2000) with the permission of the International Technology Education Association.

outline subjects students should experience. Five states place technology education in vocational or tech-prep frameworks. Fourteen states report that technology education is required in some form, while others report that it is subject to local districts' policies. Most often technology education is an elective. Whether the subject is a requirement or an elective, the states reported that some 38,537 teachers are teaching technology education in middle grades and high school.

Much is yet to be done. At the classroom level, teachers do not need to have an official technology education assignment to promote technological literacy in their students' lives. Using ITEA's recommendations, teachers can integrate technology education across the curriculum. Another source of help is Project XL: The Inventive Thinking Curriculum Project sponsored by the U.S. Department of Commerce, Patent and Trademark Office (www.uspto.gov/web/offices/ac/ahrpa/opa/projxl/invthink/invthink.htm).

Editor's Note: ENC encourages readers to share their experiences in technology education with other educators. Writers' guidelines are on page 5 or visit ENC Online (enc.org/focus/write).

Wes Perusek directs an after-school Invention Innovation Center program funded by the Ohio Space Grant Consortium. A former college professor and state education agency administrator, he was an invited reviewer of the National Research Council's science education standards, ITEA's technology standards, and early drafts of the Science 5/13 Project in England.

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A Team Approach to Plastic

(This vignette from ITEA's *Standards for Technological Literacy* presents some activities that deal with plastics as a manufactured product. Students not only study plastics, but they also design and make plastic products. Finally, they communicate their learning to others.)

The seventh-grade technology, language arts, and science classes worked together to implement an interdisciplinary unit on making and recycling plastics. The students were challenged to investigate the chemistry of plastics, the various products made with plastic, how new products are made from recycled plastic and plastic scraps, and the benefits the community receives through the use of plastics and recycling.

The students developed an action plan to complete the project, interviewed various engineers, scientists, technologists and industry personnel, and toured a local plastic manufacturing plant and a recycling facility. In the course of the unit, the students worked with various types of plastics and designed and made examples of the individual objects they had investigated.

Students also conducted research on how synthetic materials differ from natural materials. Additionally, the teacher asked the students to create a company that involved the design, development, production-line operation, and assessment of a plastic product made in quantity. During their activities, students documented their work by using videos and cameras. They produced a three-minute presentation describing what they had learned and then broadcast the segment on the school's television station. Finally, they produced a similar presentation for their school's World Wide Web site.

(This vignette highlights elements of the Grades 6-8 Technology Content Standards that provide connections with Standards 3, 8, 9, 10, 11, 12, 15, and 19. See the complete list of standards on page 40)

Reprinted from *Standards for Technological Literacy: Content for the Study of Technology* (2000) with the permission of the International Technology Education Association.

DISCUSS

ENC is hosting an online discussion of this article! Join other educators talking about:

- What you do in your classroom to help your students increase their technological literacy.
- How your school district can meet the International Technology Association's Standards for Technological Literacy.

Visit enc.org/focus/discuss/perusek

Basketsful of Math and Science Learning

Baskets containing picture books and manipulatives allow children to explore new mathematics and science concepts.

by Susan Cox, Shaw Elementary School, Tampa, Florida

What appears to be a basket of books and playthings to the casual observer of my combined kindergarten and first-grade classroom is actually a closing activity for a math or science concept the children have recently experienced. Unlike a culminating "ditto" sheet or textbook activity, the basket allows each child to

explore a concept using his or her own learning style. Some children especially need this open-ended approach.

Each basket contains a picture book that relates to a mathematics or science concept along with a collection of manipulatives. One of our most popular baskets, organized around the picture book *One Hundred Hungry Ants* by Elinor Pinczes (Houghton, 1993), is designed to teach the numerical properties of 100. The basket contains a picnic blanket, 100 plastic ants, interlocking units such as Unifix cubes, plastic food items, large sheets of paper for drawing, and a journal for writing. (I make the journal by binding blank sheets of paper inside a construction paper cover.)

After reading the book to the class, I explained that the basket contained items similar to those mentioned in the book and would be placed at one of the learning centers in our classroom. Together, the children and I thought of ways to use the items in the basket. Later the children, in groups or individually, could choose to explore the basket during learning center time.

The mathematical concept of numerical properties was reinforced as the students arranged the 100 plastic ants into columns and rows of different sizes. Some of the arrangements replicated those described in the book, while others were unique and creative alternatives. The children also discovered different counting strategies (by fives and tens). Measuring skills were incorporated as students measured the length of individual ants and columns of ants, using the Unifix cubes or other measuring manipulatives. All of these activities encouraged the use of

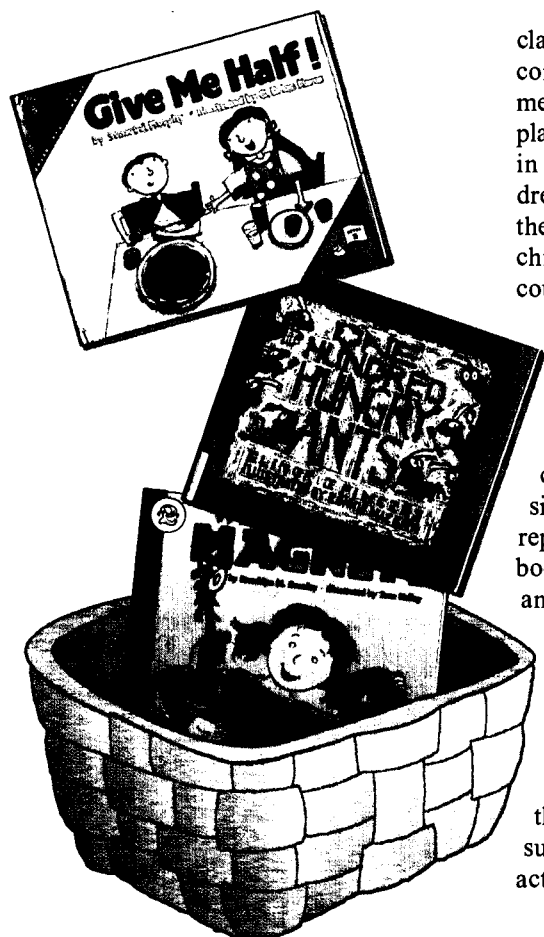
math-related vocabulary and writing skills.

The journal facilitated information synthesis and communication. One first-grade student wrote: "The ants went to the picnic with just their family and the family had 10 ants." The accompanying picture showed 10 distinct "families" in rows of 10 advancing toward the blanket and plastic food items. She also recorded the length (in Unifix cubes) of each row of 10 and the length of all 100 ants together. When a journal in a basket is filled with the children's writings, it is moved to our classroom bookshelf.

When I prepare a basket, I look for a book that relates to the target concept and a variety of manipulatives and assessment materials. In general, I seek out materials that are open-ended enough to allow each student to apply his or her own cognitive strategy. It is also important to consider the relevance of the learning materials to the children's lives and environment. Journals or other recording materials may be included in a student's portfolio or displayed in the classroom, providing assessment opportunities as well as a way for students to engage in cooperative learning.

Despite the curiosity that the baskets generate initially, it is necessary to rotate or update the materials to maintain interest. Typically, the materials in a basket will hold children's attention for a week (or the length of the unit of study), but occasionally, new materials may be required after a few days.

A basket based on the book *Give Me Half* by Stuart J. Murphy (HarperCollins, 1996) has been effective in teaching the concept of equal parts. Preparing this basket was a cooperative class project. Students offered their suggestions as to what



graphic: Andy Ault

Investigating “Stretchy” Benchmarks

the basket could contain and then generated a list to be sent home so that parents could contribute. The resulting collection of plastic food items, paper cups and plates, cans, boxes, modeling clay, and real snack food filled the basket. This basket proved to be as helpful in encouraging social exchange as it was in teaching the mathematical concept. Students often discussed equitable sharing of the materials as they worked in cooperative groups.

In response to this basket, a kindergarten student drew a room on paper and divided it in half. He then distributed an equal number of modeling clay items on each side of the division. When I asked why, he explained that he and his brother had to share a room and he had thought of a way to share it equally.

A favorite science basket features the book *What Makes a Magnet* by Franklyn Branley (HarperCollins, 1996). The basket contains magnets of many sizes and shapes as well as experiment cards with easy-to-follow directions.

Creating math and science baskets often involves asking parents for materials or for their help in supervision of activities. Sometimes, the students' enthusiasm for a particular basket activity carries over to their home. Parents have reported being coerced into replicating a basket activity at home so that their children can show them what they did in school. Following the equal-parts activity, a first grader insisted on putting the food on everybody's plate at dinner-time. The parent was excited about her child's enthusiasm for school activities but less than thrilled to wait as he counted out equal numbers of corn kernels for each plate!

Susan Cox teaches at Shaw Elementary School in Tampa, Florida. In 2000, she successfully earned National Board Certification.

Reprinted from one of the author's popular science activity books, this investigation illustrates the importance of mathematical measurement in scientific experiments.

by Janice VanCleave, Riesel, Texas

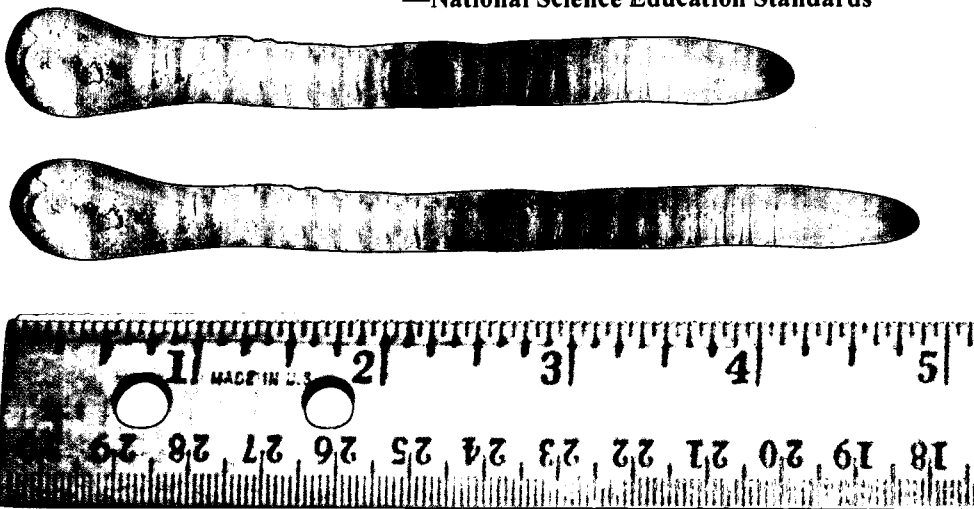
Teaching Tips for the Investigation

Standards Met in this Activity

By the end of the 5th grade, students should know that things can be done to change the properties of a material, but all materials do not change the same way.

By the end of the 8th grade, students should know that only one variable at a time must be changed for the results of an experiment to be clearly attributed to the variable.

—National Science Education Standards



In this investigation, students are expected to:

- Describe the physical property of elasticity.
- Compare the elasticity of different materials.

Elastic Data Table			
Test Material	Starting Length	Length When Stretched	Final Length
gummi worm			
rubber band			

Preparing for the Investigation

Prepare an Elastic Data Table and make one copy for each student.

Presenting the Investigation

1. Introduce the new science terms:

- **Contract:** To draw together.
- **Elasticity:** The physical property of being able to return to the original length or shape after being stretched.
- **Standard:** A material to which other materials are compared.

2. Explore the new science terms:

Rubber bands and gummi worms are both elastic. Ask your student to think of things that are elastic, such as a basketball or bungee cord. When stretched out of shape, elastic materials contract or draw back to their original size.

To determine how elastic a material is, you have to have something to compare it to. This would be something commonly known, called a standard. In this investigation, the elasticity of the gummi worm is

Did You Know?

Rubber originally meant a natural, elastic product obtained from the secretion of certain plants. Today the term is applied to a class of materials having the unique property of high elasticity. A strip of rubber can often be stretched to several times its original length without breaking and will return to that length when released.

compared with the rubber band as a standard.

Performing the Investigation

Purpose:

To determine how elastic a gummi worm is.

Materials:

rubber band
Elastic Data Table
scissors
gummi worm
ruler

Procedure:

1. Without stretching the rubber band, cut a section that is the same length as the gummi worm.
2. Place the gummi worm along the edge of a ruler. Measure the worm to the nearest millimeter. In the Elasticity Data table, record this as the Starting Length.
3. Stretch the gummi worm as far as possible without breaking, and record the greatest length as the Length When Stretched.
4. Release the gummi worm, wait for it to stop contracting, and again measure its length. Record this as the Final Length.
5. Repeat steps 2 through 4 using the piece of rubber band instead of the gummi worm.

Results:

The gummi worm is found to be either more, less, or equally elastic when compared with the rubber band, depending on the data recorded. The author found the worm to be slightly less elastic, about fifteen-sixteenths as elastic as the rubber band.

Why?

Elasticity is the ability of something to return to the same length after being stretched. A rubber band is generally considered to be perfectly elastic, meaning it returns to its original length after being stretched. The rubber band is used as the standard (a material to which other materials are compared) against which you are comparing the elasticity of the gummi worm. A gummi worm will generally contract (draw together) to almost its original length. So, the elasticity of the worm is great, but the author's worm was slightly less elastic than the rubber band.

Extensions:

1. Investigate the effect of temperature on the elasticity of the gummi worms. Do this by cooling the gummi worms in a refrigerator. If a refrigerator is not available, place the gummi worms in a resealable bag. Then place the bag of gummi worms in a larger resealable bag containing ice. Once data have been collected, heat the gummi worms by placing them in a sunny area.
2. Determine if the elastic properties of a gummi worm change with repeated stretching. Repeat the investigation several times, using the same gummi worm.

Janice VanCleave is the author of more than 45 science books for children. The "Stretchy" activity came from Janice VanCleave's Teaching the Fun of Science (Wiley, 2001). It is reprinted with permission. The book can be found at your local bookstore or to order copies, call (800) 225-5945.

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We Need More Earthworms!

First graders learned in science class what earthworms do and then wrote letters to convince their principal to purchase a supply for the school garden.

by Francine Plotycia, Harford County,
Maryland, Public Schools

Researchers have suggested that young children become more engaged in reading and acquiring science content knowledge when language arts and science are integrated (Guthrie et al., 1999). I integrated reading instruction with writing and science activities in my first-grade classroom by requiring the students to write a persuasive letter based on student-led inquiry. Building the children's knowledge base was my first step.

In small groups, independently or with a buddy, the children read *Wonderful Worms* by Linda Glaser for information about earthworms. I used a K-W-L-H (Know-Want to learn-Learned-How to learn more) chart and semantic webbing to determine the children's knowledge about worms.

Next, in a whole group setting, I recorded the first-graders' questions about worms that were not answered by the book. The students decided that observing real worms would be helpful in finding answers to their questions.

The following day, I brought a bucketful of soil from my home garden. Working in groups, the children observed the earthworms through magnifying glasses. They also measured the worms in both inches and centimeters. I reminded the children to use their senses of sight, touch, smell, and hearing to gather information and to record their observations.

The students' recorded observations included the colors and sizes of the earthworms as well as the worms' reactions to touch. The students also noted that their sense of hearing did not help them with their observations.

In addition, when the children walked past the school flower gardens for their recess, I asked students to observe the condition of the plants. In class, the students discussed why the plants did not appear to be growing very well. With these observations and their new understanding of worms, especially the role of earthworms in conditioning soil, they had the necessary information to enable them to write to persuade.

Before the children began their letters, I read to them a writing prompt and a scoring rubric (see sidebar on



page 46). Then each first grader wrote a letter to urge the principal to buy worms for the school's flower gardens. The students gave convincing reasons, and their principal agreed to purchase worms for the students to release into the garden.

Learning about worms did not end with the release of the worms. The children continued to locate and read books about worms and flowers and monitor the condition of the school's flower garden. When I present the unit again, I will identify Internet sites and locate directions for building a worm bin, which will allow for extended observations.

Francine Plotycia teaches first grade at Abingdon Elementary School in Harford County, Maryland. This is her fifth year in the county system.

Resources

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Worms Writing Prompt for First Graders

This week in science, we have been reading *Wonderful Worms*, written by Linda Glaser. We have learned many facts about worms, including how worms help plants. As

we observed, the plants in our school's flower garden are not growing very well. You need to write a letter to Mr. Wallace, persuading him that our school's garden needs more worms to help the flowers grow. When you write to persuade, you want to convince someone else to do something or think about something the way you do.

Before you begin writing, think about:

- three or more the facts about how earthworms help plants that you read in *Wonderful Worms*,
- correct letter form, and
- the need to state your purpose in a persuasive letter.

Now write a letter to persuade Mr. Wallace to buy worms for our school's garden. Include at least three of the facts about how worms help plants that you learned from reading *Wonderful Worms*. Remember to use beginning capitals and ending punctuation.



Rubric for the Worms Writing Prompt

Content:

- 4 points: Student stated purpose.
Student included at least three relevant facts from the text.
- 3 points: Student stated purpose.
Student included at least two relevant facts from the text.
- 2 points: Student stated purpose.
Student included at least one relevant fact from the text.
- 1 point: Student stated purpose, or
Student included at least one relevant fact from the text.

Mechanics

- 4 points: Student used correct letter form.
Sentences consistently showed proper capitalization.
Sentences consistently showed ending punctuation.
First-grade words consistently spelled correctly.
- 3 points: Student used correct letter form.
Sentences frequently showed proper capitalization.
Sentences frequently showed ending punctuation.
First-grade words frequently spelled correctly.
- 2 points: Student attempted to use correct letter form.
Sentences sometimes showed proper capitalization.
Sentences sometimes showed ending punctuation.
First-grade words sometimes spelled correctly.
- 1 point: Student did not attempt to use correct letter form.
Sentences sometimes showed proper capitalization,
or
Sentences sometimes showed ending punctuation.
First-grade words rarely spelled correctly.

Learning Every Day from Everyday Problems

Get a glimpse of how problem-based learning works in an Illinois school district.

by Melanie Shreffler, ENC Publications

Problem-based learning (PBL), one method for integrating subject areas across the curriculum, is working well in the Springfield, Illinois, Public School District 186. The district's web site (www.springfield.k12.il.us) provides an example of how a problem is chosen:

A problem design team was trying to think of a way to immerse high school biology students in the study of viruses, monerans, protists, and fungi. One of the team members noted current news stories about Midwestern flooding problems and subsequent drinking water contamination. Another team member remembered a case where a co-worker became ill after exposure to flood waters in his basement. It turned out the unfortunate co-worker was infected by a water-borne protozoan. Voila! Our anchor situation. It was these otherwise unrelated events that gave birth to a PBL problem that could drive otherwise disinterested students to study the desired subject area.

Though this example involves high school students, Springfield uses PBL successfully in elementary and middle schools as well, according to Mike Clark, a staff member at the district's Problem-Based Learning Institute. Originally funded by a National Science Foundation grant, the Institute supports Springfield teachers' use of PBL.

Teachers in the district are encouraged to be alert for a local or national problem that meets curricular goals for their classes. When a problem is identified, so are all of the curricular areas that it addresses. The teacher then involves other members of his or her teaching team. The resulting design team of teachers then refines the problem to make sure it meets the district's established criteria for a problem that can support a unit. For example:

- The problem must lead to multiple hypotheses;
- The problem must sustain student engagement;
- The problem must meet curricular goals for multiple subject areas.

Involving the Students

The problem is presented to the students as an ill-formed multi-subject situation, just as it would be in the

real world. Students need to search for information to identify and clarify the problem.

PBL follows the methods of scientific inquiry. Often the teacher breaks the class into small groups. The teacher then guides the groups through a deductive reasoning process. Students gather data, generate and test hypotheses, and draw conclusions. Class progress is organized and recorded on a chalkboard or bulletin board.

As the students gather information, they gain and use knowledge from many different subject areas. Through their research, they are always re-evaluating the problem.

During most of these initial steps, the students are engaged in self-directed learning. They organize themselves and the information they collect, and they decide the direction they will take in working toward a solution. The teachers are very much involved, constantly observing, offering the students support and assistance when needed, and acting as resources in their respective disciplines.

At the end of each problem, students report on the process, explaining how they defined and researched the problem, all possible solutions to the problem, which solution they would choose, and what they have learned in the process. Students are encouraged to be creative as they design their presentations; reports can include videos, dramatic performances, visual displays, or written reports.

Getting to Know PBL

Before teachers can use PBL successfully, they need opportunities for professional development. Springfield teachers have learned to facilitate PBL lessons at the Problem-Based Learning Institute, located at Lanphier High School in District 186. Teachers are given the opportunity, but are not required, to take either a two-semester course or three-day workshop. Both are offered free to teachers in the district and at cost to teachers from other districts. In Springfield, teachers can receive increased salary and college credit for taking the course.

Teachers typically find two aspects of PBL most challenging. One is designing the problem to ensure that it doesn't take too much time for the students to work through. The other is adjusting from a teacher-centered approach to a student-centered approach.

Springfield addresses these challenges head-on in the Institute's two-semester training course. First, teachers experience PBL as students. They work through a problem as they are coached by an experienced PBL teacher. Next, assisted and observed by a master PBL teacher, participants teach the same problem to students in a Springfield classroom. Finally, the teachers write and lead their

own PBL lesson in their classrooms. The lessons are videotaped and reviewed at the Institute to fine-tune the teachers' technique.

Time to Plan

Because PBL is cross-curricular, one of the greatest challenges is finding time for teachers to plan. Springfield middle schools have been among the most successful PBL schools in the district in part because teachers have two class periods set aside each day to plan their lessons. One period is set aside for individual planning, while one is set aside for work with one's team.

Every Springfield middle school teacher is on a team. Teacher teams consist of one English teacher, one social studies teacher, one math teacher, and one science teacher, as well as an art teacher who is attached to several teams. Each team functions as a support network and plans together, ensuring that each PBL situation addresses multiple curricular goals and meets the standards and benchmarks.

PBL has been more difficult to implement at the high school level because teachers have less time to plan together, because students don't all take the same courses, and because some students fail classes. One Springfield high school, however, has had success coupling a physics class with a second-year algebra class. The teachers plan classes together, and the class periods are scheduled back-to-back. This way, when one lesson takes two hours, the teachers can make use of the larger block of time.

How Can You Use PBL?

While you may not be able to incorporate full-scale PBL into your school district, you can still use it in your classroom. Using resources in your community, you can design your own problem-based learning units. For examples of how some teachers have done just that, see "The Power of Convergent Learning" on page 12.

You can also find resources for planning your own PBL units on the Springfield Public School District 186 web site (www.springfield.k12.il.us) or in *The Tutorial Process* by Howard Barrows, one of the founders of PBL in Springfield.

The staff at the Problem-Based Learning Institute is willing to help you understand and use problem-based learning. Feel free to contact Mike Clark or Linda Cozzolino at pbl@springfield.k12.il.us.

Melanie Shreffler edits print and online publications for ENC. She has a background working with teacher education organizations. Email: mshreffler@enc.org

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Independent Thinking in the Chemistry Lab

Chemistry laboratory experiences that are relevant to students' everyday lives prepare them to design their own experiments—and to think for themselves.

by Mark Benvenuto, University of Detroit Mercy, Detroit, Michigan

Recent high school graduates are often the enrollees in the introductory college chemistry laboratory course I teach. My goal in the course is to help my students connect classroom information to laboratory phenomena, to show them the relevance of their lab experiences in everyday life, and to motivate them to think independently.

One important part of the overall learning process is students' moving from a state in which they simply do as they are told to one in which they can develop processes and learning tools for themselves. The sequence of experiments described in this article not only encourages students to engage in some critical thinking about how to design an experiment, but does so using lab experiences that have obvious connections to real life.

Preparation for Independent Work

The first laboratory activity is an experiment to determine the percentage of dissolved solids in soft drinks. Boiling the solution (the soft drink) until only syrup remains separates the water and CO₂ from any sugars and other dissolved solids. Students then compute the percent of dissolved solids in their brand of soft drink and determine the total amount of solids in the bottle or can.

At first glance, this experiment may seem almost too simple for a high school or college chemistry course. However, I have found that the first chemistry lab is a time to establish what students already know and what they need to learn before progressing. This experiment works well for that purpose.

A Note on Chemical Safety

The chemicals mentioned in the accompanying article, specifically ammonium chloride, silver nitrate, lead (II) nitrate, and sodium sulfate, are all available through Flinn Scientific, Inc. Cautions mentioned in the catalog should be followed; in addition, local and state guidelines should be followed in their disposal.

Flinn Scientific, Inc.
P.O. Box 219
Batavia, IL 60510
(800) 452-1261
Fax: (630) 879-6962
Email: flinn@flinnsci.com
Web site: www.flinnsci.com

In the next experiment, students determine the fat content of a cheeseburger. The mass of the meat and cheese is measured and then the material is ground up with water in a blender. The solution is poured into a beaker and allowed to separate. The fat rises to the top of the settled solution, where it can be skimmed off and weighed. The mass of the fat is contrast with that of the meat and cheese to determine the percent fat in the burger. This experiment has a different procedure from the previous soft drink lab, but a similar level of mathematics is required.

As the semester progresses, students perform two more lab experiments that provide the basis for the experiment they will design on their own.

One experiment involves fish tanks that student groups maintain in the lab. For many students, the idea of setting up a fish tank may seem to be more of a biology project than an activity for a chemistry lab, but this experiment shows some basic chemistry involved in life processes. At two points during the semester, students boil dry a sample of water from the fish tanks to determine the amount of dissolved solids. We make the assumption that all the dissolved solids are sodium nitrate (not a perfect assumption, but a workable one). The lab requires students to compute molarity, as well as percent of dissolved solids and total dissolved solids in the tank. This procedure is the same as that for the soft drink lab, but adds the math required to compute molarity.

The final experiment that incorporates a technique to be used by students when they design their own lab procedure is a traditional unknown-salt lab. Each student receives an unknown salt, as well as known salt solutions against which to test it. Ammonium chloride, silver nitrate, lead (II) nitrate, and sodium sulfate (see box) are examples of the known solutions. Students make a solution of their unknown salt and distilled water, add small amounts of the known solutions to it, and record any observations about precipitates.

Designing an Experiment

When it is time for students to design their own experimental procedure, they are instructed to download the following assignment from the course web site:

How Salty Are Potato Chips?

Task: Determine the mass of salt (NaCl) in a sample of potato chips.

Procedure: You design the laboratory procedure, then explain it in writing or verbally to the instructor, who will give the OK for you to perform the investigation.

You are encouraged to ask for help from anyone in designing your procedure.

Hint: This is a combination of laboratory problems we investigated earlier in the laboratory.



Photo by Jack McIlrath

This investigation, which involves extracting the salt from potato chips then quantifying the amount of salt, can be done in one of two ways, given the experimental techniques students have already used. Students might decide to crush the chips into a powder, mix the powder with distilled water, filter through a funnel with filter paper, and finally boil dry the resulting solution. Or, the resulting solution can be titrated with a known solution that produces a precipitate, such as silver nitrate (which makes insoluble silver chloride) or lead (II) nitrate (which makes insoluble lead [II] chloride).

When students ask me for help in designing their procedure, I ask them questions about previous experiments that are relevant to the task at hand. I ask what mixtures they have already seen (such as soft drinks or cheeseburgers). I ask what methods they have used to quantify residues or solutes in solutions. I ask how they have computed a percentage in a past experiment. This usually helps them to see that procedures they have already performed in lab can be used in a new situation, for a new experiment.

Relating the Technique to Educational Standards

Educational standards vary from state to state, but most have similar requirements. In Michigan, two important K-12 educational standards are the Michigan Educational Assessment Program (the MEAP) and the Michigan High School Proficiency Test (HSPT). Both examine a student's ability to make the type of connections required in designing a laboratory procedure.

A hypothetical example might be a question about mixing gases. On a test, four diagrams might show two different types of molecules in various arrangements. The student is asked which of the four represents mixing. The wrong choices might show the two molecules combined in various chemical reactions, or not having mixed. A question like this may seem at first to be simply a matter of knowing the difference between mixing and a chemical reaction. However, the student who has had to think about designing a procedure involving mixing stands a much better chance of correctly answering the question.

Real-Life Connections

The experiments described in this article are particularly valuable because of their connections to our everyday lives. The experiments dealing with food have straightforward connections to health classes. In addition, food-based experiments help make the labels on food packaging more relevant to students.

Another benefit is the cross-disciplinary connection to mathematics. While none of the experiments requires calculus or trigonometry, algebra and a bit of geometry are

definitely needed. Many of us are familiar with student complaints that a subject has no value in real life. All of these experiments show that determining percentages is very much a real-life activity. Determining the molarity of water from a fish tank is another example of how simple algebra can be used in a common, everyday situation.

Making It Work in Your Classroom

The level of independent, critical thinking I have described is quite adaptable for high school students. I would suggest the following steps for any teacher who wishes to try such a method:

1. Look at the experiments your students perform in your class.
2. Identify the common procedures or techniques as well as the common math operations in these experiments.
3. Forewarn your students that they will be expected to design a procedure for one experiment later in the course.
4. Keep the upcoming assignment in the students' minds by reinforcing the idea that a technique, procedure, or math operation is important or may be useful later.

Prompting students to design a science experiment of their own does not require a change in your curriculum or a great deal of expensive equipment. Such a teaching technique is more a matter of examining the experiments that your students already perform and emphasizing the various techniques that will be applicable to their own independently created procedure.

Two factors that are crucial to making the technique a success in your classroom are monitoring students' hands-on lab work throughout the term and insisting on some form of written or spoken procedure from students before they perform the lab they have designed on their own.

Mark Benvenuto is an associate professor in the department of chemistry and biochemistry at the University of Detroit Mercy in Detroit, Michigan. One of his major professional interests is chemical education, specifically, working toward excellent general chemistry classes for all students. Email: Benvenma@udmercy.edu

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Connecting Science, Fiction, and Real Life

Works of fiction draw adolescent readers to further adventures in science.

by Carolyn Sue Gardiner, St. Timothy School, Columbus, Ohio

When you're planning a unit on weather, it's easy to check out every nonfiction book about the subject on the library shelves. It's not so easy to identify novels that feature a weather-related theme in the context of real or imagined lives. I have used each of the novels described here with fifth through eighth graders to introduce or expand on a number of science units, from astronomy to forensics. While these books have been the catalyst for further exploration of a topic, they have also allowed my students to experience science from a completely different perspective.

In *The Green Book* by Jill Paton Walsh, a young girl and her family are among the last people to evacuate Earth to colonize another planet. The reader is left to assume that an ecological disaster has occurred on Earth. *The Green Book* is an excellent starting point for discussing the ethical issues of environmental stewardship. Because it involves interplanetary travel, it can also be used in conjunction with a unit on astronomy. After studying the planets, students could write their own stories about planets they would travel to and why. Even though it is an easy read, the book explores some complex issues.

Some other titles on the topic of interplanetary travel are *A Wrinkle in Time* by Madeleine L'Engle, *My Teacher Is an Alien* by Bruce Coville, and *The Hitchhiker's Guide to the Galaxy* by Douglas Adams. *Son of Interflux* by Gordon Korman is a good choice for environmental stewardship.

While tornadoes are sweeping through a small Midwestern town, Dan must find a safe place for his baby brother, a friend, and himself in *Night of the Twisters* by Ivy Ruckman. The description of tornadoes is accurate, and many readers can identify with the setting and the characters.

Fortunately, most of us have never experienced a tornado. Students could research forms of weather conditions they have experienced and write stories about them. Other books in which weather conditions play a prominent role are *Julie of the Wolves* by Jean Craighead George, *The Voyage of the Frog* by Gary Paulsen, *The Voyage of the Dawn Treader*

by C.S. Lewis, and *The Little House* series by Laura Ingalls Wilder.

In *My Side of the Mountain* by Jean Craighead George, Sam runs away from home to live in the Catskill Mountains. His survival depends on his knowledge of plants, animals, and the land. This survival story can reinforce studies of plants, animals, and geography. A unit in biomes might be a good place to start. From this, students might research other biomes and write survival stories in those settings. An example of a survival novel in a very different setting is *Island of the Blue Dolphins* by Scott O'Dell.

After a wealthy man is found dead, his potential heirs must solve the mystery of his death in *The Westing Game*. Author Ellen Raskin provides an intriguing puzzle that calls for deductive reasoning. Teachers can set up a mystery in the classroom to be solved by careful observations, the proper use of microscopes, and supervised chemical tests.

Other mysteries that can prompt the use of deductive reasoning skills include: *And Then There Were None* by Agatha Christie, *Wolf Rider* by Avi, and *From the Mixed-up Files of Mrs. Basil E. Frankweiler* by E.L. Konigsburg. A number of series challenge youngsters' problem-solving skills: The Nancy Drew and Hardy Boys series by Carolyn Keene and Frank Dixon, The Mathnet Casebooks series by David Connell, and the Encyclopedia Brown series by David Sobol.

In *The Real Mother Goose* by Blanche Fisher Wright, well-known characters find themselves in many unusual predicaments. By using problem-solving skills, the students can help the characters avoid peril. For example, they can determine the maximum height for a candle that Jack (who might be as tall as an average first grader) could safely jump over. They could research building materials or design a bridge that would not fall down. Or, they could suggest a covering to protect Humpty Dumpty.

Since there are four main areas of science content taught each year in our school system, I set aside novels, short stories, and poems that lend themselves to those areas. I often provide an assortment of literature to give the students choices in their reading. Those who choose the same reading material meet in groups to discuss the literary aspects of the works; the group then shares the science content with the rest of the class.

This sharing is often manifested in lively discussions following a lab, simulation, or process drama. Building museums, drawing posters, recreating scientific events, and charting information are some of the other ways literature is explored. Finding connections between engaging novels for young people and the mathematics and science curriculum can be fun for teachers and students alike.

DISCUSS

ENC is hosting an online discussion of this article!
To join the conversation, visit enc.org/focus/discuss/gardiner

Go Off the Subject

Carolyn Sue Gardiner is currently the K-8 technology teacher and coordinator at St. Timothy School in Columbus, Ohio. For 24 of her 26 years as an educator, she taught science and language arts in grades 5-8. In 1996, she received the Presidential Award for Excellence in Science and Mathematics Teaching. She also serves on ENC's Ohio Teachers Advisory Group.

Resources

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This mathematics teacher gives examples of brief digressions that use mathematics to enliven other lessons.

by Rhonda D. Cummins,
Dickinson, Texas, Independent School District

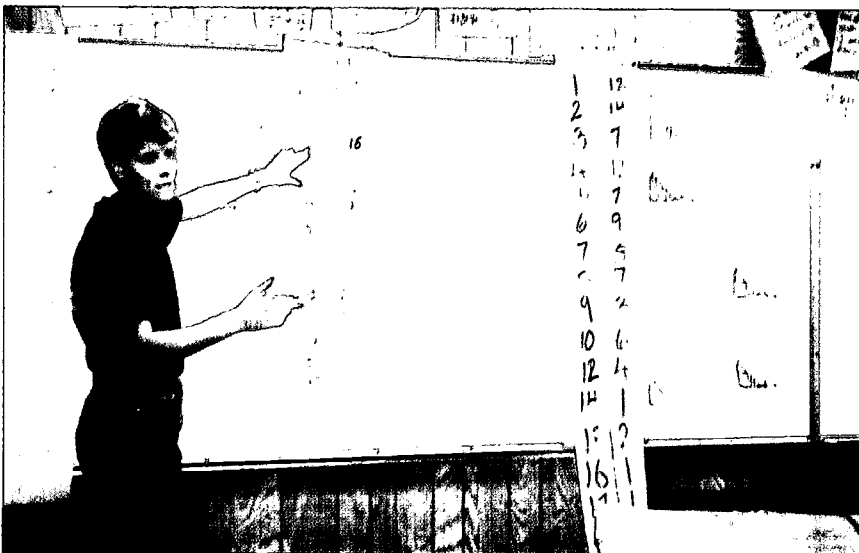
We've all heard the old joke about how you get to Carnegie Hall: Practice! Practice! Practice! This sage advice serves our mathematics students equally well. Math must be practiced everywhere, not just in the math classroom. The question is: How can we persuade our colleagues who do not teach mathematics to include math skills in their teaching?

First, we must assure other teachers that we aren't asking them to teach math concepts that are new to the students. Rather we must stress that we want them to reinforce concepts and skills already presented to and practiced by their students. Second, we must be willing to reinforce some of their material in our math classrooms. I often include science, history, and English topics in my classes. And third, we should offer suggestions and support. Colleagues who are not math teachers may be reluctant to use math in their lessons. It's up to us to help them see the opportunities.

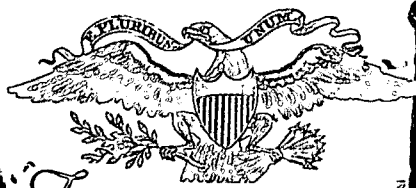
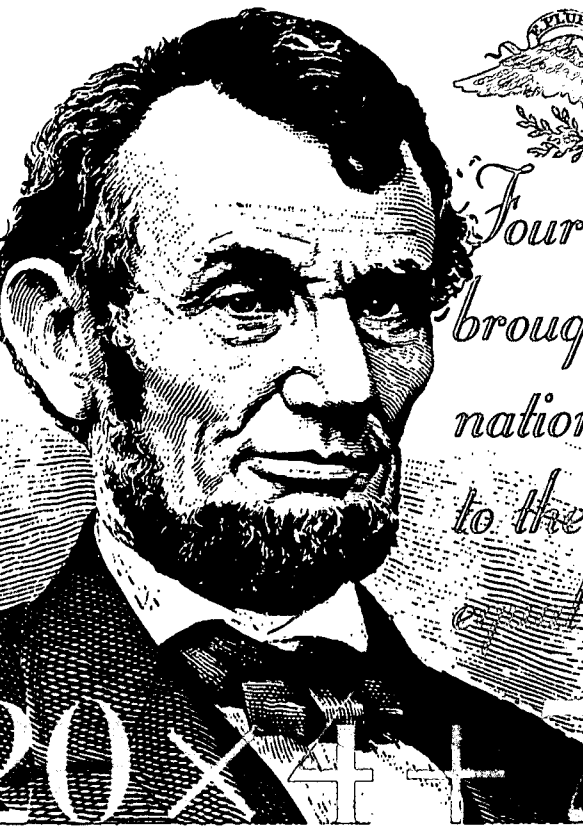
One way to work mathematics into any classroom is simply to go off the subject of a lesson for a few minutes. Young people seem to love digressions. This has been especially true for the students I teach in a juvenile justice alternative education program. Because I'm talking about something that appears unrelated to the assignment, they believe they are not really working. Approximately 25 percent of the students in our program are identified as special education; more than half are two to three grade levels behind in math or reading. All have been expelled from public school and spend from 60 to 90 days in the program.

I share my ideas with my fellow alternative teachers in presentations. I tell them about my "go-off-the-subject" idea and give some examples, such as the ones below, to get them started.

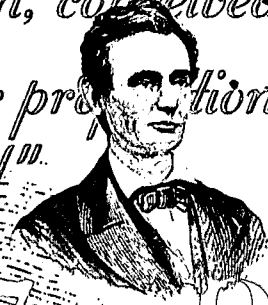
Language arts and social studies classes are especially easy to detour into math because the content is full of dates and vocabulary. Instead of quickly



for Math Fun and Learning!



Four score and seven years ago our fathers brought forth, upon this continent, a new nation, conceived in liberty, and dedicated to the proposition that all men are created equal.



20,000 Leagues Under the Sea = 87 YEARS

Flag: © Deep Studio. All other images: Daver Publications

passing over the dates of birth and book publication given for an author, have the students subtract the birth year from the publication year to arrive at the author's age at the time the book was published. Birth and death years can also be used for authors or important historical figures. In looking at the dates it may be important to review divisibility rules or place values. (Be sure to give teachers some quick definitions of these terms.)

Go beyond the definition of vocabulary words for measurements, such as fathom, league, rood, or fortnight, to calculate and compare numbers. For example, from the book title *20,000 Leagues Under the Sea*, calculate the depth of water in miles or feet. Compare the 60,000-mile depth to the diameter of the Earth, some 7,918 miles, or to the Mariana Trench's 35,800-foot depth. The opportunities for conversions and comparisons are plentiful.

When palindromes (words, phrases, and numbers that read the same forward and backward) are introduced in an English class, it is easy to use numbers as examples. Begin with 2002 and list other years that are read exactly the same forward as backward. This doesn't seem like work to the students, but it's easy to slide into some review of number theory. Have the students generate

some numbers and quickly review basics like even, odd, prime, and composite numbers. It's even possible to work on divisibility rules.

My favorite history example is drawn from the opening phrase of Abraham Lincoln's Gettysburg Address. I state the phrase and break it down like this to review the math concept of order of operations:

Four score and seven years ago

4 times 20 plus 7

$4 \times 20 + 7 =$

Have students subtract the answer to the equation $4 \times 20 + 7$ from the year of the speech, 1863, to discover the year and event to which Lincoln was referring. This leads students to 1776 and the Declaration of Independence. Consider ways you can back into the historical event of the day's lesson by using a simple math problem first. Depending on the topic, the students could discover facts such as a president's number in the succession of presidents, a state's number in the ratification of statehood, and other interesting facts.

Social studies classes often deal with area, population, and location (as in latitude and longitude). Instead of just reading statistics, students could be involved in

making graphic representations and comparisons, finding percentages, building scale models, and many other activities. This would not only reinforce mathematics but also make social studies more concrete and memorable for the students.

Using dates to reinforce math skills is easy in every class if you have one of the calendars that give trivia facts for each day. On January 31, the calendar may tell you that in 1928 the 3M Company developed Scotch tape. You could begin class announcing that today was something's 73rd birthday. Have a student subtract to find the year in question. Briefly discuss whether the year (or age) is prime, composite, even, or odd, and then share the trivia about the tape. Everyone seems to enjoy trivia, particularly students who think they have their teacher "off the subject." While you may be off your academic subject briefly, your students are on the subject of mathematics and most won't even notice.

The possibilities for integrating mathematics into other subjects at all grade levels are endless.

The mathematics involved can be simple or complex, depending on the teachers' level of comfort. The digression to math can take seconds or longer if desired. Flexibility and spontaneity are the key elements to stress when you ask other teachers to join you in teaching mathematics across the curriculum.

Mathematics teacher Rhonda D. Cummins is an employee of the Dickinson, Texas, Independent School District assigned to the Juvenile Justice Alternative Education Program.

ENC is hosting an online discussion of this article!

To join the conversation, visit

enc.org/focus/discuss/cummins



Exploring Science and Human Health

Free curriculum supplements from the National Institutes of Health make science relevant to the lives of students.

by Cynthia Delgado, National Institutes of Health, Washington, D.C.

Teachers want up-to-date life science materials that contain hands-on activities and colorful graphics, and are flexible and easily accessible. So says Gloria Seelman, recently retired master teacher and current consultant to the National Institutes of Health (NIH) Office of Science Education (OSE)—an office working to give teachers just what they want.

The NIH Curriculum Supplements, an NIH initiative to develop K-12 curricula to support the National Science Education Standards, combine the latest scientific research discoveries from the NIH with state-of-the-art instructional techniques. Units are designed to promote inquiry-based activities, to deepen student understanding of the connection between basic science and public health, and to offer opportunities to apply creative and critical thinking. Supplements have been created for elementary, middle, and high school students.

Each unit is teacher-ready and includes background information, implementation guidance, assessment tools, student pages, take-home activities, and an interactive CD-ROM. The materials are distributed free to classroom teachers and school administrators upon request.

A Partnership for Excellence in Science Education

The NIH Curriculum Supplements are the result of a partnership between K-12 teachers, scientists, and curriculum development experts. A panel of scientists from NIH's 27 institutes and centers provides scientific themes, actual case studies, and real data. Since the NIH is one of the world's foremost medical research centers, teachers are assured that the supplements contain current biomedical content. Biological Sciences Curriculum Study (BSCS)—a company nationally recognized for exemplary science curricula for more than 40 years—works with the multimedia publishing company Videodiscovery to develop the units.

Teachers play pivotal roles throughout development and testing. Each unit is field-tested nationally by teachers serving students from diverse ethnic and socioeconomic backgrounds.

In an early independent evaluation, science achievement was found to be 15 percent higher, on average, and more equitable among diverse ethnic populations in classrooms that used the supplements, compared to those that did not. Moreover, the supplements stimulated student interest in, and understanding of, scientific research.

Teachers and Students Stay Up-to-Date

The NIH Curriculum Supplements model how basic science and medical research can be creatively translated into real-life scenarios relevant to today's students. Each unit includes five to six inquiry-based activities that

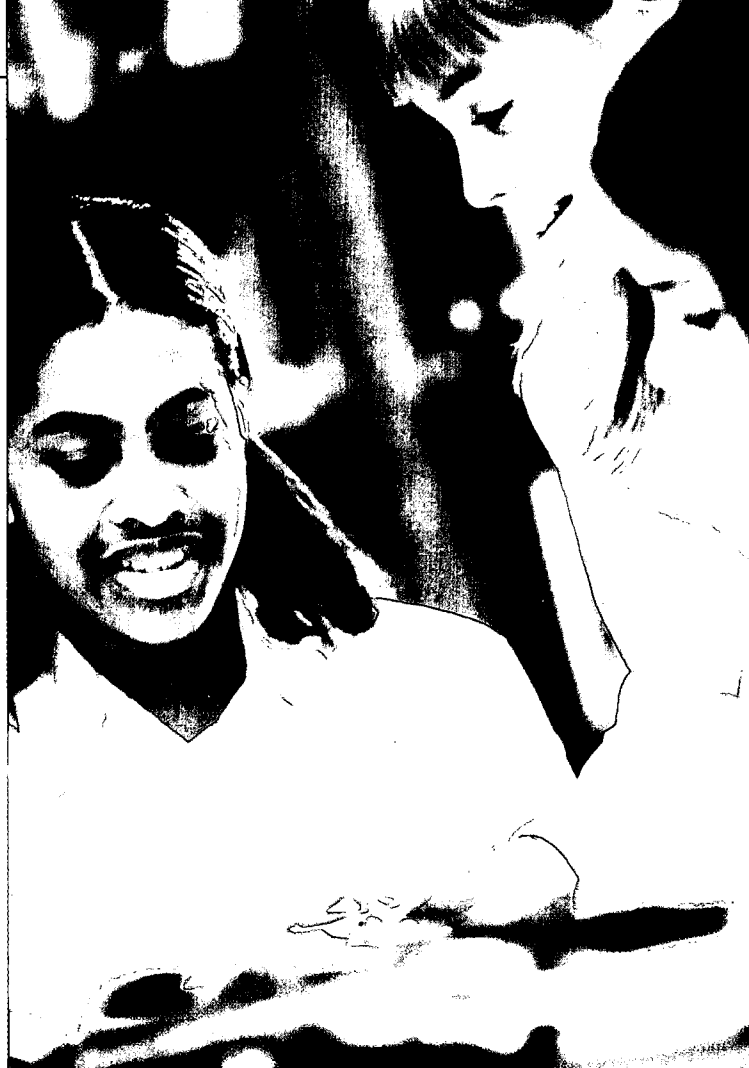
promote basic science knowledge, active and collaborative learning, problem-solving and critical-thinking skills, and application of new knowledge.

For example, Cell Biology and Cancer activities are intended to dispel common misconceptions about cancer and to deepen student understanding of the cell cycle and the development of cancer. In one activity, students apply rigorous criteria to test media reports about cancer-related developments, just like real scientists. In another activity, students role-play as federal legislators to support or oppose a proposed law on cancer prevention.

The supplements are not intended to introduce extra material into teachers' busy schedules. Unit charts specify how activities fit into existing curricula and popular textbooks and how they correlate with the National Science Education Standards.

The OSE continues to develop new supplements each year, and three additional units will be available in 2002. Plans are underway to provide online versions of the CD-ROM and video components and to sponsor teacher workshops.

Cynthia Delgado, a writer and editor at the National Institutes of Health, Washington, D.C., enjoys speaking to local schools about the NIH, science, and related careers. Prior to her current position, she spent 15 years as a biological researcher at the NIH.



Teachers Say...

The NIH Curriculum Supplements are appreciated by new teachers and seasoned veterans alike. Cynde Aaron, a first-year teacher at AIMS High School, Socorro, New Mexico, says she had no difficulties using the Human Genetic Variation kit, and using it helped her learn how to write excellent curricula. She likes the hands-on activities, and her students especially like the "dice game in which they saw that consequences resulted from choices in life."

"I always learn from these supplements," says teacher Greg Nichols of New Option Middle School in Seattle, Washington. A field tester of Chemicals, the Environment, and You: Explorations in Science and

Human Health, Nichols says the units teach the teacher while removing the fear of having to be an expert on a particular topic. He notes that the units can "puzzle fit" into the school's curriculum, and they represent current advancements in science. He reports that his students say the unit's activities "force them to think, respond, and defend their answers."

Nichols knows first-hand what teachers think about the NIH's middle school unit. An instructor at several teacher workshops using the supplement, he says, "Teacher responses were amazingly favorable. About 98 percent of teachers who attend say they will use the supplements. [They] feel confident to use [the supplements] right away...They go away with ready-to-use materials."

Janet Crockett, a teacher at Shepherd Elementary school in Washington, D.C., was surprised to learn that the initial onset of a cavity can be reversed by brushing and flossing. "I didn't know that," she said. Crockett field-tested the elementary unit, Open Wide and Trek Inside, which goes beyond the traditional brushing and flossing instruction to explore the oral environment.

Crockett recalled a student's mother reporting on the unit's impact. The student ate a piece of candy just before dinner and told her mother she needed to brush her teeth. The mother assured the child that she could wait until after dinner. The child replied, "I have to brush my teeth before I have a big acid attack!"

Focus on the Collection

This section presents highlights from the full ENC record for exemplary resources selected to illustrate this issue's theme.

ENC's Collection and Catalog

ENC's collection of mathematics and science resources is the most comprehensive in the nation. 20,000 resources are housed in our national repository, with new items arriving daily. We collect materials from federal and state agencies, commercial publishers, professional organizations, school districts, and individuals. The collection includes print materials, software and CD-ROMs, kits and manipulatives, along with hundreds of excellent Internet sites.

All materials are cataloged by ENC, and the catalog records are searchable from our web site (enc.org). Part of each catalog record is a detailed description of the resource written by ENC experts in mathematics and science education. These descriptions are not evaluative reviews, but the online record does include references to reviews, awards, and other evaluative materials.

Math, Science, and So Much More: Making the Cross-Curriculum Connection

By Carol Damian and Terese Herrera, ENC Content Specialists

When we design a student's education, we emphasize the importance of considering the whole person—background, culture, special learning abilities, motivation, and interests. The theme of this issue of *Focus*, Math and Science Across the Curriculum, fits right into this line of thinking. To educate wholly is to develop in students an understanding of the connectedness of thoughts, experiences, and knowledge. Such a holistic approach to education opens endless vistas of choices to the maturing child.

When science or mathematics (or any subject area, for that matter) is studied in isolation, many students find no connection to the complex world around them; the subject can seem just plain boring and without purpose. At the first opportunity, they drop it. But if we as educators succeed in relating the subject to real and engaging cross-curricular experiences, we offer a world of opportunity to our students.

All over the world, mathematics and science play an ever-increasing

role in jobs, communication, health concerns, pastimes, politics, and everyday technology. Truly engaging our students in math and science—and encouraging them to stay with these studies—may be our greatest long-term gift of learning to them.

For the Collection Section of this *Focus* issue, we targeted resources that explore many different aspects of science and mathematics. In our selection, we placed high priority on materials that include cross-curricular applications of math and science, along with the building of new content knowledge, understanding, and related skills.

In this special collection, you will find items that connect math and science to each other. We also highlight resources that connect math and science to art and music, social studies, language arts, and popular literature for young and old.

The items in this *Focus* on the Collection section are drawn from the total ENC collection of more than 20,000 math and science educational materials. The featured items represent a variety of formats such as print, CD-ROMs, activity kits, videos, and web sites. All featured items are considered to be exemplary, based on this theme of Math and Science Across the Curriculum, and worthy of your examination, discussion, and reflection.

It is not possible to include here all of the exemplary materials from the entire ENC collection that would fit this *Focus* theme. You are invited to visit the ENC web site at enc.org, where you will find many more ideas for cross-curricular instruction.



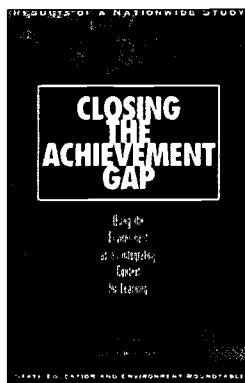
ENC graphic: Jisun An

Featured Resources

Connecting Mathematics and Science Across the Curriculum

Why Cross-Curricular Teaching?

- 60 Closing the Achievement Gap
- 60 Connecting Mathematics Across the Curriculum
- 60 Inquiry Works!
- 60 Integration Strategies for Science Instruction, Grade 5
- 61 Interdisciplinary Learning in Your Classroom
- 61 Learning Through Real-World Problem Solving
- 61 Transforming Middle School Science Education

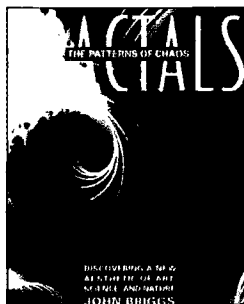


- 66 Create a Co-op City
- 67 Fractal Explorer
- 67 Functional Melodies
- 67 Geometry in Architecture
- 67 Helaman Ferguson
- 68 Helaman Ferguson Sculpture
- 68 Math and Music
- 68 Frequency & Vibration
- 68 MathArts
- 69 Mathematical Quilts
- 69 Math-Kitecture
- 69 Music Is Physics
- 69 Native American Geometry
- 70 Rock Music
- 70 Science Art
- 70 Symmetry and Tessellations
- 70 Teaching Mathematics Through Children's Art
- 70 A World in Motion II



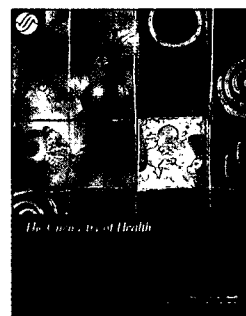
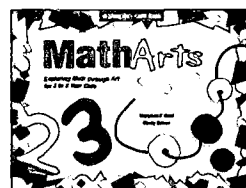
Connecting Mathematics and Science

- 62 Architecture
- 62 Communication Pathways
- 62 The Day Manhattan Ran Dry
- 62 Designing Environments
- 63 Enviromath
- 63 Fractals
- 63 Functions and Statistics
- 64 Janice VanCleave's Teaching the Fun of Science
- 64 K'NEX Classroom Super Set
- 64 Mission Mathematics, Grades 9 to 12
- 64 Nature at Your Doorstep
- 65 Shape of the World
- 65 TIMS Laboratory Investigations
- 65 Under Construction



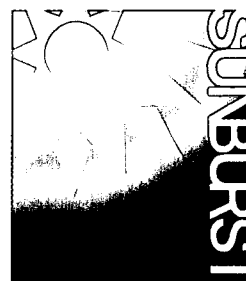
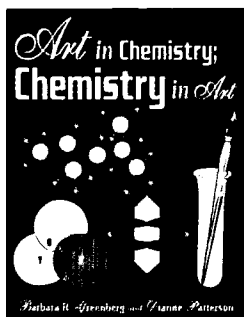
Connecting to Social Studies

- 71 Bioethics Forums
- 71 Changing Climate?
- 71 Chemicals, Health, Environment, and Me (CHEM-2)
- 72 The Chemistry of Health
- 72 Crashed, Smashed, and Mashed
- 72 Decisions Based on Science
- 72 Fostering Sustainable Behavior
- 73 Fourscore and 7
- 73 Geometry Activities from Many Cultures
- 73 Ice Cream Truck
- 73 Is Democracy Fair?
- 74 Kidbits
- 74 The Life Cycle of Everyday Stuff
- 74 Mathematics from Many Cultures, Level B

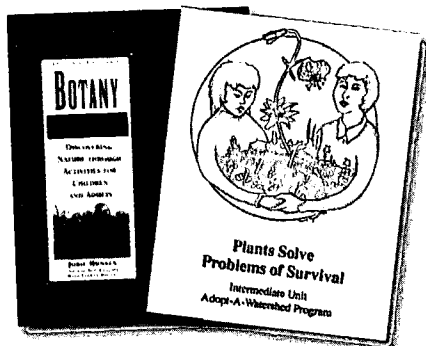


Connecting to Art and Music

- 66 The Art and Science Connection
- 66 Art in Chemistry; Chemistry in Art
- 66 Building a Teen Center

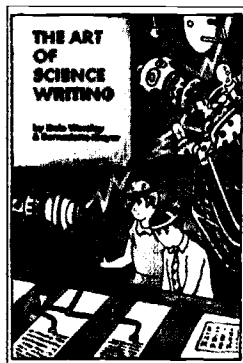


- 74 The Multicultural Math Classroom
- 75 Newton's Apple Program 1011
- 75 One-Minute Readings
- 75 People and the Planet
- 76 Plants Solve Problems of Survival
- 76 The Power of Numbers
- 76 Rivers Curriculum Guide: Biology
- 76 Rivers Curriculum Guide: Chemistry
- 77 Rivers Curriculum Guide: Earth Science
- 77 Rivers Curriculum Guide: Geography
- 77 Rivers Curriculum Guide: Language Arts
- 77 Rivers Curriculum Guide: Mathematics
- 77 Science for All Americans
- 78 The Theory of Plate Tectonics
- 78 Through the Eyes of Explorers
- 78 The Titanic in the Classroom
- 78 Trash and the Environment
- 79 Understanding Car Crashes
- 79 Water

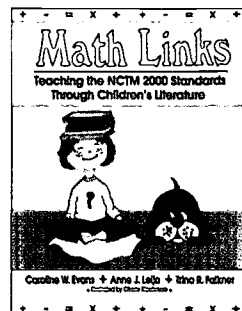


Connecting to Language Arts

- 79 The Art of Science Writing
- 79 Caldecott Connections to Science
- 80 Integrating Science and Language Arts in Your Classroom
- 80 Learning English Through Science
- 80 Literacy and Mathematics, Grade 5
- 80 Literacy and Science, Grade 8
- 81 Literature and Science Breakthroughs
- 81 Math and Literature (Grades 4 to 6)
- 81 Math and Writing

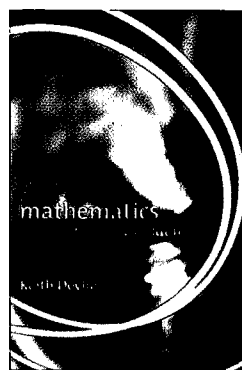
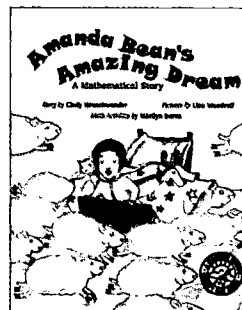


- 81 Math Is Language Too
- 82 Math Links
- 82 Mathematics the Write Way
- 82 Promoting Student Thinking
- 83 Science Adventures with Children's Literature
- 83 Science and Stories, Grades 4-6
- 83 Storytime, Mathtime
- 83 Teaching Physical Science Through Children's Literature
- 84 Writing Math Research Papers
- 84 Writing to Learn Mathematics



Connecting to Literature for All Ages: Math

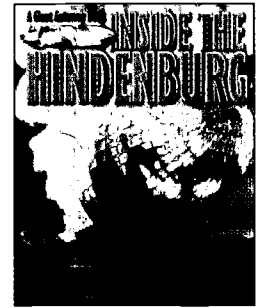
- 84 Amanda Bean's Amazing Dream
- 84 Amazing & Incredible Counting Stories!
- 84 Anno's Mysterious Multiplying Jar
- 85 Counting on Frank
- 85 Flatland
- 85 How Big Is a Foot?
- 85 If You Made a Million
- 85 The King's Commissioners
- 85 Let's Count
- 85 The Librarian Who Measured the Earth
- 85 Marvels of Math
- 86 Math Cure
- 86 Mathematicians Are People, Too: Volume 1
- 86 Mathematics
- 86 The Number Devil
- 86 One Hundred Hungry Ants
- 86 Quack and Count
- 87 Sir Cumference and the First Round Table
- 87 Ten Beads Tall
- 87 Twelve Snails to One Lizard



Connecting to Literature for All Ages: Science

- 87 A Brief History of Time
- 87 And Then There Was One
- 87 The Boy with Paper Wings
- 88 Dear Children of the Earth
- 88 Earthsteps
- 88 Enrico Fermi and the Revolutions of Modern Physics
- 88 Everybody Has a Bellybutton
- 88 Exploring the Environment Through Children's Literature
- 88 The Bald Eagle

- 89 Hungry Animals
- 89 Inside the Hindenburg
- 89 Keepers of the Earth
- 89 Louis Pasteur
- 89 Margaret Mead
- 89 Moonbear's Pet
- 90 Seashore Surprises
- 90 Six Easy Pieces
- 90 Snowflake Bentley
- 90 Tales of the Shimmering Sky
- 90 What Happens When...?
- 90 Where Once There Was a Wood



Searching the ENC Collection of Resources

The resource descriptions printed in this magazine are abbreviated versions of the full catalog records available online. You can access ENC's vast collection of curriculum resources by visiting ENC Online (enc.org).

To find the online record for resources featured in *ENC Focus*:

The easiest way to browse the online records of resources featured in an issue of *ENC Focus* is to go to our web site (enc.org) and select the link in the top right corner to ENC Focus Magazine. Select the title of the appropriate issue, then scroll down to the Focus on the Collection section. Finally, follow the links to the records of your choice.

To find other resources:

When you visit ENC Online (enc.org), the Curriculum Resources section in the left navigation bar offers both a simple and an advanced search with help features for each. The advanced search allows you to choose particular subject words, grade level, cost, and type of material to find exactly what you need.



For example, materials for this magazine were found through the use of subjects such as integrated approaches, language arts, social sciences, and environment.

Also in the Curriculum Resources section is the Browse option. Find the subject you are interested in. Once a first page of results is returned, you can use the "Customize using advanced search" feature to further limit your search.

The screenshot shows the ENC Online search page. At the top, there's a navigation bar with links like 'About ENC', 'ENC Database', 'Register with ENC', 'ENC Focus Magazine', and 'Contact Us'. The main section is titled 'Search' and includes a search engine interface with fields for 'What topics should the resources cover?', 'What type of resources are you looking for?', 'What grade levels should the resources cover?', and 'How much should the resources cost?'. There are also buttons for 'Submit search' and 'Need help? Check out our search help frequently asked questions or get in touch'.

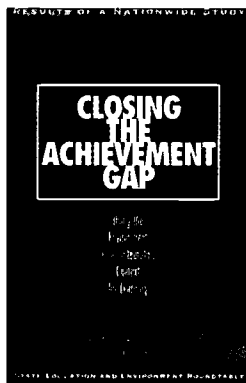
Additional assistance is available online (enc.org/resources/search/help) or by contacting the ENC Information Services staff by email (library@enc.org) or phone (614) 292-9734.

Why Cross-Curricular Teaching?

Closing the Achievement Gap

Grades K-12
1998

Contributor(s): Gerald A. Lieberman and Linda L. Hoody
Publisher: State Education and Environment Roundtable



This report presents the results of a nationwide study of schools, teachers, and students involved in the Environment as an Integrating Context for Learning (EIC) program. EIC is a curriculum framework that integrates natural and sociocultural environments with pedagogical techniques considered to be best practices in the educational field. The program emphasizes hands-on and project-based activities, team teaching, and individualized instruction. An overview of the study includes

a discussion on assessment instruments and validity measures. A discussion of the impact of EIC implementation is divided into eight major sections ranging from general education and specific subject areas to thinking skills and interpersonal abilities. Data tables, found throughout the text, summarize and analyze the quantitative outcomes. Teacher comments and school vignettes offer a qualitative component. An executive summary piece outlines the major aspects of the study and presents evidence that EIC improves student achievement across the curriculum. (Author/JG) ENC-019378

Ordering Information
Science Wizards, 13648 Jackrabbit Road, Poway, CA 92064
(858) 676-0272 / Fax: (858) 676-1088
www.seer.org
\$13.00 per book (paperback)

Connecting Mathematics Across the Curriculum

Series: NCTM Yearbook
Grades K-12
1995

Contributor(s): Arthur F. Coxford and Peggy A. House

NCTM's 1995 yearbook, featuring papers submitted from professionals across the country, is designed to help classroom teachers, teacher educators, supervisors, and curriculum developers broaden their views of mathematics. The volume illustrates connections and uses of mathematics within the discipline itself, between mathematics and other disciplines, and in the life, culture, and occupational experiences of adult communities. Readers will also find practical strategies to engage students in exploring the connectedness of mathematics. The first part of the yearbook addresses general issues related to the meaning and scope of mathematical connections and the role these connections play in teaching and learning mathematics. The second part focuses on connections within mathematics itself, including how concepts emerge in the early grades and grow in sophistication and applicability throughout the mathematics curriculum. Papers in the last three parts

of the yearbook discuss opportunities to connect mathematics across the curriculum in the elementary, middle, and secondary school years. The examples include connections to other school subjects and to mathematics as it is used in adult life. (Author/KFR) ENC-008429

Ordering Information
National Council of Teachers of Mathematics, Inc., 1906 Association Drive, Reston, VA 20191
(703) 620-9840 / Fax: (703) 476-2970 / Toll-free: (800) 235-7566
www.nctm.org
\$26.95 per book (hardcover)

Inquiry Works!

Grades 6-12
2000
Contributor(s): Concord Consortium

This book presents the reflections and journal entries of middle and high school teachers as they implemented inquiry-based practices into their math or science classrooms. These teachers were participants in the International Netcourse Teacher Enhancement Coalition (INTEC), in which they explored the nature of inquiry and selected one of 11 curricula for in-depth study. Some of the curricula they chose from include Algebra with Manipulatives, Texas Instruments' Calculator Based Laboratory, and Chemical Kinetics by LOGAL and SimCalc. The book includes stories that highlight the stresses involved in balancing content with student questions, developing assessment strategies that match learning processes, and letting go of teacher-centered pedagogy. A sample story, *Walking a Tightrope over Mars*, describes the initial dissatisfaction Gary Webber and his class experienced with the Mars Project by JPL. The materials seemed less than inspiring, the students did not seem to be engaged, and Webber had a hard time fitting all the concepts together. Finally, in response to student disconnectedness and apathy, Webber showed a video called *The Planets*, which sparked student investigations with wallpaper trays, sand, and water. Three weeks of experimentation with ice, sand blasting silica, and a digital camera generated new questions and methods. The transformation left Webber wondering how an experience such as his could be justified when only a small part of what needed to be covered was actually studied. (Author/JG) ENC-020160

Ordering Information
The Network, Inc., Suite 900, 300 Brickstone Square, Andover, MA 01810
(508) 470-1080 / Fax: (508) 475-9220 / Toll-free: (800) 877-5400
\$15.00 per book (paperback)

Integration Strategies for Science Instruction, Grade 5

Grade 5
1998
Contributor(s): North Carolina Department of Public Instruction

Integration Strategies for Science

Grade 5



The 10 investigations in this curriculum guide focus on the concept of energy. Background information, correlations to North Carolina state standards, and materials lists are provided, as well as suggestions for integrating topics with language arts, mathematics, and social studies. Using a definition-by-example approach, students construct their own understanding of energy

through observations and analyses of real-world situations. Activities are based on a three-stage learning cycle of exploration, invention, and expansion. For example, during the Burn It Up! sequence, students burn various foods to compare the amount of heat calories produced by each one. Drawing on this knowledge, students make connections between the fact that food contains energy to the fact that we need energy to carry out our daily activities. Students then expand their knowledge by exploring the amount of calories in common foods, identifying the calorie requirements for fifth graders, and researching how different exercises affect calorie burning. Extensions are also included that utilize computer applications. Multiple assessments feature open-ended questions and performance tasks adapted to different learning styles. Cooperative learning is emphasized throughout. Appendices contain information on teaching styles, tips on the use of cooperative learning, and ideas for improving questioning skills. A section about safety offers a complete checklist of safety information. (Author/SSD/JG). ENC-019446

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North Carolina Department of Public Instruction, Publication Sales, Room B75, 301 North Wilmington Street, Raleigh, NC 27601
(919) 807-3451 / Fax: (919) 807-3482 / Toll-free: (800) 663-1250
www.dpi.state.nc.us
\$12.00 per book (loose-leaf)

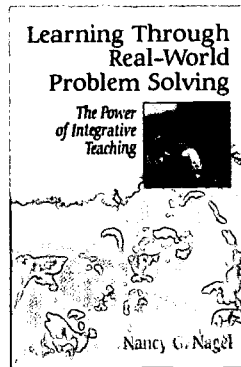
Interdisciplinary Learning in Your Classroom

www.thirteen.org/wnetschool/concept2class/month10/index.html
Series: Concept to Classroom Workshops
Grades K-12
1999
Contributor(s): Amy Benjamin, Anna Chan Rekeate, Cindy Gaston, and Heidi Hayes Jacobs
Publisher: Thirteen/WNET

The interdisciplinary teaching and learning workshop on this site is divided into four sections: an explanation of the approach, a demonstration of an integrated lesson plan for different grade levels, a seven-step template for implementing the method, and helpful hints from an expert. Also provided are examples of the requisite materials for pursuing professional development credit, such as a letter to an administrator about the online program. Four discussion boards allow educators to share ideas and experiences. Icons direct users to integrated lesson plans, real-life dilemmas, and buzzwords as well as expert advice, to-do lists, and video clips of interviews with educators practicing integration in their classrooms. One sample section describes the steps for creating an integrated unit. Before brainstorming about the content of an interdisciplinary unit, the text recommends that teachers perform a student assessment. This technique allows educators to better tailor the unit to students' individual and group needs. Scaffolding the curriculum also includes taking a look at the state and national education standards. As teachers examine the standards, they are counseled to record which objectives to address and their preferred ways to assess that students have met those objectives. A resources link provides more information on standards. (Author/LEB) ENC-020714

Learning Through Real-World Problem Solving

Grades K-8
1996
Contributor(s): Nancy G. Nagel



Intended for mathematics and science educators of all grade levels, this book helps educators employ integrative teaching methods that incorporate real-world problems. The book uses the term *integrative teaching and learning* to emphasize the dynamic process in the proposed curriculum and teaching model. Initially, definitions and models are presented and are followed by supporting arguments for implementation. Four separate cases are introduced and analyzed for their use of integrative teaching and

learning. Each case includes an objective, an opening activity, a lesson activity, and a closing activity. The book also describes assessment formats, assessment samples, and assessment of teaching. An in-depth discussion analyzes the concept of student ownership of learning. The text also provides suggestions for implementation. (Author/SXA) ENC-006457

Ordering Information
Corwin Press, Inc., 2455 Teller Road, Thousand Oaks, CA 91320
(805) 499-9734 / Fax: (800) 417-2466
www.corwinpress.com
\$24.95 per book

Transforming Middle School Science Education

Series: Ways of Knowing in Science
Grades 6-8
2000
Contributor(s): Paul DeHart Hurd

This book presents a vision for rethinking and recreating the middle school science curriculum. A review of educational literature supports the author's viewpoint that effective reformation begins with a study of adolescents, including their social behavior, biological characteristics, and physical and emotional health. Topics include student motivation, peer relationships, and the nature of deviant behaviors. Subsequent chapters address ways in which these understandings can be embedded within the framework of a meaningful curriculum. A sample chapter, *Preparing for Life: A Science of Ourselves*, discusses the critical need for students to be personally involved in the learning process. The use of real-life situations, laboratory-type experiments, and community studies are cited as ways to accomplish this goal. Criteria are listed to assist in organizing a three-year life science program, beginning with the human as an individual and exploring how that relates to the larger global picture. Suggestions for future education include improving teacher education and establishing a permanent national curriculum center to address school science issues. (Author/YK/JG) ENC-019391

Ordering Information
Teachers College Press, Columbia University, PO Box 20, Williston, VT 05495
Fax: (800) 417-2466 / Toll-free: (800) 575-6566
www.teacherscollegepress.com
\$19.95 per book (paperback)

Connecting Mathematics and Science

Architecture

Series: Intermediate Themedworks
Grades 4-6
1996
Contributor(s): Kelly Stewart

Part of the Intermediate Themedworks series, this book uses hands-on activities and simple text to teach students about architecture. The series consists of theme-based books that provide learning experiences in science, math, language, social studies and art. Using this book, students learn what architecture is, explore a construction site, and examine building materials. Readers also discuss why the shape and the function of a building are equally important. The text addresses how both environment and people influence the development of architecture. Students investigate the forces acting on buildings, examine various types and examples of architecture in their town and in the world, and study a variety of bridges. In addition, they research the amazing structures built by animals and create a site development plan for an area in their community. Finally, students plan an Architecture Night on which they display models of buildings, dress up in period and ethnic costumes, and prepare foods from different cultures and periods. The book provides activity sheets, suggestions for culminating activities, and a list of related fiction and nonfiction books. A curriculum chart lists subjects covered in the book and related learning goals. (Author/RA) ENC-010254

Ordering Information
Creative Publications, 1250 George Road, Ashland, OH 44805
Fax: (800) 624-0822 / Toll-free: (800) 624-0821
\$23.95 per book

Communication Pathways

Series: Integrated Mathematics, Science and Technology (IMaST) Project
Grade 8
1999
Contributor(s): CeMaST and Illinois State University

In this curriculum unit, part of the Integrated Mathematics, Science, and Technology (IMaST) program for middle school students, students use a problem-solving process to analyze, design, and construct a communication system. The standards-based IMaST program is designed to promote experientially based, hands-on learning for students and to facilitate teaming among teachers from three or more disciplines. Even though the curriculum emphasizes connections among mathematics, science, and technology, connections are often made to other disciplines as well. The program is built on major themes that are presented in separate modules. It uses the learning cycle approach with problem solving as the key instructional technique. Each unit contains a student text and a teacher's resource binder. The student text contains explorations for topics such as the codes involved in students' everyday experiences, the use of electricity and light waves to transmit codes, and the technology involved in translating the codes. The teacher's resource binder explains how to implement the IMaST program and how the mathematics, science, and technology activities can be scheduled to coordinate among the team of

teachers. Teachers can find directions and teaching suggestions for each portion of the activities as well as assessments and grading criteria. Student journal pages have questions, tables, and graph paper to guide the students' recording of their answers and results. (Author/JR) ENC-018079

Ordering Information
Illinois State University Integrated Mathematics, Science and Technology (IMaST), PO Box 5960, Normal, IL 61790
(309) 438-3089 / Fax: (309) 438-3592
tu.edu/depts/cemast/imast/imasthome.htm
\$25.75 per teacher edition (loose-leaf)
\$8.50 per student edition (paperback)

The Day Manhattan Ran Dry

Series: Eddie Files
Grades 3-6
1997
Contributor(s): Kathie Heard, Kay Toliver, Rob Mikuriya, and Steven R. Heard
Publisher: PBS Video

In this video, student Eddie Lisboa considers the implications for Manhattan residents of a day without water. The video is part of the Eddie Files series, which combines fiction with real-world math and science to show how classroom learning can be applied in everyday situations. Each episode has three major elements: the classroom lesson, Eddie's experience, and interviews with professionals who use the featured mathematics in their jobs. As this episode begins, math teacher Miss Toliver challenges students to determine, using models, how much water it would take to cover with one inch of water their classroom floor, the playground, a basketball court, and Central Park. Eddie considers what a day without water would be like and meets with a water system manager to learn how water is collected and dispensed to cities. Eddie discovers a New York City law that requires every building over 80 feet tall to have a water tank on its roof. He talks with a water tank maker and with city engineers who explain how water is transported. A teacher's guide offers activities to enhance the mathematics covered in each episode. (Author/SXA/JRS) ENC-020562

Ordering Information
Foundation for Advancements in Science and Education, 4801 Wilshire Boulevard, Park Mile Plaza Suite 215, Los Angeles, CA 90010
(213) 937-9911 / Fax: (323) 937-7440 / Toll-free: (800) 404-3273x267
www.fasenet.org
\$44.95 per video
\$3.50 per book (paperback)

Designing Environments

Series: MESA
Grades 5-8
1998
Contributor(s): Christine V. Johnson

In this project module, part of the Real-World Mathematics Through Science series, students investigate how perimeter and area concepts can influence design decisions and cost factors. The cross-curriculum series combines essential prealgebra topics with hands-on science explorations to motivate students in both areas of study. Using materials and group collaboration to solve open-ended problems, students are encouraged to make connections between classroom and real-world applications through links to writing, history, technology, and careers. In this module, the focus is on scale drawing, proportion, and area-perimeter relationships. Each

activity begins with an overview page summarizing the student work and how the teacher needs to prepare. This is followed by background information for the teacher's use and a detailed description of the activity, along with suggested discussion questions and assessment strategies. Also included are project ideas for students to complete with their families. In a sample activity, *Pondering Perimeter*, students design the layout for a 40-acre animal preserve located at the environmental camp. In addition to determining all the perimeter possibilities for preserves made up of 40 square tiles, students examine a plot plan of the campsite, decide on the location for their animal preserve and cabins, and then determine how long it might take them to walk the preserve perimeter. Materials lists, blackline activity masters, and transparency masters are included. (Author/YK) ENC-014438

Ordering Information

Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$21.95 per activity book (paperback)

Enviromath

Grades K-8

1997

Contributor(s): Bobbie S Oh and Michael Wright

Publisher: Kendall/Hunt Publishing Company

Using a hands-on, inquiry-based approach, the 25 activities in this teacher resource book combine mathematics and environmental science. This book utilizes mathematical skills including patterning and classifying, graphing, measuring, computation, and problem solving. Each activity contains background information, needed materials (commonly found in the classroom or home), reproducible student pages, and extension ideas. The book uses real-world contexts to interest students and to integrate disciplines that have traditionally been taught separately. Students are also given the chance to investigate and learn through inquiry. In a sample activity, students learn how to measure the circumference, crown width, and height of a tree. Students make predictions and then actually measure the three dimensions for a tree in their schoolyard. The champion point value for the tree is the sum of these three dimensions. Students work in pairs to determine the dimensions for other trees and calculate their champion point value. In a related extension activity, students calculate the age of the champion tree using the rule that each inch in a tree's girth represents one year's growth. They also learn about historic events through which the tree has lived. References are included for each activity. (Author/JRS) ENC-016378

Ordering Information

Two Herons, PO Box 722, Oxford, OH 45056
(513) 523-7223
miax1.muohio.edu/~kaufmadg/2herons.html
\$17.95 per book (spiral-bound)

Fractals

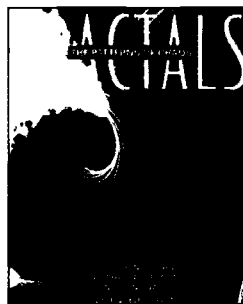
Grades 7-12

1992

Contributor(s): John Briggs

Publisher: Touchstone Book

This illustrated book explores fractals and patterns of chaos as visual, artistic links to mathematics and science. It shows the significance and the beauty of fractals, which are unique



patterns left behind by unpredictable movements. These patterns are found in nature and can be generated by the computer using an iterative process. In a unique approach, the author suggests that the book be read in a nonlinear fashion, either by following the reader's whim to learn more about some aspects of fractal/chaos topics or by following path-of-interest

buttons through the book. These buttons lead to topics such as the Mandelbrot set, biofractals, space, and visualizing chaos. Linear and nonlinear systems, chaos theory, and dynamical systems are some of the underlying mathematics and science topics described and illustrated. Illustrations and discussions link mathematics, science, and visual representations; examples include a picture of Jupiter's giant swirling eye taken by Voyager 1, the fractal patterns created by starfish bodies washed up on rocks, and Euclidean geometric forms found in a sixteenth-century Flemish painting. Included with the book is software for creating fractals on home computers. (Author/JRS) ENC-020289

Ordering Information

Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$22.95 per book (paperback) •

Functions and Statistics

Series: NASA Connect Video Series 2000-2001

Grades 6-8

2000

Contributor(s): Bob Starr, Jennifer Pulley, and William Benson

Publisher: Central Office of Resources for Educators

Teen hosts Jennifer and Van introduce functions and statistics in this video that shows how scientists use data to predict the success of technical improvements in space flight. In each video of this series, viewers are presented with a real-world problem and watch interviews with NASA scientists and engineers who explain how science and math are used to investigate these issues. Video segments show classrooms in which students engage in hands-on math and science activities and then work on related web-based projects. The series is designed to support national standards and includes a teacher's guide with background information and lesson plans. NASA maintains a related web site with the featured activities and experiments. In this video, Jennifer and Van interview scientists who explain that when people spend time in space, they lose some of their bone density. They reveal that there is a relationship between the time spent in space and total bone loss. In the classroom activity segment, students construct models of solar panels and thermal radiators using transparency film and aluminum foil. They then plan their own designs of the International Space Station, constructing its modules with common items such as aluminum cans and flexible straws. Students also find the mass of the individual pieces and of the assembled station. For the technology component, students practice docking using an office chair pulled by ropes; they are directed by students at mission control, who are seeing the activity through a video camera. The docking activity is also available on the NASA Connect web site. The teacher's guide

contains instructions for completing the activities with a class. (Author/JRS/SB) ENC-020729

Ordering Information

NASA Headquarters Educational Division NASA CORE/Lorain County JVS, Lorain County JVS, 15181 Route 58 South, Oberlin, OH 44074
(440) 775-1400 / Fax: (866) 775-1460 / Toll-free: (866) 776-2673
www.core.nasa.gov
\$10.00 per video + educator's guide (paperback)

Janice VanCleave's Teaching the Fun of Science

Series: Science for Fun

Grades 3-6

2001

Contributor(s): Janice Pratt VanCleave

Part of the Science for Fun series, this book provides activities and experiments in life science, Earth science, and physical science. The book begins with a brief overview of science as inquiry and the scientific method. The activities are grouped according to science strands. Each activity is accompanied by an overview with teaching tips, correlations to the Benchmarks for Science Literacy, expectations of student learning, and suggestions for preparing materials. Background information and one or more extensions are also provided for each activity. In a sample activity, students investigate the effect height has on the gravitational potential energy of an object. Students pour one cup of dry rice into a sock and measure its mass with a food scale. While one student holds his or her palm in line with the sock, another student releases the sock from different heights. Then the students record their observations in a table. Black-and white-illustrations and a glossary are included. (Author/FCM) ENC-019587

Ordering Information

John Wiley and Sons, Inc., One Wiley Drive, Somerset, NJ 08875
(908) 469-4400 / Fax: (732) 302-2300 / Toll-free: (800) 225-5945
www.wiley.com
\$19.95 per book (paperback)

K'NEX Classroom Super Set

Series: K'NEX in the Classroom

Grades K-8

1994

Contributor(s): Connector Set Toy Company and K'NEX Industries Inc Education Division

Included with this deluxe building kit are lesson plans, materials, and instructions for 25 different K'NEX models. The instruction cards show students how to assemble various models that range from simple geometric shapes and working pinwheels to more complex models of motorcycles, Ferris wheels, and tractors and airplanes. The teacher's guide provides supporting activities divided into three sections. The first section contains open-ended manipulative activities designed to acquaint students with the K'NEX parts and how they fit together. Students explore concepts of length and size, two- and three-dimensionality, and basic geometric shapes. The second section contains projects that explore and expand upon math and science concepts, principles, and skills. These activities are more structured, with concrete answers and results. Sample activities in this section require students to build weight-bearing bridges and explore balance by building teeter-totters. In the third section of the guide, the activities integrate social studies and technology as students create two-dimensional pictures, a model sea turtle, and vehicles that run on wind or solar energy. Also included are connections to cur-

riculum topics, a summary of learning objectives, and instructions for conducting the lesson. Extension activities and journal topics are provided. (Author/LCT) ENC-014249

Ordering Information

K'NEX Educational Division, 2990 Bergey Road, PO Box 700, Hatfield, PA 19440
(215) 997-7722 / Fax: (215) 996-4222 / Toll-free: (888) 222-5639
www.knex.com
\$60.00 per teacher's guide
\$350.00 per set

Mission Mathematics, Grades 9 to 12

Series: NASA/NCTM Project

Grades 9-12

1997

Contributor(s): Adele Hanson, Alice B. Foster, Margaret Butler, Mary Jo Aiken, Michael C. Hynes, Minot H. Parker, Peggy A. House, Richard A. Hanson, and Roger P. Day

This teacher's book, a collaborative effort of NASA and NCTM, features classroom-tested activities on selected aerospace topics. These activities provide models to help students conceptualize the magnitudes of measurements in aerospace applications. Students gain reinforcement in ratio and proportion concepts and learn to apply estimation strategies, proportional reasoning, and topics from discrete mathematics. The material may be used by students at all levels of mathematics as well as to provide challenging activities for advanced students. One unit presents the mathematics underlying the Global Positioning System (GPS). It develops a conceptualization of GPS through examples in one, two, and three dimensions, identifies the mathematics inherent in the systems, and offers a series of activities. In the one-dimensional setting, students try to locate a football coach somewhere along the sideline of a football field. They must determine a signal's travel time from a transmitter in a known position to a receiver in an unknown position, determine the distance traveled by a signal, and determine the position of the receiver. The three-dimensional setting requires triangulation to determine an individual's position on the Earth's surface. The instruction in these activities is standards-based. The book includes three posters describing binary trees and cryptography; satellite orbits and Kepler's laws of motion; and position, navigation, and the GPS. (Author/LDR) ENC-010961

Ordering Information

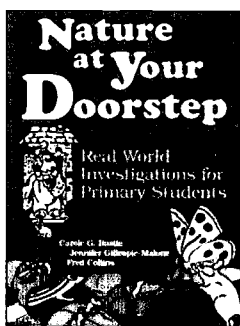
National Council of Teachers of Mathematics, Inc.(NCTM), 1906 Association Drive, Reston VA 20191
(703) 620-9840 / Fax: (703) 476-2970 / Toll-free: (800) 235-7566
www.nctm.org
\$24.95 per book (includes 3 posters)

Nature at Your Doorstep

Grades K-3

1997

Contributor(s): Carole G. Basile, Fred Collins, Jennifer Gillespie-Malone, and Sabra Booth



The focus of this activity book is on ecological topics such as endangered species, insects and birds, communities and habitats, and biodiversity. Each chapter deals with a discrete topic and includes background information, directions for making investigations and comparisons, and guidelines for creating learning extensions. As part of their

investigations, students formulate hypotheses, collect observational data, and draw conclusions. They then analyze their data using a variety of mathematical representations. Sample activities include determining the general form of trees, distinguishing birds by color and location, and determining food preferences of ants. In other activities, students explore the kinds of living organisms found in the schoolyard and record animal and plant interactions. To enhance the development of student skills, the book includes numerous opportunities for integrating language arts, visual arts, social studies, parental involvement, and assessment. Activity sheets and references for related children's literature are also included. (Author/RA) ENC-009065

Ordering Information

Teacher Ideas Press/ Libraries Unlimited, PO Box 6633, Englewood, CO 80155
 (303) 770-1220 / Fax: (303) 220-8843 / Toll-free: (800) 237-6124
 www.ti.com
 \$23.50 per book

Shape of the World

Series: Life by the Numbers

Grades 7-12

1998

Contributor(s): David Elisco, Gregory Andorfer, Janet Driscoll Smith, Joe Seamans, and Mark Knobil
 Publisher: WQED

In this video, viewers learn how the ancient Greeks used mathematics to determine the size and shape of their world. The episode also addresses how mathematics is used today to explore and chart the Earth and the cosmos. It is one of seven videos in the Life by the Numbers series, which explores areas of modern life that have mathematics at their core. Topics include sports, technology, and space exploration. This video features 10 program segments, which include: the work of a graphic artist and mapmaker, who discusses scale and map distortion; and the development by the Air Force of the precision-mapping system, which combines a simulation of an airplane in flight with a three-dimensional map of the terrain. The program focuses on the two domains of exploration: the physical and the mathematical. The video highlights a mathematician who is using mathematics to explore the shape of the universe: he runs light from stars and galaxies through a prism and examines the color spectrum to determine whether the galaxy is moving toward the Earth or away. An accompanying teaching guide provides classroom activities, thematic overviews, and background information for each program segment. The guide includes a description of a school math trail, with activities geared to locations likely to be found in most schools. Students work with proportion and scale, the tangent function, slope, and patterns and fractals while answering questions related to their school. All activities in the guide can be used independently or to support classroom use of the videos. (Author/JRS) ENC-014173

Ordering Information

Monterey Media, 566 St. Charles Drive, Thousand Oaks CA 91360
 Fax: (805) 496-6061 / Toll-free: (800) 424-2593
 www.wqed.org
 \$19.95 per video
 \$120.00 per series (7 videos)

TIMS Laboratory Investigations

Series: TIMS Laboratory Investigations

Grades 1-9

2000

Contributor(s): TIMS Project, Institute for Mathematics and Science Education, University of Illinois at Chicago

Developed by the Teaching Integrated Mathematics and Science (TIMS) Project, this CD-ROM contains 147 investigations that link mathematics and science through quantitative hands-on experiences. The material is based on the premises that children are natural scientists and that mathematics is best taught through active involvement in real problems. As students conduct these experiments, they collect, organize, graph, and analyze data; examine relationships among variables; look for and express patterns mathematically; and use the data to make predictions and inferences. These materials provide a description of instructional strategies, a tutorial for prerequisite skills and knowledge, and a description of each investigation in the set. Each investigation is designed to last four to five days for about 30 to 40 minutes a day. In a sample investigation, middle school students investigate the acceleration of rolling objects in an open-ended assessment lab. Student directions are minimal, and students use their skills as scientists to conclude that when an object rolls down an incline, its acceleration does not depend upon its mass but upon its shape. Students use spheres, solid cylinders, and cylindrical rings and determine the acceleration for each. The objects are raced in pairs, with students first predicting and then determining which one will win and by how much. (Author/CCC/JRS) ENC-020710

Ordering Information

Kendall/Hunt Publishing Company, 4050 Westmark Drive, PO Box 1840, Dubuque, IA 52004
 Fax: (800) 772-9165 / Toll-free: (800) 228-0810
 www.kendallhunt.com
 \$99.99 per CD-ROM (hybrid)

Under Construction

Series: AIMS Activities

Grades K-2

1997

Contributor(s): Barbara Ann Novelli, Betty Cordel, Carol S. Gossett, Jeanne VanDoros, Kay Kent, Linda Fawcett, Margo Pocock, Marylou Miller, Sally Edgerton, and Violet Robinson

The hands-on activities in this book let students use technology by making constructions for themselves as well as for characters from child-centered literature. Technology construction is the vehicle for facilitating the developments of concepts, inquiry skills, and vocabulary. The trial-and-error nature of the activities helps students understand that failures are opportunities to learn. It is part of a series that integrates mathematics and science with other curriculum areas, including language arts, social studies, physical education, art, and music. The 26 activities in this book contain problems to heighten curiosity, questions to stimulate thinking, suggestions to develop analytic skills, and opportunities for exploration. The activities broaden in scope as the students progress through them. Each activity lists the key questions, corresponding standards, and integrated disciplines. In one activity, students explore different designs of can-openers. They analyze the purpose of can-openers and people's motivation to change them. As an extension, the book suggests that students explore the evolution of the ink pen design. Tables elaborate how the project meets Project 2061 benchmarks, the NSES, and the NCTM standards. Reproduc-

ible handouts and a bibliography are included. (Author/JR)
ENC-015981

Ordering Information

AIMS Education Foundation, PO Box 8120, Fresno, CA 93747
(559) 255-4094 / Fax: (559) 255-6396 / Toll-free: (888) 733-2467
www.aimsedu.org
\$18.95 per activity book (paperback)

Connecting to Art and Music

The Art and Science Connection

Grades 4-6
1994

Contributor(s): Addison Wesley Publishing Company and Kimberley Tolley
Publisher: Innovative Learning Publications

The lessons in this activity book integrate art and science concepts and processes in creative art activities. They are organized around three themes: structure, interactions, and energy. All of the lessons involve students in activities requiring some form of cooperative group work. Examples of the media involved include drawing, painting, sculpture, collage, textiles, and mixed media. A typical lesson contains an overview, student objectives, a list of materials, and instructions on setting up the lesson. Guidelines are given for an opening discussion in which students share their previous knowledge about the concepts to be learned. Each activity includes suggestions for evaluating learning, additional resources, extension ideas, and background information. Tips for classroom management are also provided. (Author/KSR) ENC-019576

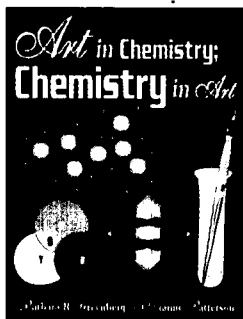
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(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$22.95 per book (paperback)

Art in Chemistry; Chemistry in Art

Grades 7-12
1998

Contributor(s): Barbara R. Greenberg and Dianne Patterson



This book contains demonstrations and 60 hands-on activities that integrate chemistry and art. Designed to help educators motivate disinterested students, the book covers most of the material found in a traditional art course and in a general chemistry curriculum. In the first chapter, color from visible light is compared with color from mixing paints. Color is also related to the arrangement of elements in the periodic table. Chapter two covers the topic of paint:

classes of matter are related to paint type as students examine saturated, unsaturated, and supersaturated solutions and their relationship to paint composition. In chapter three, students consider the function of acids and bases in paper and the use of oxidizing agents as paper whiteners. Chapter four studies chemical bonding connection with three-dimensional works of

clay art; in addition, students prepare clay glazes while studying the mole concept. In chapter five, organic molecules are treated as microsculptures, and kinetic sculpture movements are related to molecular motion. Chapter six uses jewelry making to explore metals, alloys, and electrochemistry. The remaining chapters use photography as a vehicle for examining chemical equilibrium and oxidation reduction reactions; use qualitative analysis as a method of detecting art forgery; and discuss some of the chemical hazards encountered by artists. Each activity is preceded by background information and includes a summary of learning objectives for both art and chemistry. Also given with each activity are classroom procedures and ideas for adapting the activities for higher or lower grade levels. Bibliographic resources are provided for both art and chemistry. (Author/LCT) ENC-013863

Ordering Information

Teacher Ideas Press/ Libraries Unlimited, PO Box 6633, Englewood, CO 80155
(303) 770-1220 / Fax: (303) 220-8843 / Toll-free: (800) 237-6124
www.tlu.com
\$26.50 per book (paperback)

Building a Teen Center

Grades 6-10
1998

Contributor(s): Mary Ann Christina

The 25 lessons in this activity book involve students in a year-long project to build a teen center. By promoting meaningful mathematics through application on the teen center project, the author makes a distinction between traditional algebra—which only manipulates variables and constants—and a way of thinking mathematically that uses equations to analyze important relationships. The overview section provides a description of the mathematics involved in each unit. There are five different types of activities: class, group, partner, individual, and home. In the lesson on three-dimensional coordinates, for example, students work in small groups to find the coordinates of objects in the classroom, and each group tries to identify the other groups' objects from the coordinates. There is also a home activity in which students graph points and planes in three dimensions. (Author/MM) ENC-018254

Ordering Information

Key Curriculum Press, 1150 65th Street, Emeryville CA 94608
Fax: (303) 541-2442 / Toll-free: (800) 995-6284
www.keypress.com
\$16.95 per activity book (paperback)

Create a Co-op City

Grades 4-12
1997

Contributor(s): Peter Barricelli

Students and teachers can use the step-by-step instructions in the guide to design and build a scale model city. The guide describes a classroom architectural project that integrates architecture and design with math, social studies, science, and language arts. Students first learn about one-quarter-inch scale drawings and blueprints by drawing an aerial or plan view of their desks or classroom tables in scale. The next step is to create floor plans and drawing elevations for windows. Working in groups or individually, students design and build a complete house in one-quarter-inch scale. When multiple classes are working cooperatively on this city project, each class votes on

its favorite design and a 50-scale (one inch equals fifty feet) version of the winning house is built using small blocks of wood cut to the correct scale and shape. Foliage, driveways, and other accents are added for additional realism. Students need triangular-shaped architect's and engineer's rulers to work with the scales used in the project. Suggested activities include visiting an architectural or engineering firm, meeting with a surveyor or lawyer about land use issues, and visiting a construction site. Enrichment ideas and a teacher's bibliography are included. A supporting web site is also available. (Author/JRS) ENC-016415

Ordering Information
J.L.B. Publishers, PO Box 198, Waterville, ME 04903
(207) 873-6016 / Fax: (207) 877-8582
www.designacity.com
\$9.95 per teacher's guide (paperback)

Fractal Explorer

www.geocities.com/CapeCanaveral/2854
Grade 11 and up
2000
Contributor(s): Fabio Cesari
Publisher: Yahoo! GeoCities

Explore the infinite complexity and beauty of fractals through this web site's interactive introduction to two fractals, the Mandelbrot set and Julia sets. The site includes background information about complex numbers, their operations, and the iterative process. This fractal tutorial explains, in simple terms, how the Mandelbrot set and Julia sets are generated. It also explores how these two fractals are different. Fractal Explorer provides an informal introduction to these fractals and is only intended to be a starting point to learn more about fractals and fractal geometry. Included with the site are a fractal images gallery and links to other fractal sites. (Author/JRS) ENC-019167

Functional Melodies

Grades 8-12
2000
Contributor(s): Scott Beall

This book is designed to provide activities that help students connect musical ideas to mathematical concepts. Eleven activities explore such concepts as functions, transformations, and multiple representations of relationships. The activities encourage students to hear, visualize, perform, think, graph, and write about musical relationships and the mathematics they illustrate. Four levels of connection are emphasized between mathematics and music: physics of sound, musical language, aesthetics, and metaphor. The first two chapters explain the author's pedagogy and philosophy in connecting mathematics and music. An accompanying CD provides audio support for the various activities. Each activity lists mathematics and music topics, connections to the standards, objectives, and preparation necessary for students. An activity script is interspersed with teaching tips, including suggestions for discussion and follow-up projects. In the activity Name That Function, for example, students hear a basic melody, which is then transformed in various ways. Through guiding questions, students find an equation for the transformation in terms of the original function. The process is repeated for various transformations. Blackline masters and complete solutions for each activity are provided. (Author/MM) ENC-019585

Ordering Information
Key Curriculum Press, 1150 65th Street, Emeryville, CA 94608
Fax: (800) 541-2442 / Toll-free: (800) 995-6284
www.keypress.com
\$24.95 per book + CD

Geometry in Architecture

Grade 7 and up
1984
Contributor(s): William Blackwell



Through the context of architecture and design, this resource book reviews geometric concepts and illustrates the relationships among symmetry, harmony, order, and architecture. Each chapter begins with a summary of familiar geometric principles, followed by the author's insights on the application of geometry to architecture. Topics include the idea of a two-sided polygon and the progression of fourths, which are the architecturally relevant properties of regular polygons that have a number of sides divisible by four. Also covered are the diamond and diagonal geometry of city planning, and the relationship of wall height to floor area for optimum enclosure. The book begins with planar shapes, such as right triangles, regular polygons, circles, and rectangles, and progresses to geometric solids such as prisms, pyramids, spheres, and classical solids. The mathematics is intended to be simple, yet the concepts should be engaging to architects, designers, planners, engineers, mathematicians, and others who enjoy viewing the world through a geometric perspective. (Author/GMM) ENC-007847

Ordering Information
Key Curriculum Press, 1150 65th Street, Emeryville, CA 94608
Fax: (800) 541-2442 / Toll-free: (800) 995-6284
www.keypress.com
\$17.95 per book

Helaman Ferguson

Grade 9 and up
1994
Contributor(s): Claire Ferguson and Helaman Ferguson

This book presents sculptures by Helaman Ferguson, each of which embodies a mathematical formula, theorem, or idea. Facing pages contain a full-page photograph of a sculpture on one side and two smaller photos of the sculpture from different angles on the other side; also provided is a discussion of each work and the mathematics incorporated in it. For example, photos of a work entitled Eine Kleine Rock Musik III are accompanied by text that explains that the honey onyx piece weighs 60 pounds and was personally quarried by the sculptor after two uranium prospectors discovered the vein by chance. The sculpture was inspired by the mathematics of the Klein bottle, a non-orientable four-dimensional surface. While the Klein bottle is not realizable in three dimensions, this piece is intended to provide some insight into what it may look like. Other pieces are based on the mathematics behind wild spheres, tori, knots, folds, and hyperbolic objects. In a final section, the artist discusses his thoughts on the pieces and the mathematics behind them. (Author/SB) ENC-020631

Connecting to Art and Music

Ordering Information

Meridian Creative Group, Inc., 1762 Norcross Road, Erie, PA 16510
(814) 898-2612 / Fax: (800) 550-9968 / Toll-free: (800) 695-9427
www.meridiancg.com
\$29.95 per book (hardbound)

Helaman Ferguson Sculpture

www.helasculpt.com

Grade 5 and up
1999

Contributor(s): Claire Ferguson, Helaman Ferguson, Jonathan Ferguson, Richard Barbieri, Sam Ferguson, and Terry Clough
Publisher: Helaman Ferguson

At this web site, visitors will find images of sculptures created by an artist with a Ph.D. in mathematics. The sculptures are fashioned from a variety of materials and have a mathematical basis for their designs. Pictured sculptures include a torus, a double torus, and a hyperbolic knotted wye (a sculpture with a shape resembling the letter y). The artist's home page shares his thoughts about the development of his sculptural interpretations of mathematical ideas and offers many more examples of his work. (Author/JRS) ENC-017257

Math and Music

Series: Bigger World

Grades 6-12

2000

Contributor(s): Lawrence B. Bangs and OpenBox Interactive LLC

Explore the mathematics and physics behind music with the lessons and instruction on this CD-ROM, which provides a wealth of historical, cultural, and mathematical information. The instruction begins with basic mathematics, such as counting and the Pythagorean theorem, and continues to the higher mathematics of sine waves, a topic that more closely relates to music. The CD presents background information on music throughout history and in different cultures to show the development of certain aspects of Western music, such as tonality, beat patterns, and orchestration. Music theory lessons range from notation to understanding how the frequencies of intervals are related. A real-time test assesses content knowledge of each program section. Teacher and student guides are included, along with a math workbook and textbook containing selected sections of the material in the CD-ROM. (Author/SB) ENC-020705

Ordering Information

Wildridge Software Inc, 245 Wildridge Farm Road, Newark, VT 05871

Fax: (802) 467-3442 / Toll-free: (888) 244-4379

www.wildridge.com

\$99.95 per hybrid CD-ROM with texts (spiral-bound)

\$9.95 per teacher's guide (spiral-bound)

\$11.95 per math workbook (spiral-bound)

Contact publisher for additional ordering options.

Frequency & Vibration

Series: Math in the Middle...

Grades 5-8

1997

Contributor(s): Beth Switzer, Gary N. Vance, John Hollenbeck, Keith Galloway, and Shirley Ann Smith

Part of the Math in the Middle series, this video introduces simple harmonic motion and describes how ratios can be used to plot the harmonic series of a single vibrating surface. The series comprises five units (oceans, music, design, motion, and

nature), each with 12 20-minute lessons that include interviews with people in nontraditional careers and scenes showing how mathematics is embedded in real-life activities. This lesson features a math teacher and a journalist experimenting with pendulums and springs to understand fundamental frequency. Other tones, called harmonics, can be generated when a length of string is divided into simple ratios of the fundamental frequency. In this lesson, a computer-based lab (CBL) unit is used to graph motion. A guitar player illustrates the musical ideas and a violin maker explains the construction of a violin. Included in the teacher's guide are musical background details, directions for doing the pendulum experiment using a CBL, and suggestions for leading the class discussion. The video lessons are aligned with the 1989 NCTM standards. (Author/JRS) ENC-013174

Ordering Information

Great Plains National (GPN), PO Box 80669, Lincoln, NE 68501

(402) 472-2007 / Fax: (800) 306-2330 / Toll-free: (800) 228-4630

gpn.unl.edu

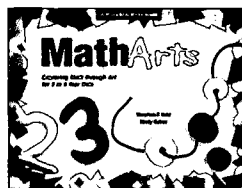
\$39.95 per video + teacher's guide

MathArts

Grades PreK-1

1996

Contributor(s): Cindy Gainer and MaryAnn F. Kohl



Young mathematics students can use the collection of activities in the book to increase their awareness of math through art. Children can draw from their everyday world to explore math concepts such as matching and sorting; patterns, sequence, and order; and one-to-one correspondence. Additional topics include spatial relationships such as direction, boundaries, and the whole and its parts. Activities also address number values, number recognition, counting, and measuring. Students use basic materials such as paint, dough, twigs, and blocks to develop appropriate math concepts. In one activity, students glue yarn to bottles to form interesting patterns. In another, students each paint one section of a large grid to make a class design. (Author/KFR) ENC-006717

Ordering Information

Gryphon House, Inc., PO Box 207, Beltsville, MD 20704

Fax: (301) 595-0051 / Toll-free: (800) 638-0928

www.ghbooks.com

\$19.95 per book

Mathematical Quilts

Grades 7-11

1999

Contributor(s): Diana Venters and Elaine Krajenke Ellison

Two math teachers with an interest in quilting wrote the activities in this book to help students improve their visualization skills and discover the underlying mathematical concepts in quilt designs. The authors based their activities on the van Hiele model for learning geometry, which defines five levels of learning and visualization through which students must progress in order to succeed in geometry. Activities explore topics ranging from the Pythagorean theorem to Fibonacci sequences, spirals, tessellations, and tiling. The book is divided into thematic sections, each highlighting a series of quilts with similar designs:

Golden Ratio Quilts, Spiral Quilts, Right Triangle Quilts, and Tiling Quilts. In each section, an introduction to the theme discusses the mathematical concepts related to the quilt design. The student activities then guide students through the development of the mathematical concepts. Students interested in sewing their own quilts can use the description of how to actually make the quilt. Each section also includes research activities, teacher notes, solutions to activities, and a bibliography. In a selected activity, students investigate the properties of the Wheel of Theodorus, a spiral based on the ratio of lengths of successive pairs of hypotenuses for the right triangles forming the Wheel. Students measure triangle sides, calculate ratios, and use the ratios to determine if the Wheel represents a logarithmic spiral. The book contains more than 50 blackline masters for the student activities. (Author/JRS) ENC-016040

Ordering Information
Key Curriculum Press, 1150 65th Street, Emeryville, CA 94608
Fax: (800) 541-2442 / Toll-free: (800) 995-6284
www.keypress.com
\$17.95 per book (paperback)

Math-Kitecture

www.math-kitecture.org
Grades 6-8
2000
Contributor(s): Charles Bender
Publisher: New York City Board of Education, Office of Instructional Technology

Drawing from famous buildings such as the Parthenon and Frank Lloyd Wright's *Fallingwater*, the activities on this web site link mathematics and architecture. First, students study architecture to recognize patterns, geometric shapes, and the golden ratio. A class activity asks students to measure the length and width of the classroom and to find the perimeter. Next, students draw a sketch of the floor plan and finally create a scale plan using a computer. In another activity, students sketch a design for a bedroom that contains no right angles, construct a blueprint to scale, and use a computer to create an electronic draft of the blueprint. The site also contains examples of student work and links to mathematics, architecture, and computer-aided design sites. (Author/SB) ENC-020680

Music Is Physics

Series: Science Club
Grades 5-8
1999
Contributor(s): I Musici de Montreal, Micro-Intel, and Musee Media



Part of the Science Club series, this CD-ROM presents the physical basis of music through illustrations, movies, interactive activities, and musical extracts. The series presents important scientific principles in the context of everyday life by linking scientific concepts to their practical application. In this CD-ROM, topics

covered include the physical properties of sound, the human ear, acoustics, and musical instruments. Each section features written text and spoken narration illustrated by drawings or animations, a search engine for locating words and phrases, and a music vocabulary game. In a sample section, students

explore how different musical instruments make sound and how to group them into families according to how they vibrate. In another section, students learn how oceanographers chart the bottom of the ocean by bouncing sound waves off it and recording their echoes. This section also explains how people use acoustics to locate oil at the bottom of the sea, and how doctors use ultrasound to track fetal development. Students are also introduced to five gypsy tales with musical themes. The main menu provides an 80-question quiz on the contents of the program. Users can produce reports that incorporate text, drawings, photographs, and videos using the CyberEditor, a page editing tool. A print version of the user guide is available as a PDF file. (Author/YK) ENC-017687

Ordering Information
Micro-Intel, Suite 301, 1200 Papineau Avenue, Montreal, QC H2K 4R5
Fax: (514) 528-1770 / Toll-free: (800) 530-8789
www.micro-intel.com
\$49.95 per CD-ROM package

Native American Geometry

www.earthmeasure.com
Grades 4-9
1999
Contributor(s): Chris Hardaker
Publisher: Geometric Explorations

Intricate and colorful designs from various Native American nations are used at this web site to describe a physical, proportional geometry that originates from the simple circle. The site provides the fundamentals of compass and straightedge constructions, along with instructions and templates for creating geometric designs. These two-dimensional geometry constructions, designed to enhance students' spatial reasoning, use a simple dot-connection approach and are grounded in the natural laws of proportion. The web page discusses sources of this non-random geometry in a wide range of other cultures and provides ideas linking art and mathematics. (Author/JRS) ENC-013761

Rock Music

Grades K-6
2000
Contributor(s): Gary Swan



This kit contains a collection of fun and instructional songs designed to help students learn about rocks, minerals, and other Earth science subjects. Materials include a music CD-ROM, a teacher's guide, and a poster that depicts the National Energy Foundation's Out of the Rock illustration. The CD-ROM features upbeat songs designed to help students learn specific content material, such as the uses of rocks and minerals, the production and use of electricity, and the rock cycle. Additional topics include the geological time scale and mining reclamation. The teacher's guide presents 11 songs and learning activities dealing with basic concepts in Earth science and mineral education.

Each lesson includes a song, a hands-on activity, and additional information for teachers. The lessons focus on integrating the arts as a means of enhancing science content. In a sample lesson, students sing along with the Rocky Minero song and then talk about the importance of minerals and their origins. In a subsequent activity, students use a map of their state's major mineral deposits to investigate uses for those minerals. In another lesson, students explore the process for making electricity using coal. The guide includes all of the song lyrics and scores. (Author/YK) ENC-019169

Ordering Information
National Energy Foundation, 3676 California Avenue, Salt Lake City, UT 84104
(801) 908-5800 / Fax: (801) 908-5400
www.neff.org
\$19.00 per kit

Science Art

Grades K-4
1997
Contributor(s): Deborah Schecter and Joan Novelli

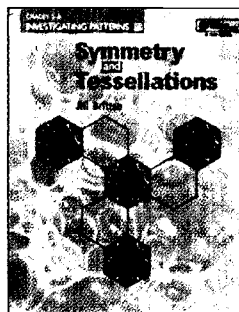
The creative art activities in this book are designed to help students grasp abstract science concepts. As students create their art projects, they use science process skills such as observing, predicting, investigating, and communicating. Each activity is designed to appeal to a range of learning styles, from linguistic and logical mathematical to intra- and interpersonal. For example, as students create windchimes, those with a sensitivity to music may be more aware of the sounds different materials make. This activity also develops logical mathematical thinking as students look for patterns and relationships in the way the size, shape, and weight of objects affect the sounds they make. The activities are divided into eight sections that cover plants and animals, energy and change, gravity and magnets, and the physical properties of liquids and crystals. Each section is correlated to the NSES (1995). In a sample activity, students use an acid and base indicator to create paper chameleons that change colors before their eyes. In another, children make mini merry-go-rounds to discover how stored energy can make things move. Each activity includes scientific background information, a list of required materials, and a step-by-step procedure. Reproducible worksheets, cartoons, and black-and-white illustrations are found throughout. (Author/LCT) ENC-012370

Ordering Information
Scholastic, Inc., PO Box 7502, Jefferson City, MO 65101
Fax: (800) 560-6815 / Toll-free: (800) 724-6527
www.scholastic.com
\$14.95 per book (paperback)

Symmetry and Tessellations

Series: Investigating Patterns
Grades 5-8
2000
Contributor(s): Jill Britton

Part of the Investigating Patterns series, this book includes 30 hands-on activities to help students learn concepts in symmetry and tessellation. The series emphasizes the importance of patterns in mathematics and their connections to art. Each activity in this book includes a list of the materials needed, new vocabulary terms, and extension and follow-up activities. An appendix supplies additional information for



each activity, including sources for materials, extension activities, and related Internet sites. In a sample activity, From Crackers to Soap Bubbles, students consider a real-world application of tessellations: cracker manufacturers need to be aware of shapes that tessellate. The teacher begins by demonstrating that cutting circular crackers from a sheet of dough will result in wasted material between the circles. Students then examine honeycombs for

the tessellation of hexagons and the efficiency of the use of space. Finally, students explore the shapes soap bubbles make when they tessellate. Blackline masters for all activities are included. (Author/MM) ENC-019479

Ordering Information
Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$25.95 per book (paperback) with materials packet

Teaching Mathematics Through Children's Art

Grades K-6
1995
Contributor(s): Doug Williams

Elementary teachers can use this book to give them a fresh approach to mathematics teaching through creative art and craft activities. These activities are described in step-by-step lessons for all levels. The author hopes to help teachers integrate mathematics and art in exciting new ways. Each lesson lists the concepts and skills used, the equipment needed, and the steps of the activity. In one chapter, students create and draw large human characters. They then use these characters to work on concepts such as measurement and counting. In another, students use painting and drawing activities to explore symmetry, reflection, rotation, and patterns. Blackline masters are provided. (Author/KFR) ENC-006399

Ordering Information
Heinemann Educational Books Inc, 88 Post Road West, PO Box 5007, Westport, CT 06881
(603) 431-7894 / Fax: (203) 750-9790 / Toll-free: (800) 793-2154
www.heinemann.com
\$18.00 per book

A World in Motion II

Grade 7
1996
Contributor(s): Bernard Zubrowski, Brian Williams, Cindy Char, Dan Dick, Doug Haller, Jan Ellis, Lorena Martinez, Marilyn Quinsaat, Myles Gordon, and Shelley Isaacson

The Society of Automotive Engineers developed this multidisciplinary curriculum unit to emulate real-world design scenarios. It is part of a series of challenges that focus student design teams, teachers, and volunteer professionals on the math, science, and technology concepts required to solve a design problem. In this unit, the challenge is posed in a letter from a fictitious toy company, Mobility Toys, Inc. (MTI). MTI is looking for designs for a new line of motorized, gear-driven toys. The letter requests written proposals, sketches, and working models of designs that meet a specific set of requirements. Students complete activities that help them develop a proposal and a

prototype for a toy of their own design. In the process, students learn about energy, force and friction, simple machines, levers and gears, and torque. They explore geometric concepts inherent in body design and performance, gear ratios, and the radius of a wheel. Students also acquire data collection and retrieval techniques and basic statistical analysis. In addition, students practice public speaking and writing skills as they prepare their proposal and presentation for a review panel. Selected activities ask students to measure the rim force transmitted by three different-sized driver gears and to experiment with possible toy body materials to understand how they can be cut, shaped, and assembled. Students also conduct a customer survey and write interview questions that will give them information about the buying preferences of parents. The teacher's guide provides background information, teacher and volunteer tips, and guidelines to help visiting engineers and other partners evaluate student work. Assessments and blackline masters are included. Additional materials include an orientation video, a planning poster, and a classroom design poster. (Author/LCT) ENC-008426

Ordering Information
Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096
(724) 772-8513 / Fax: (724) 776-0890 / Toll-free: (800) 457-2946
www.sae.org
Free kit

Connecting to Social Studies

Bioethics Forums

Series: Bioethics Forums
Grade 9 and up
1995
Contributor(s): D. Joseph Clark, Dennis Liu, Jeff Dalto, Mark Lutwak, Michael McCarthy, Shaun Taylor, and Y. York

The 12 forums on this laserdisc explore societal dilemmas arising from recent breakthroughs in biology, genetics, and biomedical technology. Accompanied by a teacher's manual and resource book, the laserdisc shows video clips of a diverse group of people with a wide range of opinions about bioethical topics. Students are asked to consider different viewpoints and weigh the consequences of various decisions while they evaluate their own ideas and sharpen their communication skills. Each forum begins with a video segment in which a character presents a bioethical dilemma and seeks counsel from viewers. In addition, each forum contains resources with information about different or related aspects of the ethical dilemma. The teacher's manual suggests that, after viewing the opening scenes as a class, the activities can be conducted in either a consensus format or a position format. In the consensus format, the teacher leads the class through the discussion and controls which videos and resources to present. In the position format, small groups select a character or interest group to represent and analyze the materials from their point of view. One forum deals with the issue of releasing transgenic organisms into the environment. Its premise is that researchers are seeking grant money for growing an insect- and herbicide-resistant sunflower outdoors. Students are asked to decide if the grant should be funded. The disc has footage of a variety of stakeholders,

including the agricultural researcher, an environmental activist, and a consumer rights lobbyist. The documents in the resources section discuss topics such as agricultural techniques, fisheries management, and the vigor of the transgenic organisms. The teacher's manual contains a bioethics primer, a bioethics subject matrix, and student worksheets. (Author/JR) ENC-018903

Ordering Information
Videodiscovery, Inc., Suite 600, 1700 Westlake Avenue North, Seattle WA 98109
(206) 285-5400 / Fax: (206) 285-9245 / Toll-free: (800) 548-3472
www.videodiscovery.com
\$375.00 per laserdisc (Level 1) with 2 texts (softcover)

Changing Climate?

Grades 9-12
1997
Contributor(s): Eleanor Morris

Part of the Films for the Humanities & Science series, this video investigates the dynamics between scientists and politicians on the topic of global warming. Many scientists have been concerned about the threat of a global climatic change for a couple of decades; however, it is only in the recent past that scientists have determined that the actions of humans have a direct effect on the world's climate. This video emphasizes that although the world recognizes the dangers of global warming, the economic interests of each country have stifled the development of a unified strategy to combat it. Interviews with politicians and scientists describe their views about global warming and their opinions as to what should be done to decrease the amount of greenhouse gases in the atmosphere. Focusing on Europe, many environmental groups there have chosen not to rely on their political leaders to take action. Rather, group members have chosen to lobby local banks to withhold financing from industries that contribute to the greenhouse effect. (Author/TMH) ENC-020453

Ordering Information
Films for the Humanities & Sciences, PO Box 2053, Princeton, NJ 08543
(415) 328-3825x239 / Fax: (609) 275-3767 / Toll-free: (800) 257-5126
www.films.com
\$129.00 per video

Chemicals, Health, Environment, and Me (CHEM-2)

Series: Science Education for Public Understanding Program (SEUP)
Grades 4-6
1997
Contributor(s): Lawrence Hall of Science, University of California, Berkeley and SEUP

Students in grades 4-6 can use this hands-on kit to learn about the nature of chemicals and how they interact with the environment. Three boxes of laboratory equipment (enough for a class of 32) support 15 topics of study that explore everyday applications of scientific concepts. Activities are contained in a teacher's resource binder that is divided into units. Each unit section contains background information and instructional guidelines as well as suggestions for extensions and cross-curricular integration. In addition, there are blackline masters of transparencies and student worksheets. A sample unit, Mystery Spill, focuses on how qualitative tests can be used to identify chemicals. Students investigate and categorize properties of various household substances used to simulate hazardous materials commonly transported on highways. In doing so, they uncover the identity of the unknown material. (Author/JG) ENC-020715

Ordering Information

Lab-Aids, Inc., 17 Colt Court, Ronkonkoma, NY 11779
(631) 737-1133 / Fax: (631) 737-1286 / Toll-free: (800) 381-8003x121
www.lab-aids.com
\$50.00 per teacher's manual (loose-leaf)
\$342.00 per kit

The Chemistry of Health

Grade 9 and up
2000

Contributor(s): NIGMS, NIH, and USDHHS



The National Institutes of Health created this 66-page booklet that describes cutting-edge chemistry and biochemistry research as it relates to human health. In each of the book's five chapters, readers will find an interview with a scientist and sidebars that provide additional information. At the end of the book is a set of comprehensive review questions. In one chapter, carbohydrates and lipids are described as the structural scaffolding of cells,

organs, and tissues. Frontier research illuminates how sugars, which adorn the surface of cells, affect the way cells move around the body. This knowledge holds great promise in helping researchers devise ways to prevent diseases and conditions that rely on cell movement. One researcher, for example, is developing a way to "trick" cancer cells into redecorating their surface with synthetic sugar molecules that attract killer immune cells. The end of the booklet includes a summary page on the future of chemistry research and a glossary. (Author/LEB) ENC-020244

Ordering Information

National Institutes of Health, National Institute of General Medical Services, Public Information Office, 45 Center Drive MSC 6200, Bethesda, MD 20892
(301) 496-7301 / Fax: (301) 402-0224
Free booklet

Crashed, Smashed, and Mashed

Grades K-6
2001

Contributor(s): Joyce Slayton Mitchell and Steven Borns

This children's book follows the progress of crashed and smashed cars as they proceed through the recycling process in junkyard heaven. The story, which takes place at Gates Salvage Yard in Hardwick, Vermont, explains how incoming automotive wrecks are drained of their fluids and then stripped for spare parts. The book also takes the reader through the stages of torching the cars' internal parts, removing sheet metal assemblies, and shredding the cars with the monster machine. Color photographs on each page support the text, along with a glossary of key terms and a list of recycling facts. (Author/JG) ENC-019241

Ordering Information

Tricycle Press, PO-Box 7123, Berkeley, CA 94707
(510) 559-1600 / Fax: (510) 559-1629 / Toll-free: (800) 841-2665
www.speed.com
\$14.95 per book (hardbound)

Decisions Based on Science

Grades 9-12
1997

Contributor(s): Brian Jerome, Jocelyn Lofstrom, Linda Whyman, and Vincent Campbell

The lessons and activities in this book are designed to help students use scientific information to make everyday decisions. Part one of the book provides an overview for teachers, including background information on decision making, introductory activities, teaching tips, presentation ideas, and a teaching plan. Part two contains guided activities with student and teacher pages, and part three provides independent exercises that suggest additional topics for practicing the skills students have learned. Topics include biotechnology, environmental conservation, and energy use. In a sample case study, students read background information about the effects of chlorofluorocarbons (CFCs) and discuss how CFCs should be regulated. As students develop their decision-making skills, they brainstorm ideas, make notes on their research, and record their conclusions in journals. The appendices provide sample grading rubrics and notes on using journals as assessment. Also included are bibliographic references, information on national standards, and Internet resources. (Author/LCT) ENC-012221

Ordering Information

National Science Teachers Association, PO Box 90214, Washington, DC 20090
(703) 243-7100 / Fax: (888) 433-0526 / Toll-free: (800) 722-6782
www.nsta.org
\$19.95 per book (Nonmember price)

Fostering Sustainable Behavior

Grade PreK and up
1999

Contributor(s): Doug McKenzie Mohr and William Smith

This book discusses the use of community-based marketing strategies to educate the public about environmental issues. Emphasizing the need to adopt sustainable behaviors, the text identifies the common barriers to wide-scale adoption and suggests ways in which these obstacles can be overcome. Also addressed are program design, examples of effective marketing, and evaluation. Black-and-white photographs, figures, and checklists organize concepts and reinforce topics. A quick reference section summarizes key factors to consider when facilitating social change. A sample chapter, Building Community Support, describes the nature and influence of social norms on the actions of a society. Studies document the impact of modeling on water conservation measures. The text compares the concepts of compliance and conformity and explores the importance of internalization. A checklist recommends that norms should be noticeable, explicit, and used for positive reinforcement. Examples involve adding a composting decal to recycling containers and attaching gas mileage bumper stickers to fuel-efficient cars. (Author/JG) ENC-019475

Ordering Information

New Society Publishers, PO Box 189, Gabriola Island, BC V0R
(250) 247-9737 / Fax: (800) 567-7311
www.newsociety.com
\$14.95 per book (paperback)

Fourscore and 7

Grades 5-8
1999

Contributor(s): Addison-Wesley Educational Publishers, Inc. and Betsy Franco
Publisher: Good Year Books

Designed for middle-grades students, the lessons and activities in this book integrate historical facts or events into the mathematics class. Each chapter begins by extracting data from background information, charts, and graphs from a particular event. Students are then presented with a challenge to perform a task using the data. An example activity centers on Sieur de La Salle, the land claimed by French explorer Rene-Robert Cavalier. The text describes how he claimed for France all of the seas and rivers that flowed into the Mississippi River. Students estimate how many square miles that would have included, what states that would encompass today, and what fraction of the United States would be considered French territory. In an extension question, students calculate the cost per square mile of the Louisiana Purchase. The book provides further background information on La Salle and possible solutions to the challenge. Other chapters use historical information on such subjects as Navajo blankets, Betsy Ross, the Boston Tea Party, and the Pony Express. The book also includes a bibliography. (Author/SB) ENC-020727

Ordering Information

ETA/Cuisenaire, 500 Greenview Court, Vernon Hills, IL 60061
(847) 816-5050 / Fax: (800) 382-9326 / Toll-free: (800) 445-5985
www.eta-cuisenaire.com
\$14.95 per book (paperback)

Geometry Activities from Many Cultures

Grades 6-10
1997

Contributor(s): Beatrice Lumpkin

The 65 reproducible worksheets in this book form a structured approach for teaching geometry in a multicultural context. Topics addressed include art, measurement, mapmaking, architecture, and trigonometry. Each one is placed in a cultural context, such as ancient Greek, Native American, modern African, or Aztec. To facilitate classroom integration of the activities, the book is structured in the standard geometry textbook sequence. Units for each topic open with one or two pages of reading about the geometric achievement of the culture, followed by questions for critical thinking. Each unit concludes with teacher notes, answers, activities, and projects. In the activity on non-Euclidean geometry, for example, students are introduced to the idea of different geometries by a discussion on parallel lines in different spaces. Students then investigate a geometry with no parallel lines by pasting a right-angled triangle onto a sphere and taking measurements with a flexible protractor. Specific questions included with the activity address the sum of the angles of plane and spherical triangles. (Author/MM) ENC-018170

Ordering Information

J. Weston Walch Publisher, 321 Valley Street, PO Box 658, Portland, ME 04104
(207) 772-2846 / Fax: (207) 772-3105 / Toll-free: (800) 341-6094
www.walch.com
\$20.95 per book (paperback)

Ice Cream Truck

Grades 2-6
2000

Contributor(s): Houghton Mifflin Company and Sunburst Communications, Inc.



The game on this CD-ROM lets students run an ice cream delivery business and try to turn a profit. It opens with a map in which the ice cream factory sits in the center and a series of roads leads to four possible sites for selling ice cream. The simulation begins with the student stocking the truck with a variety of ice creams, setting sale prices, and decorating the outside of the truck with colorful posters to increase vis-

ibility. Decisions about quantity and price should be based on information that includes the time of day and the temperature. Next, delivery sites are selected and the ice cream truck is shown moving along the roads of the map. At each stop, the truck makes a random number of sales and the information is given to the driver. While making deliveries, the driver must keep an eye on the gas tank so that the truck does not run out of gas. Other features of the software include a journal where students can write about their business strategies, a spreadsheet to analyze sales data, and a calculator for sales and profit calculations. An accompanying guide includes installation instructions, information about the various game settings, and four activities that expand on ideas presented in the game. (Author/JRS) ENC-017349

Ordering Information

Sunburst Technology, 101 Castleton Street, PO Box 100, Pleasantville, NY 10570
(914) 747-3310 / Fax: (914) 747-4109 / Toll-free: (800) 321-7511
www.sunburst-store.com
\$89.95 per CD-ROM, 10 user package (Windows/Macintosh)

Is Democracy Fair?

Grades 7-12
1997

Contributor(s): Leslie Johnson Nielsen and Michael de Villiers

In this book, mathematics and social studies intertwine through activities that use mathematical methods to explore different types of election decision procedures. The 18 activities are suitable for weekly enrichment or for use as a several-week intensive unit. Included is a long-term research project investigating and reporting on elections in other countries. Activities in the first half of the book introduce alternatives to the winner-take-all strategy used in elections. In later activities, students investigate apportionment in the U.S. House of Representatives and the proportional representation system used in some other countries. Each activity contains an informational section, research suggestions, and an optional calculator exploration. In a sample activity, students are introduced to Arrow's theorem, which states that any conceivable democratic voting system can yield undemocratic results. Data are then presented on preferences for physical education activities in the next school quarter. Students use the previously learned Borda's election decision procedure to analyze the data, which may make the winner not the true choice of the survey participants. Students then investigate approval voting, in which voters, rather than ranking options,

give any number of options or candidates that they approve of one vote. The winner is the option or candidate who receives the most approval votes. Students apply approval voting to a problem involving T-shirt color selection. (Author/JRS) ENC-020730

Ordering Information

Key Curriculum Press, 1150 65th Street, Emeryville, CA 94608
(914) 747-3310 / Fax: (914) 747-4109 / Toll-free: (800) 321-7511
www.keypress.com
\$14.95 per book (paperback)

Kidbits

Grades 4-12
2001

Contributor(s): Bob Italiano and Jenny Tesar

The statistics in this book, gathered for teenage and pre-teenage demographics, cover topics ranging from SAT scores to NFL salaries to hazardous waste. Data are arranged and presented in a visual format that integrates illustrations, icons, and other graphics with full-color charts, tables, and maps. Each visual presentation includes a reference to the source of the data displayed. In one bar graph in the Music section, for example, sales for audio cassettes and CDs are compared for 1987 and 1997. The size of the CD or cassette icon pictured on each bar of the graph is proportional to the amount of sales for the specified year. The graph is based on data from the Recording Industry Association of America. Also included in the this section are tables showing Grammy winners for the past 10 years, as well as top-grossing concert appearances and best-selling albums of all time. (Author/GAB) ENC-020725

Ordering Information

Blackbirch Press, Inc., PO Box 9187, Farmington Hills, MI 48333
(914) 747-3310 / Fax: (914) 747-4109 / Toll-free: (800) 321-7511
www.blackbirch.com/
\$27.95 per book (paperback)

The Life Cycle of Everyday Stuff

Grades 8-12
2001

Contributor(s): Mike Reeske and Shirley Watt Ireton



Developed through a National Science Teachers Association (NSTA) project, these seven investigations examine the life cycle of manufactured products from design to disposal. Key scientific concepts, such as energy transformation and the relationship between structure and function, provide the basis for exploring the components, materials, and durability of various common objects. Background information, teaching guidelines, and

lists of resources are provided, as well as correlations to the *National Science Education Standards* (NSES). Supplementary information is included in sciLINKS web sites and in an educational poster that depicts the life cycle of a pencil. A sample unit, *Manufacturing a Product*, studies how raw materials are used to create packaging products. Students experiment with

different substances to make a wrapper for a frozen dessert. Economic and environmental impacts of the final design are considered along with the trade-offs and effects of each decision. Students then measure the efficiency of repeating the design and make suggestions for improvement. Other lessons involve simulating metal extraction, estimating the useful life spans of common materials, and comparing waste reduction methods. Reproducible student worksheets and scoring rubrics are included. (Author/JG) ENC-019470

Ordering Information

National Science Teachers Association, PO Box 90214, Washington, DC 20090
(703) 243-7100 / Fax: (888) 433-0526 / Toll-free: (800) 722-6782
www.nsta.org
\$19.95 per book (paperback)

Mathematics from Many Cultures, Level B

Series: Mathematics from Many Cultures

Grade 1
1993

Contributor(s): Calvin J. Irons, James Burnett, Stanley Wong Hoo Foon, and Wong Hoo Foon
Publisher: Mimosa Publications

Multicultural studies and mathematics meet in this kit, which encourages children to investigate the cultural origins of numbers and counting. Each kit in the series uses brightly colored posters and Big Books to reinforce mathematics concepts and to help children see how these areas connect with various cultural backgrounds and experiences. In this kit, six investigations provide a range of experiences based on topics such as the days of the week and how they got their names; the finger counting methods of people from East Africa, the Great Plains, and New Guinea; and the use of geometric shapes and designs in Native American and Hawaiian rock art. Students also explore patterns that have been used to decorate textiles from Mexico, North America, South America, and Africa. The kit investigates the origins of the symbols used for numbers and includes games that develop mathematical problem-solving skills. The teacher's guide provides three related activities and discussion questions for each investigation. In sample activities, students create a story mural using petroglyph figures and write numbers using Hindu, Arabic, and Mayan numerals. The guide also provides introductory and historical notes, lists mathematics and cultural links, and includes blackline masters of student handouts. (Author/LCT/JRS) ENC-011255

Ordering Information

Wright Group/McGraw-Hill, 19201 120th Avenue NE, Suite 100, Bothell, WA 98011
(800) 523-2371 / Fax: (800) 593-4418 / Toll-free: (800) 648-2970
www.wrightgroup.com/index.html
\$79.00 per kit (specify English or Spanish)

The Multicultural Math Classroom

Grades 1-8
1996

Contributor(s): Claudia Zaslavsky

Beginning with a rationale for providing a multicultural mathematics education, this book describes the works of mathematics educators who are bringing multicultural perspectives into their classrooms. It includes multicultural lessons that provide background information and suggestions for cooperative learning activities that encourage creativity and critical thinking.

Also included is advice on opportunities for open-ended, long-range projects. One lesson, *How People Use Numbers*, teaches children about how numbers are used in trading within a variety of cultures, including West Africa, China, and Egypt. After learning about various systems of exchange, such as the use of wampum by the Iroquois and the use of cocoa beans by the Aztecs, students might pretend that they live in a culture that uses cowrie shells or beads for currency. This cooperative learning activity can be extended to include long-range projects such as setting up a model marketplace and researching forms of money used in various parts of the world. Resource pages are organized by categories such as children's literature, organizations, and multicultural perspectives and equity issues. (Author/CMS) ENC-008965

Ordering Information
Heinemann Educational Books, Inc., 88 Post Road West, PO Box 5007, Westport, CT 06881
(603) 431-7894 / Fax: (203) 750-9790 / Toll-free: (800) 793-2154
www.heinemann.com
\$25.00 per book

Newton's Apple Program 1011

Series: Newton's Apple
Grades K-12
1992
Contributor(s): Bob Perkerwicz, Dan Fiorucci, David Heil, Gary Leatherman, Jeffrey Nielsen, Jeffrey Weihe, Kathryn A. Scott, Kathy Kraemer, Kristian Berg, Leslie Kratz, Peggy Knapp, Richard C. Hudson, and Sheldon Erickson
Publisher: KCTA, Twin Cities Public Television, Inc.

Newton's Apple is a science series on public television that answers viewers' questions about science, nature, technology, and the world around us. Each episode, hosted by David Heil, consists of hands-on demonstrations and interviews with experts, teachers, and naturalists. Topics covered in this episode include a discussion of what causes traffic jams, how traffic management systems can ease congestion, and future systems for managing traffic. Also addressed is cryogenics and its future; the program considers how some animals can survive subfreezing temperature and how human cells react to freezing and thawing. Viewers also learn about static electricity and go on a tour of a Rochester, MN, high school. Included with the series is a compilation of teacher's guides designed to accompany each of the Newton's Apple episodes. The guides include lessons related to each topic covered in the episode; each lesson comprises a general discussion about the topic, a main activity, several extension activities, and a list of resources. (Author/RA) ENC-006640

Ordering Information
Great Plains National, PO Box 80669, Lincoln, NE 68501
(402) 472-2007 / Fax: (800) 306-2330 / Toll-free: (800) 228-4630
www.gpn.unl.edu
\$24.95 per video
\$21.95 per teacher's guide

One-Minute Readings

Grades 6-12
1992
Contributor(s): Dana L. Zeidler, Pearson Learning, and Richard F. Brinckerhoff
Publisher: Dale Seymour Publications

The author of this book of short readings is interested in promoting critical thinking about controversial issues in the real

world of science. The goal is to foster the development of students into citizens able to intelligently participate in decisions that affect society. The accompanying teacher's manual offers strategies on how to most effectively use the readings, from presenting the topics to posing thought-provoking questions. Also included is a strategy for how teachers can develop their own issue-oriented topics for class discussion. The book provides reproducible multiple-choice questions, extension activities, and resources. Issues are categorized under subject headings such as biology, chemistry, physics, and space science. In one selected reading, under the category of bioethics, students consider society's responsibility to care for AIDS patients. One argument is that caring for terminally ill people increases insurance premiums for everyone and strains hospital budgets, to the detriment of patients with more manageable illnesses. In opposition to this viewpoint is the belief that no one should be denied health care under any circumstances. Another issue presented is the risk that health care providers take to treat AIDS patients. The appendix includes quotations that describe the presence of science in our culture. (Author/LEB) ENC-020793

Ordering Information
Pearson Learning, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(402) 472-2007 / Fax: (800) 306-2330 / Toll-free: (800) 228-4630
www.pearsonlearning.com
\$11.95 per book (paperback)
\$8.95 per teacher's manual (looseleaf)

People and the Planet

Grades 6-8
1996
Contributor(s): Pamela Wasserman

The interdisciplinary lessons in these hands-on modules address topics of human population growth, natural resource use, solid waste management, biodiversity, social justice, and community well-being. Each section begins with a reproducible student reading that provides an overview of topics covered in the activities. Activities include simulations and role playing, science labs, graph/chart creation and analysis, word-problem solving, and library research. In a suggested activity for investigating waste management, students construct a mini landfill in a jar, calculate the amount of garbage each person generates per year, and brainstorm ways to reduce solid waste. In a subsequent activity, students learn about precycling (ways of selecting products with minimal amounts of packaging) as a way to limit waste production and to help preserve natural resources. This book forms a complete unit on human communities and the environment, but specific activities can be used individually to emphasize a particular topic. The activities develop knowledge and skills applicable to science, social studies, math, and family life education. Included are a glossary and sources for further research. (Author/JRS) ENC-012006

Ordering Information
Zero Population Growth Inc, Suite 320, 1400 16th Street NW, Washington, DC 20036
(202) 332-2200 / Fax: (202) 332-2302 / Toll-free: (800) 767-1956
www.zpg.org
\$22.95 per book (paperback)

Plants Solve Problems of Survival

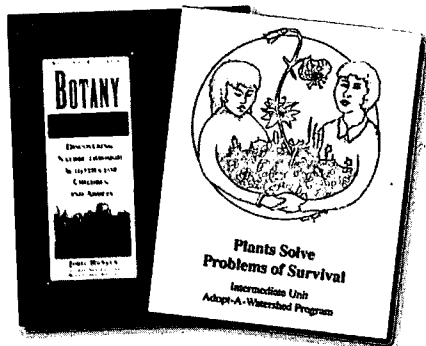
Series: Adopt-A-Watershed Program

Grade 5

1993

Contributor(s): Alysia Krapfel, Bob Miller, Globe Pequot Press, Jorie Hunken, and Kim Stokely

Publisher: Adopt-A-Watershed Program



Part of the Adopt-a-Watershed curriculum, this unit explores how wild animals live and interact. The curriculum uses the local watershed as a focus for applying and integrating scientific theories. The program intends to instill the importance of environmental stewardship in students, nurture their decision-

making skills, and illustrate the relevance of science to their lives. Each unit includes cross-curricular hands-on activities, long-term field studies, and restoration projects as well as community action projects and reflection activities. Topics covered in this unit include the relationship between structure and function that allows plants to withstand forces in their environment, utilize water and nutrients, and reproduce successfully. The unit also provides information about how people can maintain a healthy environment for native plant populations. One lesson that focuses on root strength allows students to observe that bean seeds will break through plaster and contribute to the weathering process of rocks. Students also take a walk during which they test the holding power of plants by pulling and digging them up. Another lesson integrates activities from the accompanying *Botany for All Ages* as students investigate how water and gases are transported through stems and are exchanged through leaves. Using colored water, students trace the flow of water up a celery stalk and compare the uptake of water in celery with and without leaves. The lessons identify the time requirements and process skills that are developed. Supplemental reproducible sheets are included. (Author/JR) ENC-019697

Ordering Information

Adopt-A-Watershed, 98B Clinic Ave, PO Box 1850, Hayfork, CA 96041

(530) 628-5334 / Fax: (530) 628-4212

www.adopt-a-watershed.org

\$55.00 per kit

The Power of Numbers

Grades 6-9

1993

Contributor(s): Fred E. Gross, Patrick Morton, and Rachel A. Poliner

Publisher: ESR Educators for Social Responsibility

The lesson plans and activities in this guide promote the learning of mathematics in the context of real-world decision making. Contexts include polling, studying trends in census data, and designing a public rail transportation system for Los Angeles. Students work on thematic projects that require reasoning and communication skills as they apply quantitative techniques in social studies. In a sample activity, students investigate trends and patterns in census data. They learn the meaning of rate of change, especially the difference between *average* increases or

decreases and *actual* increases or decreases. Lesson activities include three discussions, a group activity on formula making, a graphing exercise, and a handout in which students use their formula to explore trends in actual census data. Each lesson plan contains teacher questions for guiding class discussion, relevant mathematics information, and answers, with explanations, for all activities. The lessons may be used sequentially or selectively. The guide also includes assessment suggestions, an appendix on cooperative learning techniques, and a reference list. A student handout packet is included. The curriculum activities are correlated with the 1989 NCTM standards. (Author/JRS) ENC-014176

Ordering Information

Educators for Social Responsibility, 23 Garden Street, Cambridge, MA 02138

(617) 492-1764 / Fax: (617) 864-5164 / Toll-free: (800) 370-2515

www.esrnational.org

\$28.00 per teacher's guide (paperback)

\$12.00 per student handouts packet

Rivers Curriculum Guide, Biology

Series: Rivers Curriculum

Grades 9-12

1998

Contributor(s): Al Schuitema, Art Hessler, Bill Beckman, Bill Donato, Bill Henske, Dan Bean, Don Dickey, Janet Franklin, Jim Gager, Kathy Newsom, Marvin Mondy, Robert Williams, and Taylor Delaney

This teacher's book, part of the Rivers Curriculum series, provides information and activities focused on biology in rivers. The series uses the river as the common strand weaving together six units across disciplines from science to language arts to math. Rivers Project units are designed to be used by teachers both individually and in multidisciplinary teams. In this book, topics range from river and stream ecology to habitat surveys. Each section begins with a set of teacher notes offering suggestions on time management, assessment, and extensions. Information is presented in a textbook format with short-answer and discussion questions at the end of each section. Activities include worksheets and crossword puzzles, as well as hands-on explorations and labs. Reproducible diagrams, graphs, and student pages are provided, along with a glossary of biology terms introduced in the text. In one chapter of this book, information sections introduce benthic macroinvertebrates, fish, and plankton as biological indices of water quality. Reproducible flashcards show black-and-white drawings of the various organisms. In an activity on water-quality index, students convert the given results of nine water-quality tests into Q-value percentages in order to arrive at an overall water-quality rating for the fictitious sample. The activity includes procedures, data tables, and journal assignments for students to complete. (Author/GAB) ENC-020805

Ordering Information

Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216

(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907

www.pearsonlearning.com

\$27.95 per book (paperback)

Rivers Curriculum Guide, Chemistry

Series: Rivers Curriculum

Grades 9-12

1997

Contributor(s): Allen Burbank, Jack Ballinger, Virginia Bryan

This teacher's book, part of the series described above, provides information and activities focused on the chemistry of rivers. Topics range from temperature and turbidity to the concentra-

tion of nitrate and phosphates in river or stream water. In one chapter on dissolved oxygen in river or stream water, the solubility of gases is explored through an activity that involves varying the temperature and pressure of cans of soda. In another activity, students measure the amount of dissolved oxygen in river or stream water using a dissolved-oxygen test kit. Students can visit a local river or stream to gather water samples for comparison. Both activities include procedures, data tables, and journal assignments. (Author/GAB) ENC-020801

Ordering Information

Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$27.95 per book (paperback)

Rivers Curriculum Guide, Earth Science

Series: Rivers Curriculum

Grades 9-12

1998

Contributor(s): David Winnett, Don Larson, Michelle Corlew, Rion Turley, Stan Danielsen, and William Donato

Part of the Rivers Curriculum series described earlier, this teacher's book focuses on topics ranging from the basics of watersheds to erosion and deposition to the geology of a river or stream. In one chapter on the geology and pH of a river or stream, information sections introduce the three major rock types, the geologic time scale, and water pH. The last of these is explored through an activity focused on the effect of bedrock type on stream pH. In the activity, students add different crushed rocks to water and measure any changes in pH. Students can then visit a local river or stream to gather water samples for comparison. A similar activity is provided for measuring water hardness. (Author/GAB) ENC-020802

Ordering Information

Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$27.95 per book (paperback)

Rivers Curriculum Guide, Geography

Series: Rivers Curriculum

Grades 9-12

1997

Contributor(s): Bob Ashley, Cynthia Bidlack, Dennis Paul, Jack Herschbach, Larry Underwood

Part of the Rivers Curriculum series, this guide deals with the geography of rivers. Topics range from determining the location of a watershed to characteristics of a river to geographic field study. A chapter on how humans interact with rivers introduces the ways humans modify rivers and explores how to make environmentally responsible decisions regarding watershed areas. This section includes an activity in which groups of students are given a topographic map of the *Simulation River* area and a problem statement. The activity also includes procedures, discussion questions, and a journal assignment. (Author/GAB) ENC-020803

Ordering Information

Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$27.95 per book (paperback)

Rivers Curriculum Guide, Language Arts

Series: Rivers Curriculum

Grades 9-12

2001

Contributor(s): Catherine Scharle, Cathleen Bartlow, GeorgeAnn Kislia Siwicke, Jacyln Sue Schliepsiek, Janet Lueck, Judy Hager, Robert Williams, and Sue Cording

This unit of the Rivers Curriculum series focuses on writing and reading about rivers. Topics range from journaling and lab report writing, to creative writing and reading literature about rivers. A chapter on oral presentations includes basic guidelines concerning how to prepare an oral presentation. Activities include outlining a possible presentation on a topic related to rivers or water and creating the appropriate visual aids. The execution of the oral presentation is described as a student assessment. (Author/GAB) ENC-020804

Ordering Information

Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$27.95 per book (paperback)

Rivers Curriculum Guide, Mathematics

Series: Rivers Curriculum

Grades 9-12

1998

Contributor(s): Dianne Winney, Donna Clendenin, Ernie Berman, Gail Brueggeman, Mike Tresnak

The final unit of the Rivers Curriculum covers topics ranging from statistics and graphing to solving first-degree equations. The Rivers Curriculum Guide Mathematics supplement attempts to present a relationship between mathematics and the real world. Activities include a lesson on graphing in which students record and graph precipitation data with river level information. In another lesson, students explore equations and formulas with the graphing calculator by gathering information about how much water people use. (Author/AMS) ENC-020820

Ordering Information

Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$27.95 per book (paperback)

Science for All Americans

Grades K-12

1990

Contributor(s): Andrew Ahlgren and F. James Rutherford

The recommendations in this book address what understandings and ways of thinking are essential for scientific literacy. Most of the book discusses the content to be learned, while the remaining chapters cover teaching, reform, and future actions. The theme of each chapter is introduced through a black-and-white illustration of artwork, such as George Catlin's *A Little Sioux Village* for the chapter on human society. Throughout this chapter, the author discusses the effect of culture on human behavior. Readers analyze the patterns of societal organization, change, and conflict and consider the interdependence of worldwide social systems. Other chapters focus on the habits of the human

mind, effective learning and teaching methodologies, and the progress of Project 2061. (Author/JG) ENC-018805

Ordering Information
Oxford University Press, 2001 Evans Road, Cary, NC 27513
(919) 677-0977 / Fax: (919) 677-1303 / Toll-free: (800) 451-7556
www.oup-usa.org
\$15.95 per book (paperback)

The Theory of Plate Tectonics

Grade 8 and up
1999
Contributor(s): Dennis Tasa, Edward J. Tarbuck, and Leon McNeill
Publisher: Tasa Graphic Arts Inc

This CD-ROM presents the theory of plate tectonics, explains the driving mechanism, offers supporting evidence, and describes present-day geologic phenomena attributable to plate movement, such as earthquakes. Information is presented in a textbook-like format with contents divided into chapters; review questions can be found at the end of each section. Chapters can be selected from the main menu, as can a glossary that contains labeled figures and an audio pronunciation guide. A Newsflash icon describes past geologic events as if they were occurring in the present. Some chapters contain data for students to plot into computer graphs to visually represent key geologic concepts. Computer animations, color photographs, and diagrams illustrate the text throughout. In a selected chapter, fossil evidence of plate tectonics is presented through an animation showing prehistoric animals marching across a map of the world. Following this, their tracks are printed on the continents where their remains have been found. For instance, both the Mesosaurus and Cynognathus have been found in South America and Africa, indicating that the two continents once fit together like puzzle pieces. Double-clicking on a clock icon allows students to explore noteworthy events of geologic time, in addition to the length of time they spanned. Both Spanish and English versions are available for the high school edition. (Author/LEB) ENC-020752

Ordering Information
Forestry Suppliers, Inc., PO Box 8397, Jackson, MS 39284
(919) 677-0977 / Fax: (919) 677-1303 / Toll-free: (800) 451-7556
www.forestry-suppliers.com
\$53.50 per CD-ROM (with single-user license agreement)

Through the Eyes of Explorers

Series: AIMS Activities
Grades 5-9
1994
Contributor(s): Betty Cordell, Brenda Howsepian Dahl, Judith A. Hillen, and Sheldon Erickson

The five interdisciplinary units in this teacher resource book, part of the Activities Integrating Mathematics and Science (AIMS) series, use historical themes to introduce mapping. Mathematical topics covered include reasoning, measurement, and geometry in the real world. Unit activities connect to other curriculum areas including language arts, social studies, physical education, art, and music. The mathematical concepts grow progressively more complex. Four of the five units begin with historical context dealing with the mapping of the United States for its westward expansion. In a sample activity, students read a series of historical journal entries and develop an itinerary for a fur trapping expedition that occurred in 1832. Students

calculate distances traveled each day and for the entire trip, then determine the path of fur trappers on a map. Each activity in the book includes correlations to *Project 2061 Benchmarks* and the 1989 NCTM standards. All activities come with detailed background information, teaching suggestions, and classroom discussion questions, along with illustrated student activity sheets and ideas for extending the activity. (Author/JRS) ENC-016207

Ordering Information
AIMS Education Foundation, PO Box 8120, Fresno, CA 93747
(559) 255-4094 / Fax: (559) 255-6396 / Toll-free: (888) 733-2467
www.aimsedu.org
\$18.95 per activity book (paperback)

The Titanic in the Classroom

www2.nexus.edu.au/Teachstud/titanic2/home/titicl.htm
Series: Lifelong Education and Resource Network, South Australia
Grades 9-12
1996
Contributor(s): Australia Government of South Australia
Publisher: Department of Education, Training and Employment, Government of South Australia

The eight student research projects on this web site explore the mysteries of the Titanic, drawing from a specially developed database of Titanic-related information. Originally published by the Department of Education Training and Employment (South Australia), the database is searchable by a variety of passenger and crew characteristics. Each research project contains original source artifacts and suggestions for enriching the project with information from video and print sources. The site also presents plans for the layout of the Titanic and its lifeboats, newspaper articles, and links to further sources of information. In one research project, students learn that the Crew List signed by Captain Smith indicates that the crew was divided into three departments: Deck Department, Engine Department, and Steward's Department. Students read a letter to *The Times* praising the efforts of some sections of the Titanic's crew whom the author felt had been overlooked. A second letter, written by the parents of one of the lost engineers, is also included. The project includes pictures of memorials to the various crew and directs students to look for memorials in their own towns. Students investigate how many crew members were in each of the departments and draw conclusions based on the survival rates of the various departments. (Author/JRS) ENC-018942

Trash and the Environment

Series: Real World Science
Grades 3-5
1999
Contributor(s): Leslie Beatson
Publisher: Sunburst Communications

Cassie, the student host of this video program, describes Earth's natural recycling process and explains how humans have altered this process. Color photographs and footage highlight the ways in which humans produce solid waste, from lunch bags and leftover food to worn out socks and homework mistakes. Information about the composition of landfills includes a percentage breakdown of each major component, such as 35.6% paper and 20.1% garden waste. The program also addresses the processes of reducing, reusing, and recycling. Key terms, such as decomposition and waste-to-energy facilities, appear at the bottom of the screen as they are defined. A teacher's guide identifies learning objectives and guidelines for using the program. Activities are provided that involve students in writing synonyms for given

solid waste words, reading and writing numbers using place value, and completing a decomposition timeline for various objects. Hands-on post-viewing investigations ask teams to use petroleum jelly to determine the types of particles in air and to study the effects of acid rain (vinegar and water) on houseplants. Interdisciplinary activities focus on graphing the weight of trash generated by the class during the week, creating an ecology poster, and participating in a book and toy swap. (Author/JG) ENC-020364

Ordering Information
Sunburst Technology, 101 Castleton Street, PO Box 100, Pleasantville, NY 10570
(914) 747-3310 / Fax: (914) 747-4109 / Toll-free: (800) 321-7511
www.sunburst-store.com
\$59.95 per video with teacher's guide

Understanding Car Crashes

Grades 9-12
2000
Contributor(s): Griff Jones

The Insurance Institute for Highway Safety developed this video to explore the physical laws that govern the outcome of automobile crashes. Hosted by Griff Jones, an award-winning high school physics teacher, the program discusses and demonstrates Newton's laws of motion, kinetic energy, and momentum. Scenes from the Institute's Vehicle Research Center illustrate how crumple zones absorb energy and decrease the amount of g force exerted on the driver and passengers. The significance of seat belts, airbags, and other engineering advances is also highlighted. A sample segment describes the physics involved in multi-vehicle crashes. Students learn about the Law of Conservation of Momentum and about the energy transformations that take place during the collision process. The relationship between vehicular mass and injuries is used to underscore the importance of increasing deceleration time. In addition, the program evaluates and compares the crash worthiness of a variety of occupant compartments. An accompanying teacher's guide contains student worksheets and hands-on lessons that investigate the concepts. (Author/JG) ENC-020463

Ordering Information
Insurance Institute for Highway Safety, Suite 800, 1005 North Glebe Road, Arlington, VA 22201
(703) 247-1547 / Fax: (703) 247-1588
www.hwaysafety.org
\$35.00 per video with teacher's guide

Water

Series: Thematic Units
Grades 4-6
1993
Contributor(s): Barbara Cooney, Cheryl Buhler, David Jefferies, Joanna Cole, and Vera B. Williams
Publisher: Teacher Created Materials, Inc.

This unit on water is part of a series of whole-language thematic units with integrated hands-on activities that engage students in reading, writing, listening, observing, and creating. Each book in the series includes summaries of two to four children's books with related lesson plans and activities. Cross-curriculum activities are provided for language arts in the form of daily writing suggestions, as well as activities in math, science, social studies, art, music, and life skills. The book includes suggestions and patterns for bulletin boards and unit management plans, cooperative learning projects, and a culminating activity that requires students to synthesize their learning. In addition to

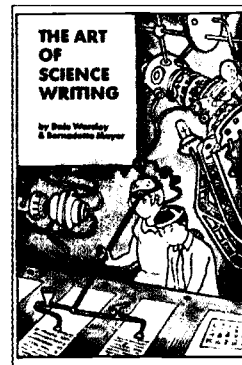
explaining the water cycle, this unit explores the area and states of New England, examines the different species of shore birds, and studies the main rivers of North America. Students also learn how water is used and consider ways to conserve water. In some of the many activities included in this book, students learn to tie different knots, make water filters, learn water poems, and determine population density. Some of the activities include short-answer questions, math problems, labeling, drawing, matching, and multiple-choice questions. Answers to the questions are provided at the end of the book. The books highlighted in this unit are *Island Boy*, *Three Days on a River in a Red Canoe*, and *The Magic School Bus at the Waterworks*. (Author/RA/JH) ENC-007710

Ordering Information
Teacher Created Materials, Inc., 6421 Industry Way, Westminster, CA 92683
(703) 247-1547 / Fax: (703) 247-1588 / Toll-free: (800) 662-4321
www.teachercreated.com
\$9.95 per book

Connecting to Language Arts

The Art of Science Writing

Grades 9-12
1989
Contributor(s): Bernadette Mayer and Dale Worsley



In this book, teachers of both science and English will find advice on how to write about science in many forms, including essays, notes, personal memoirs, poetry, and fiction. The book details how to write an essay from start to finish and provides 47 specific assignments. Teachers will also find the answers to over 30 questions commonly asked about science writing. Writing samples are included from notable figures like Darwin, Einstein, Rachel Carson, Stephen Jay Gould, and others. Also included are an annotated bibliography and an appendix on teaching math writing. (Author/KSR) ENC-019579

Ordering Information
Teachers & Writers Collaborative, 5 Union Square West, New York, NY 10003
(724) 772-8513 / Fax: (724) 776-0890 / Toll-free: (800) 457-2946
www.twc.org/tmain.htm
\$15.95 per book (paperback)

Caldecott Connections to Science

Grades K-6
2000
Contributor(s): Shan Glandon

The activities in this book integrate the use of Caldecott Award-winning books into the science curriculum. The Caldecott medal is awarded annually for the most distinguished picture book published during the previous year. Ten winning stories are used as a springboard for introducing units of study in

Connecting to Language Arts

science. The lessons are based on a modified learning cycle involving engagement, elaboration, exploration, and connection. Library research is a significant component of the units. Each unit includes reference information on the picture book, a summary of the story, and connections to the science curriculum. There are three to 13 activities associated with each story. The activity plans provide ideas for completing the various phases of the learning cycle. Using the book *Frog Went A-Courtin'*, for example, students learn about the life cycle of the frog by carrying out dramatizations, reading nonfiction books, and observing over time an aquarium containing tadpoles. Reproducible blackline masters are found throughout the book. (Author/SSD) ENC-019389

Ordering Information

Teacher Ideas Press/ Libraries Unlimited, PO Box 6633, Englewood, CO 80155
(303) 770-1220 / Fax: (303) 220-8843 / Toll-free: (800) 237-6124
www.lu.com
\$29.00 per book (paperback)

Integrating Science and Language Arts in Your Classroom

Series: Walch Reproducible Books

Grades 5-8

1996

Contributor(s): Jean Pottle and Mary Rutley

This resource book explores how science and language arts can be integrated within the classroom context. Each chapter centers on a specific book that addresses such topics as insects, environmental awareness, and inventions. Students perform hands-on activities to deepen understanding and extend learned concepts. Background information, reproducible student sheets, and instructional strategies are provided along with literary overviews and connections to other disciplines. A sample chapter investigates the nature of ecosystems by drawing from the book, *One Day at Teton Marsh*, written by Sally Carrighar. Students learn how various animals living in the marsh find food, build houses, and respond to changes in their environment. Follow-up activities involve collecting stream invertebrates and observing pond life in the laboratory. There is also a journaling assignment from a marsh organism's point of view. (Author/JG) ENC-020726

Ordering Information

J. Weston Walch Publisher, 321 Valley Street, PO Box 658, Portland, ME 04104
(207) 772-2846 / Fax: (207) 772-3105 / Toll-free: (800) 341-6094
www.walch.com
\$24.95 per book (paperback)

Learning English Through Science

Grades K-12

1986

Contributor(s): Francis Shoemaker, Francis X. Sutman, and Virginia French Allen
Publisher: National Science Teachers Association

For teachers who work with limited English proficient (LEP) students, this booklet describes general strategies for teaching all classes that include these students, specific methods teachers can use to prepare LEP students for reading science materials, and activities that can be used in teaching science concepts. One chapter contains detailed examples of science lessons that teach both English language and science content. The booklet provides a model for developing lessons that stress hands-on activities. This model includes suggestions for dealing simultaneously both with science skills and with those language

skills most fundamental to science comprehension. (FEB) ENC-001937

Ordering Information

National Science Teachers Association, PO Box 90214, Washington, DC 20090
(703) 243-7100 / Fax: (888) 433-0526 / Toll-free: (800) 722-6782
www.nsta.org
\$4.95 per book

Literacy and Mathematics, Grade 5

Series: Literacy and Learning, Reading in the Content Areas

Grade 5

1999

Contributor(s): Al Godoy, Clay Fourrier, Julie H. Lester, and Martha H. Head

Part of the Literacy & Learning series, this video demonstrates how teachers can use literacy strategies to help students comprehend and retain mathematics content. Designed to show middle school teachers how to integrate literacy instruction into content teaching, the series is based on four elements of literacy (reading, writing, listening, and communicating) that contribute to teaching and learning content material. An accompanying handbook includes supplementary information, program guides, and transparency masters. The handbook also contains the sample lesson plans presented in the videos. This video illuminates three literacy strategies useful for mathematics instruction. These strategies can provide a structured approach to helping students develop effective study habits through pre-reading, during-reading, and post-reading activities. To introduce the first strategy, Think Aloud, the teacher explains how describing every step involved in the solution of a problem helps students and then has a student model the strategy to solve a problem. The second suggested strategy, SQRCQ (Survey, Question, Reread, Question, Compute, and Question), is designed specially for mathematics instruction. Here the teacher guides the students through the six-step process as they solve a word problem. The final strategy, Quick Write, can be used at any point in a lesson to let students reflect on their learning and/or to provide the teacher with feedback. (Author/LCT/JRS) ENC-020811

Ordering Information

Great Plains National, PO Box 80669, Lincoln, NE 68501
(402) 472-2007 / Fax: (800) 306-2330 / Toll-free: (800) 228-4630
gpn.unl.edu
\$44.95 per video and 2 handbooks (loose-leaf)

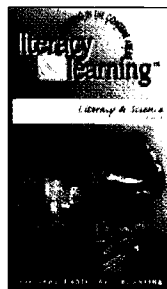
Literacy and Science, Grade 8

Series: Literacy and Learning, Reading in the Content Areas

Grade 8

1999

Contributor(s): Adrian Hirsch, Bryant Langlois, Clay Fourrier, Dolores Simoneaux, Julie H. Lester, and Kevin Gautreaux
Publisher: GPN



Part of the series described above, this video describes how teachers can use journals in the science classroom. The program introduces journaling as a literacy strategy that involves all four components of literacy: reading expository text materials; listening to teacher lectures and peer explanations; communicating about the design of experiments; and writing in various journal formats. Journals may include observations, anecdotal records, thoughts, reflections, and written responses to questions or challenges.

Journaling also offers an opportunity for dialog between teacher and student. The video presents a sample lesson in which students use their journals to research and observe the resurrection fern. In addition to recording their observations and data interpretations, students use the journals in a peer assessment activity in which they exchange journals and offer positive critiques. (Author/LCT) ENC-019791

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Great Plains National, PO Box 80669, Lincoln, NE 68501
(402) 472-2007 / Fax: (800) 306-2330 / Toll-free: (800) 228-4630
gpn.unl.edu
\$44.95 per videoe

Literature and Science Breakthroughs

Grades K-6
2000
Contributor(s): Jo-Anne Lake
Publisher: Pembroke Publishers

The strategies offered in this book are designed to help teachers use fiction and nonfiction books to teach science skills and principles. The book provides a variety of hands-on activities that connect children's literature to science concepts in the real world. The book is organized around five main strands in science: life systems, matter and materials, energy and control, structures and mechanisms, and Earth and space systems. Throughout the book, reviews and recommendations for children's literature can be used in each learning strand. The book begins with an introduction that provides the framework for implementing a literature-based approach in teaching science. The first part of the book presents the advantages of using the approach, a method for integrating literature and science, and information about strategies, tools, and applications that are appropriate for such an approach. These chapters are followed by specific literature suggestions and hands-on activities for each learning strand. For each topic, the book gives a statement of learning expectations, a sequence of key questions, and a topic organizer that provides an overview of the topics and the recommended books. In a sample lesson, students read *Butterfly House*, which traces the life cycle of a butterfly. Students then discuss the concepts of time, growth, and change as they relate to the life cycle of a butterfly. In a following hands-on activity, students raise a butterfly from a caterpillar to investigate the growth and development of a butterfly. An annotated bibliography and a list of additional resources are also included. The book concludes by discussing a model that integrates topics from the five science strands. (Author/YK) ENC-019089

Ordering Information
Stenhouse Publishers, 477 Congress Street, Suite 4B, Portland, ME 04101
(402) 472-2007 / Fax: (800) 306-2330 / Toll-free: (800) 228-4630
www.stenhouse.com
\$17.50 per book (softcover)

Math and Literature (Grades 4 to 6)

Grades 4-6
1995
Contributor(s): Rusty Bresser
Publisher: Math Solutions Publications

The third book in the Math and Literature series incorporates a variety of children's literature to motivate students to think and reason mathematically. The reading level of the books used in this series varies; some are picture books geared for younger

children, but the teachers who tested the lessons found that the simpler books often led to mathematical investigations of suitable complexity for older students. In addition to problem solving, lessons involve students in many mathematical tasks including: recognizing number patterns; understanding fractions, ratios, and proportion; logical reasoning and mental computation; measuring and estimating; and applications such as using money. The Math and Literature series is designed to show the connection between mathematics and the imaginative ideas in books. Series authors advocate writing in the mathematics classroom as a significant instructional technique to help children sort out, clarify, and define their thinking. Student writing also provides an assessment opportunity that allows teachers to identify students' understanding of mathematics. Each book in the series describes classroom-tested ideas for linking mathematics and literature. Sample lessons are written as vignettes describing actual classroom occurrences. Included in each are examples of children's written work. Complete bibliographic information for the literary works is provided. (Author/GMM) ENC-007864

Ordering Information
ETA/Cuisenaire, 500 Greenview Court, Vernon Hills IL 60061
(847) 816-5050 / Fax: (800) 382-9326 / Toll-free: (800) 445-5985
www.eta-cuisenaire.com
\$15.95 per book

Math and Writing

Grades 3-5
1995
Contributor(s): Sandra Short and Valerie Rose-Piver

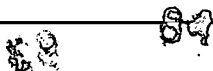
The 15 classroom-tested lessons in this resource book connect open-ended mathematical experiences with writing opportunities. Number sense, geometry, and measurement are some of the topics explored in the multiday lessons. Students write letters, poems, stories, and their own problems. The lessons focus on the four process areas specified by the 1989 NCTM standards. Each lesson includes an overview, recommended children's literature books, and specific information on the focus and rationale of the mathematical task. Multiple activities and assessment suggestions are included. In a sample lesson, Square Number Patterns, students identify square numbers, explore and describe patterns in square numbers, and create a square number design. Reading the book *Sea Squares* is suggested. Pairs of students use tiles to build the first eight or 10 square numbers and record and organize what they find. In a concluding activity, students journal in response to the following prompt: Patterns can make predictions beyond what you already know. (Author/JRS) ENC-018881

Ordering Information
Teaching Resource Center, PO Box 82777, San Diego, CA 92138
(510) 895-8193 / Fax: (800) 972-7722 / Toll-free: (800) 833-8552
www.abc.com
\$15.95 per book (paperback)

Math Is Language Too

Grade 4
2000
Contributor(s): David J. Whitin and Phyllis E. Whitin
Publisher: NCTE and NCTM

The first joint publication of the National Council of Teachers of Mathematics and the National Council of Teachers of English,



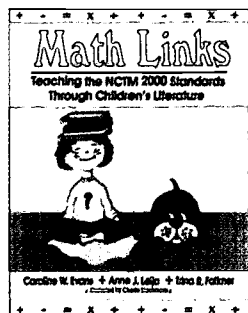
Connecting to Language Arts

this book explores how fourth-graders use story, metaphor, and language to develop mathematical thinking skills and strategies. In the first chapter, the authors set forth their ideas on the importance of classroom climate and focus on process for student learning. Students are to be treated as “sense makers” and given the opportunity to make sense of mathematics in an individual way. Throughout the book are ideas on using children’s literature to instigate mathematical investigations and to teach mathematical concepts. Several lessons include samples of student work and vignettes of classroom dialogue or discussion. In conclusion, the authors specify and discuss 15 strategies for supporting talking and writing about mathematics and four strategies for building a supportive classroom culture. (Author/MM) ENC-018319

Ordering Information
National Council of Teachers of Mathematics, Inc., 1906 Association Drive, Reston, VA 20191
(703) 620-9840 / Fax: (703) 476-2970 / Toll-free: (800) 235-7566
www.nctm.org
\$23.95 per book (paperback)

Math Links

Grades K-3
2001
Contributor(s): Anne J. Leija, Caroline W. Evans, Cherie Blackmore, and Trina R. Falkner



In this book are 36 lessons for teaching mathematics using children’s literature. Each lesson includes a suggested time frame, assessment suggestions, and ways to adapt the lesson for children with special needs. The book’s chapters correspond to the 10 mathematics standards that appear in NCTM’s *Principles and Standards for School Mathematics* (April 2000). The authors suggest using the Preview, Predict, Read, Retell, and Connect

method to introduce books. They feel that this process will help students notice connections between mathematics and the literature selected. Information is indexed by author, title, and subject for easy teacher reference. The chapter on algebra, for example, offers students opportunities to repeat and predict patterns, create models and pictures, and interpret symbols—essential background knowledge for a formal study of algebra. An included lesson is based on an English folktale in which a teeny tiny woman discovers and takes home a teeny tiny bone. For four days, students construct a tiny town on a grid, explore words that describe size, and write their own pattern story. A pattern story contains a repeating phrase that holds the story together. For example, the bone owner in the teeny tiny story repeatedly demands: Give me my bone! (Author/JRS) ENC-019480

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Teacher Ideas Press/ Libraries Unlimited, PO Box 6633, Englewood, CO 80155
(303) 770-1220 / Fax: (303) 220-8843 / Toll-free: (800) 237-6124
www.ti.com
\$32.50 per book (paperback)

Mathematics the Write Way

Grades K-6
1996
Contributor(s): Marilyn S. Neil

This book shows how elementary children learn mathematics through creative writing activities such as parallel (copycat) stories, journals, and learning logs. Included are more than 50 examples of student work that demonstrate how writing can be used to enhance mathematical learning in a student-centered classroom. The first chapter presents a rationale for writing in mathematics, while the second chapter offers overviews and samples of the various kinds of writing tasks. In the third chapter, readers will find a description of a learning environment designed to support writing in mathematics. The next section of the book explores how writing can be used to enhance teaching within the standards for problem solving, reasoning, communication, and connections as found in the 1989 NCTM standards. The final chapter suggests ways to use writing to assess the learning of mathematics. Each chapter concludes with references and children’s literature books useful for introducing the suggested writing projects. The appendix suggests children’s literature for creating parallel stories and lists classroom prompts for writing in mathematics. (Author/JRS) ENC-016784

Ordering Information
Eye On Education, 6 Depot Way West, Larchmont, NY 10538
(914) 833-0551 / Fax: (914) 833-0761
www.eyeoneducation.com
\$29.95 per book (softcover)

Promoting Student Thinking

Grades 4-8
1996
Contributor(s): Kathleen Hogan

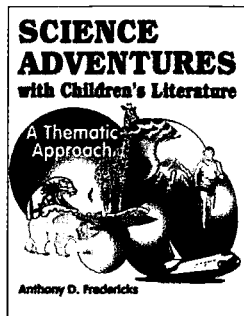
Rita is a sixth-grade girl who uses a unique set of thinking skills to solve problems. The biggest problem that she faces is the possible destruction of a wetland next to her school. Developers want to build housing on the land; as an incentive, they’re offering some of the land to the school for a new ball field. Rita must use all of her thinking skills and enlist the help of her friends to save the wetland. Included with the story is a teacher’s guide that guides students to think about thinking as they read the story and to explore the ecological themes found in the text. Part one of the guide provides the educational rationale for the story and an overview of different ways to use it in the classroom. Also included are specific techniques for promoting students’ thinking and assessment suggestions. Part two provides chapter-by-chapter teaching guidelines, including discussion questions and teaching prompts, key ideas, and small-group activities. This section also features extension ideas and ongoing assessment suggestions for each chapter. The third section contains guidelines for helping students apply their skills and knowledge to investigating environmental issues in their own community. No single environmental issue is identified for students to investigate, but a series of steps is outlined that involves using problem-solving skills to identify, investigate, and assess solutions to issues. (Author/SSD) ENC-018375

Ordering Information
Kendall/Hunt Publishing Company, 4050 Westmark Drive, PO Box 1840, Dubuque, IA 52004
(914) 833-0551 / Fax: (914) 833-0761 / Toll-free: (800) 228-0810
www.kendallhunt.com
\$21.95 per package

Science Adventures with Children's Literature

Grades 1-6
1998

Contributor(s): Anthony Allan Stoner and Anthony D. Fredericks



Teachers can look to this book for ways to engage students in a hands-on, integrated study of science. Part one describes the how-to and the rationale for creating a thematic learning environment in the elementary science classroom. It suggests ways to blend science into an integrated curriculum in which subjects support and extend each other. Part two contains thematic, standards-based science activities emphasizing the processes of sci-

ence rather than the mere repetition of facts. The activities are designed to take advantage of the natural questions children ask about the world around them. In a sample activity, students create their own homemade weather stations using bottles, straws, cardboard, and a balloon. Students use the instruments to collect data and compare it to local weather found in local newspapers. The class reads and discusses the unusual weather found in Judi Barrett's book, *Cloudy with a Chance of Meatballs*. Included with the thematic units are creative strategies for teaching science and an annotated resource list of more than 400 books, technological resources, and science web sites. (Author/JRS) ENC-013638

Ordering Information

Teacher Ideas Press/ Libraries Unlimited, PO Box 6633, Englewood, CO 80155
(303) 770-1220 / Fax: (303) 220-8843 / Toll-free: (800) 237-6124
www.ti.com
\$26.00 per book (paperback)

Science and Stories, Grades 4-6

Grades 4-6
1994

Contributor(s): Hilarie N. Staton and Tara McCarthy
Publisher: Good Year Books

Use popular literature to bring science to life with the tools outlined in this book, which describes how to create combined activities that bring in other subject areas. Activities supplement traditional science curricula, develop student problem-solving skills, and enhance understanding of the nature of science. Lessons also explore the relationships among science, technology, and society. The book covers five thematic units: the ocean, patterns of change, ecosystems, technology, and space. An organizational chart allows information to be easily accessed by teachers when preparing lesson plans. Reproducible student worksheets are also provided. Each activity contains a book summary, prereading suggestions, and science and literature connections. Also included are extension activities, additional ties to other subject areas, and study guide tips. In one lesson within the ecosystems unit, students read the book *Julie of the Wolves*, about a young woman who crosses the Arctic tundra. As a prereading exercise, students predict what type of ecosystem they will be studying based upon the illustrations on the book jacket. Students, working in cooperative learning groups, discuss and then present one of several suggested facets of the Arctic tundra, such as weather. Additional connections can be made to social studies as students study Eskimo or Inuit

culture, of which Julie is a part. The appendix provides a list of additional resources for each theme, including books, professional materials, and software. (Author/LEB) ENC-020640

Ordering Information

Pearson Learning, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(303) 770-1220 / Fax: (303) 220-8843 / Toll-free: (800) 237-6124
www.pearsonlearning.com
\$15.95 per book (paperback)

Storytime, Mathtime

Grades 1-3
1994

Contributor(s): Ann Tompert, Arnold Lobel, Bill Martin Jr, Cynthia Rylant, Don Freeman, Ellen Stoll Walsh, Eric Carle, Esphyr Slobodkina, H.A. Rey, Holly Keller, John Archambault, John Burningham, Judi Barrett, Pamela Allen, Pat Hutchins, Patricia Satariano, Tomie De Paola, Vera B. Williams, and Wanda Gag

Drawing from favorite children's literature books, such as *Mouse Count*, *Corduroy*, and *Caps for Sale*, this teacher resource book includes 67 activities that integrate major areas of mathematics and develop students' mathematical communication skills. Through discussion, cooperative learning, and hands-on experiences, students explore topics that include number, geometry, logic, and problem solving. In a sample from the four activities based on the book *Curious George Rides a Bike*, students use counters to explore odd numbers when George is asked to help his friend deliver newspapers to the odd numbered houses on the street. Students count out markers for numbers between one and 51. The odd numbers are found by forming number patterns showing that, when the markers are placed in pairs, odd numbers have one extra counter. Students then color a hundreds chart to show odd and even numbers and look for patterns of odd and even on the chart. Blackline masters are included for all activities, and a bibliography of additional children's storybooks invites further explorations. (Author/JRS) ENC-016252

Ordering Information

Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$15.35 per activity book (paperback)

Teaching Physical Science Through Children's Literature

Grades 1-4
1996

Contributor(s): Dwight J. Portman, Mickey Sarquis, and Susan E. Gertz
Publisher: Learning Triangle Press

The 20 lesson plans in this book use children's books, both fiction and not-fiction, as an integral part in teaching hands-on, discovery-oriented physical science in the classroom. The lessons are grouped into three sections based on the *NSES Physical Science Content Standard for Grades K to 4: Properties of Objects and Materials; Position and Motion of Objects; and Light, Heat, Electricity, and Magnetism*. In a sample lesson that features the book *The Black Snowman*, students explore the cultural meanings of the word *black* and use chromatography to discover that there is more to many black pigments than meets the eye. Each lesson includes a motivational introductory activity, a bridge to the science activity, and a detailed procedure for the science activity itself. Extension activities incorporate writing, art, and multicultural lessons. Additional books for further reading and bibliographic references are also provided.

Connecting to Language Arts

The assessment component recommends using diverse assessment methods, including journals, performances, portfolios, and paper-and-pencil tests. The appendices contain a shopping guide, an alphabetical list of the books used in the guide, and references to professional development centers in science education and children's literature. (Author/LCT) ENC-010989

Ordering Information

McGraw-Hill Companies, PO Box 545, Blacklick, OH 43004
(212) 512-2000 / Fax: (614) 755-5645 / Toll-free: (800) 352-3566
www.mcgraw-hill.com
\$19.95 per book

Writing Math Research Papers

Grades 10-12

1997

Contributor(s): Robert K. Gerver

Written for high school students, this book systematically describes the process of writing a research paper. It tackles the preliminary work of problem solving and reading mathematics effectively and includes the post-writing follow-up of presenting. Samples of student work illustrate the various stages of writing a research paper. The book provides a list of possible research topics, a bibliography of periodicals and problem-solving books, and information about mathematics contests. An appendix gives suggestions for implementing a math research program and ideas for assessing the paper and presentations. (Author/JAR) ENC-016617

Ordering Information

Key Curriculum Press, 1150 65th Street, Emeryville, CA 94608
(212) 512-2000 / Fax: (614) 755-5645 / Toll-free: (800) 352-3566
www.keypress.com
\$13.95 per book (paperback)

Writing to Learn Mathematics

Grades 7-12

1992

Contributor(s): Joan Countryman

The writing activities in this book are designed to help teachers enhance student learning of math. The author believes that students become active participants in learning mathematics when they write about what they are learning. The student work in this volume, from short journal entries to excerpts from longer research papers, demonstrates how students are interpreting unfamiliar texts, constructing arguments, struggling to understand complex systems, and developing new approaches to problems. Writing gives students a chance to practice skills such as inferring, interpreting, communicating, and symbolizing. Writers are also required to organize, explain, plan, and reflect. For example, a way to gain insight into how students think when doing mathematics is to have them write an autobiography of their successes and disasters in previous math classes. Another example is to use journals as a way to clarify student thinking and to provide a way for teachers to maintain dialog with students. (Author/LDR) ENC-006415

Ordering Information

Heinemann Educational Books Inc., 88 Post Road West, PO Box 5007, Westport, CT 06881
(603) 431-7894 / Fax: (203) 750-9790 / Toll-free: (800) 793-2154
www.heinemann.com
\$18.00 per book

Connecting to Literature for All Ages: Math

Amanda Bean's Amazing Dream

Series: Marilyn Burns Brainy Day Books

Grades 2-4

1998

Contributor(s): Cindy Neuschwander, Liza Woodruff, and Marilyn Burns



Part of the Marilyn Burns Brainy Day book series, this book tells the story of Amanda, who loves to count everything and learns that being able to multiply will help her count faster. A section at the end of the book explains the mathematics underlying the story and suggests ways to involve children with math. (Author/JAR) ENC-019504

Ordering Information

Scholastic, Inc., PO Box 7502, Jefferson City, MO 65101

(603) 431-7894 / Fax: (203) 750-9790 / Toll-free: (800) 793-2154

www.scholastic.com

\$16.95 per book (hardbound)

Amazing & Incredible Counting Stories!

Grades PreK-1

1995

Contributor(s): Max Grover

In this picture book, sensational numerical news events—such as the 11 telephone trees growing in the woods, or the four jelly faucets that save a whole lot of time—colorfully demonstrate the concept of counting. (Author/SXA) ENC-006261

Ordering Information

Harcourt Trade Publishers, 6277 Sea Harbor Drive, Orlando FL 32887

(619) 699-6707 / Fax: (800) 235-0256 / Toll-free: (800) 543-1918

www.harcourtbooks.com

\$14.00 per book

Anno's Mysterious Multiplying Jar

Grades 2-7

1983

Contributor(s): Masaichiro Anno and Mitsumasa Anno

Publisher: Philomel Books

Children are introduced to factorials through Anno's mysterious jar of water, which becomes a sea encompassing an island full of rolling landscapes and castles for readers to count. The book moves logically from the concrete to the abstract and then illustrates how to arrive at the answer. (Author/LDR) ENC-007472

Ordering Information

Putnam & Grosset Publishing Group, 405 Murray Hill Parkway, East Rutherford, NJ 07073

(607) 775-1740 / Toll-free: (800) 631-8571

\$19.99 per book

Counting on Frank

Grades 4-7
1991
Contributor(s): Rod Clement

As Henry and his dog, Frank, explore the world, readers are presented with all sorts of wacky counting and size comparison facts that encourage children to think about how math influences their lives. Suggestions for other counting problems are provided in the appendix. (Author/LDR) ENC-009006

Ordering Information
Gareth Stevens Publishing, 330 West Olive, Suite 100, Milwaukee, WI 53212
(607) 775-1740 / Toll-free: (800) 631-8571
www.garethstevens.com
\$22.60 per book

Flatland

downloade.org/etext/flatland/
Grade 9 and up
2001
Contributor(s): Aloysius West, Earle at Downlode Dot Org, and Edwin A Abbott
Publisher: downloade.org

This web site reproduces the text of the science fiction book *Flatland*, which explores the nature of space and dimension by imagining universes and characters that are composed of only one and two dimensions. These characters are unable to envision higher dimensions because such dimensions exist neither in their range of conception nor in their natural understandings. (Author/AMS) ENC-020810

How Big Is a Foot?

Series: Yearling Books
Grades K-2
1990
Contributor(s): Rolf Myller
Publisher: Bantam Doubleday Dell

Children learn about standard measurement through this entertaining story of a king who orders an apprentice carpenter to make a bed six feet by three feet. When constructing the bed, the apprentice uses his own small feet instead of the king's as units of measure, and the bed turns out to be far too small. (Author/KFR) ENC-009855

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Demco Media, PO Box 14260, Madison, WI 53714
(607) 775-1740 / Toll-free: (800) 631-8571
www.demcomedia.com
\$10.14 per book

If You Made a Million

Grades 1-4
1989
Contributor(s): David M. Schwartz and Steven Kellogg
Publisher: Lothrop, Lee & Shepard Books

Using a story context, this children's picture book introduces the concept of million, develops money concepts, and discusses bank accounts and interest. (AM) ENC-001654

Ordering Information
Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$18.95 per book

The King's Commissioners

Series: Marilyn Burns Brainy Day Books
Grades 2-3
1994
Contributor(s): Aileen Friedman and Susan Guevara
Publisher: Scholastic, Inc

This story introduces the concept of counting by grouping. It describes how a king's two advisors and the princess each used different methods of counting to determine how many royal commissioners the kingdom had. (Author/LDR) ENC-009718

Ordering Information
ETA/Cuisenaire, 500 Greenview Court, Vernon Hills IL 60061
(847) 816-5050 / Fax: (800) 382-9326 / Toll-free: (800) 445-5985
www.eta-cuisenaire.com
\$15.95 per book

Let's Count

Grades PreK-1
1999
Contributor(s): Tana Hoban
Publisher: Greenwillow Books

This picture book shows young readers how counting everyday objects such as wheels, flower petals, balloons, and ice cream cones can help them learn numbers. (Author/MM) ENC-019421

Ordering Information
HarperCollins Publishers, Inc. Children's Books, PO Box 588, Scranton, PA 18512
(212) 261-6500 / Fax: (800) 822-4090 / Toll-free: (800) 242-7737
www.harpercollins.com
\$16.95 per book (hardbound)

The Librarian Who Measured the Earth

Grades K-6
1994
Contributor(s): Kathryn Lasky and Kevin Hawkes

The star of this picture book is Eratosthenes, an ancient Greek who found a way to calculate the circumference of the Earth. His method for calculating the circumference is described in a way that is comprehensible to readers without a strong mathematical background. (Author/DBF) ENC-015932

Ordering Information
Little, Brown and Company, 3 Center Plaza, Boston, MA 02108
(212) 261-6500 / Fax: (800) 822-4090 / Toll-free: (800) 242-7737
www.twbookmark.com/index.html
\$16.45 per book (library binding)

Marvels of Math

Grades 3-9
1998
Contributor(s): Kendall Haven and Libraries Unlimited, Inc

These 16 stories tell about people and events associated with the development of mathematics through the ages. Stories explore the evolution of mathematics to meet specific human problem-solving needs. The stories can be read to elementary students or used as a source of information for older readers. (Author/JRS) ENC-019620

Ordering Information
Teacher Ideas Press/ Libraries Unlimited, PO Box 6633, Englewood, CO 80155
(303) 770-1220 / Fax: (303) 220-8843 / Toll-free: (800) 237-6124
www.lu.com
\$23.50 per book (paperback)

Math Curse

Series: Reading Rainbow
Grades 1-4
1998

Contributor(s): Cecily Truett, Ed Robeck, Ed Wiseman, Larry Lancit, LaVar Burton, Mary Budd Rowe, Orly Berger, Ronnie Krauss, Stacey Raider, Tami Robeck, Tony Buttino, and Twila Liggett

This video, part of the Reading Rainbow Math Series, is an upbeat adventure based on the children's book *Math Curse*. In the book, a girl feels cursed as she is inundated with mathematics problems that occur in everyday life. She eventually realizes that mathematics is the cure for her curse. (Author/LCT/SB) ENC-020549

Ordering Information
Great Plains National, PO Box 80669, Lincoln, NE 68501
(402) 472-2007 / Fax: (800) 306-2330 / Toll-free: (800) 228-4630
gpn.unl.edu
\$45.95 per video

Mathematicians Are People, Too: Volume I

Grades 3-10
1990

Contributor(s): Luetta Reimer and Wilbert Reimer

The first of two volumes, this book features 15 stories that describe moments of mathematical discovery. These are true stories about famous mathematicians such as the ancient Greek philosopher and scientist Thales, French mathematician Sophie Germain, and Srinivasa Ramanujan, an Indian mathematician. (Author/JRS) ENC-017860

Ordering Information
Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 526-9907
www.pearsonlearning.com
\$14.95 per book (paperback)

Mathematics

Grade 11 and up
1999

Contributor(s): Keith Devlin



Eleven of the most famous mathematical problems of the 20th century are presented and solved in this book, intended for readers of all levels of mathematical understanding. In several cases, the author shows how problems have not been solved by a single person, but with several people working together. (Author/SB) ENC-019821

Ordering Information
Columbia University Press, 136 S. Broadway, New York, NY 10533
(212) 666-1000 / Fax: (800) 944-1844 / Toll-free: (800) 944-8648
www.columbia.edu/cu/cup
\$17.95 per book (paperback)

The Number Devil

Grades 5-8
1998

Contributor(s): Hans Magnus Enzensberger, Michael Henry Heim, and Rotraut Susanne Berner

Robert hates math—at least, until his new friend the Number Devil leads him to many discoveries in the world of numbers. In 12 dreams, Robert and the Number Devil examine number concepts that include infinitely large and infinitely small numbers, prime numbers, Fibonacci numbers, and triangle numbers. (Author/JRS) ENC-018654

Ordering Information
Henry Holt and Company, Inc., 115 West 18th Street, New York, NY 10011
(888) 330-8477 / Fax: (800) 672-2054 / Toll-free: (888) 330-8477
www.henryholt.com
\$18.00 per book (paperback)

One Hundred Hungry Ants

Grades K-4
1993

Contributor(s): Bonnie MacKain and Elinor J. Pinczes

The marching verses and whimsical art in this book describe how a colony of 100 ants marching towards a picnic were persuaded to divide into rows of two, four, five, and ten so that they could arrive more quickly than marching single file. Drawings clearly depict all 100 ants in their several formations, illustrating the factors of 100 and the principles of division. (Author/LDR) ENC-009847

Ordering Information
Houghton Mifflin Trade and Reference Division, 181 Ballardvale Street, Wilmington, MA 01887
(978) 661-1300 / Fax: (800) 733-2098 / Toll-free: (800) 225-3362
www.hmco.com
\$16.00 per book (hardcover)

Quack and Count

Grades PreK-1
1999

Contributor(s): Keith Baker

Following the adventures of seven quacking ducklings, young children learn about counting and adding with the numbers one to seven. Simple text and cut-paper collage illustrations engage the reader as the ducklings move through the grass, play in the water, and, finally, fly away. (Author/JRS) ENC-019856

Ordering Information
Harcourt Trade Publishers, 6277 Sea Harbor Drive, Orlando, FL 32887
(619) 699-6707 / Fax: (800) 235-0256 / Toll-free: (800) 543-1918
www.harcourtbooks.com
\$14.00 per book (hardcover)

Sir Cumference and the First Round Table

Series: Math Adventures
 Grades 1-5
 1997
 Contributor(s): Cindy Neuschwander and Wayne Geehan



Discover how and why the round table was chosen as the most suitable design for King Arthur and his knights in this fanciful illustrated children's book, which emphasizes problem solving, shape, and mathematical vocabulary. (CMS) ENC-009844

Ordering Information
 Charlesbridge Publishing, 85 Main Street, Watertown, MA 02472

(617) 926-0329 / Fax: (617) 926-5720 / Toll-free: (800) 225-3214
 www.charlesbridge.com
 \$15.95 per book (library binding)

Ten Beads Tall

Series: Bead Frame Books
 Grades PreK-1
 1988
 Contributor(s): Pam Adams

In this book, part of the Bead Frame Books series, children use 10 cube beads to measure how tall, how wide, and how long the objects pictured on each page are. On the final page they use what they have learned to determine which vehicles can fit through a certain tunnel. (Author/GMM) ENC-014374

Ordering Information
 Child's Play International, 67 Minot Avenue, Auburn, ME 04210
 (207) 784-7252 / Fax: (800) 854-6989 / Toll-free: (800) 639-6404
 \$9.99 per board book

Twelve Snails to One Lizard

Grades PreK-3
 1997
 Contributor(s): Matt Novak and Susan Hightower
 Publisher: Simon and Schuster Books for Young Readers

Bubba Bullfrog helps Milo the Beaver patch the hole in a dam by explaining to him that an inch is about as long as a snail and a foot is about as long as a lizard. The book includes measurement facts about the animals in the story, such as the fact that Montana is home to a 2,140-foot-long beaver dam. (Author/JRS) ENC-016339

Ordering Information
 Intercontinental Books, PO Box 218, Paramus, NJ 07563
 (207) 784-7252 / Fax: (800) 854-6989 / Toll-free: (800) 639-6404
 \$15.00 per book (library binding)

Connecting to Literature for all Ages: Science

A Brief History of Time

Grade 9 and up
 1998
 Contributor(s): Ron Miller and Stephen W. Hawking
 Publisher: Bantam Books

Author Stephen Hawking draws from his groundbreaking research into black holes to offer clues about the elusive moment when the universe was born. He also traces the evolution of knowledge from the time of Aristotle, through the 1915 breakthrough by Albert Einstein, to the ideas of today's prominent young physicists. (Author/YK) ENC-017411

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 Random House, Inc., 400 Hahn Road, Westminister, MD 21157
 (410) 848-1900 / Fax: (800) 659-2436 / Toll-free: (800) 793-2665
 www.randomhouse.com
 New edition available

And Then There Was One

Grades 4-6
 1990
 Contributor(s): Margery Facklam and Pamela Johnson
 Publisher: Sierra Club Books

In this book, the Sierra Club examines the many reasons why animals disappear from the face of the Earth. Natural causes include earthquakes, floods, and overspecialization. Human causes include overhunting, habitat destruction, and pollution. (Author/LCT) ENC-007647

Ordering Information
 Little, Brown and Company, 3 Center Plaza, Boston, MA 02108
 (410) 848-1900 / Fax: (800) 659-2436 / Toll-free: (800) 793-2665
 www.twbookmark.com/index.html
 \$8.70 per book (paperback)

The Boy with Paper Wings

Grades 4-6
 1995
 Contributor(s): Paul Mirocha, Rhod Lauffer, and Susan Lowell

The tale begins when Paul, a boy confined to his bed with a fever, sails a paper airplane into his closet and finds himself inside the military diorama on his closet floor. Armed only with paper and the knowledge of how to fold it, Paul uses his imagination and courage to find his way out of dilemmas and disasters. (Author/JRS) ENC-019530

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 Milkweed Editions, Suite 300, 1011 Washington Avenue South, Minneapolis, MN 55415
 (612) 332-3192 / Fax: (612) 215-2550 / Toll-free: (800) 520-6455
 www.milkweed.org
 \$6.95 per book (paperback)

Dear Children of the Earth

Grades K-5
1994

Contributor(s): Greg Linder and Schim Schimmel

Written in the form of a letter from Mother Earth, this book blends lyrical blank verse and colorful artwork to deliver an inspirational message of concern for the environment. The letter's message is that humans are hurting and damaging our planet, leaving no place for her other children, the animals, to live. (RJD) ENC-016437

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Creative Publishing International, 5900 Green Oak Dr., Minnetonka, MN 55343
(952) 936-4700 / Fax: (952) 988-9101 / Toll-free: (800) 328-0590
www.creativepublishinginternational.com
\$12.95 per book (hardcover)

Earthsteps

Grades 3-7
2000

Contributor(s): Diane Nelson Spickert and Marianne D. Wallace
Publisher: Fulcrum Kids



From a large boulder to a tiny grain of sandstone, a rock progresses through 250 million years of time. Information is shared about the plants, animals, and climates of each geologic time period through which the rock passes. (Author/LEB) ENC-019939

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Fulcrum Publishing, 16100 Table Mountain Parkway, Suite 300, Golden, CO 80403
(303) 277-1623 / Fax: (800) 726-7112 / Toll-free: (800) 992-2908
www.fulcrum-books.com
\$17.95 per book (hardcover)

Enrico Fermi and the Revolutions of Modern Physics

Series: Oxford Portraits in Science
Grade 6 and up
1999

Contributor(s): Dan Cooper

Part of the Oxford Portraits in Science biography series, this book presents the life and work of Italian physicist Enrico Fermi, whose work led to the discovery of nuclear fission. Sidebars provide background information about Newton's laws of motion, Maxwell's theory of electromagnetism, and Roentgen's X-rays. (Author/YK) ENC-017178

Ordering Information

Oxford University Press, 2001 Evans Road, Cary, NC 27513
(919) 677-0977 / Fax: (919) 677-1303 / Toll-free: (800) 451-7556
www.oup-usa.org
\$22.00 per book (library binding)

Everybody Has a Bellybutton

Grades PreK-2
1997

Contributor(s): Clare Wood and Laurence Pringle

The bellybutton is used as an entry point to a discussion about human development, from the egg and sperm through birth. The book describes developmental advances such as early cell division and the transition from embryonic to fetal development. (Author/JSR) ENC-015387

Ordering Information

Boyd's Mills Press, 815 Church Street, Honesdale PA 18431
(919) 677-0977 / Fax: (919) 677-1303 / Toll-free: (800) 451-7556
www.boydspress.com
\$14.95 per book

Exploring the Environment Through Children's Literature

Grades K-4
1999

Contributor(s): Carol M. Butzow, John W. Butzow, and Rhett E. Kennedy

This book demonstrates how to use children's literature to stimulate children's interest in and knowledge of nature and the outdoors. It provides literature-based activities for science, social studies, and math, as well as music and art. Reproducible pages accompany the activities. The appendix contains the puzzle solutions. (Author/JR) ENC-016972

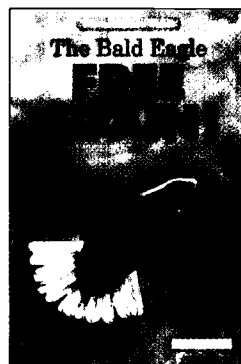
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www.lu.com
\$24.00 per book (paperback)

The Bald Eagle—Free Again!

Series: Young Readers Series
Grades 2-4
1996

Contributor(s): Carol A. Amato and Patrick O'Brien



In this book, Nikki and Chris visit a wildlife refuge to learn about eagles in the wild. They see bald eagles and an eagle's nest and observe young eaglets being fed by their parents. The children also learn about the physical characteristics of eagles and their life cycle and position in the food chain. (Author/LCT) ENC-004601

Ordering Information

Barron's Educational Series, Inc., 250 Wireless Boulevard, Hauppauge, NY 11788
(631) 434-3311 / Fax: (631) 434-3217 / Toll-free: (800) 645-3476
www.barroneduc.com
\$4.95 per book (paperback)

Hungry Animals

Series: My First Look at Nature
 Grades PreK-3
 1997
 Contributor(s): Heather Collins and Pamela Hickman

Explore the progress of the food chain as a wildflower gets eaten by a bug that gets eaten by a toad that gets eaten by a snake... and so on. Part of the My First Look at Nature series, this book also illustrates the methods used by each animal to obtain its food. A concluding section offers suggestions for extending learned concepts. (Author/JG) ENC-019593

Ordering Information
 Kids Can Press, 2250 Military Road, Tonawanda NY 14150
 (631) 434-3311 / Fax: (631) 434-3217 / Toll-free: (800) 645-3476
 www.kidscanpress.com
 \$6.95 per book (hardbound)

Inside the Hindenburg

Grades 4-8
 2000
 Contributor(s): Ken Marschall and Mireille Majoor



This oversize book tells the real-life stories of two young passengers who were actually aboard the Hindenburg on its final flight from Germany to New Jersey. The detailed paintings show readers the silk-walled public rooms and the control car. Step-by-step images and historical photographs trace the tragic demise of the airship. (Author/LCT) ENC-019633

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 Little, Brown and Company, 3 Center Plaza, Boston MA 02108
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 www.twbookmark.com/index.html
 \$18.45 per book (hardbound)

Keepers of the Earth

Series: Keepers
 Grades K-12
 1997
 Contributor(s): Carol Wood, John Kahionhes Fadden, Joseph Bruchac, Michael J. Caduto, and N. Scott Momaday

This collection of Native American stories is designed to help students understand and appreciate Native American cultures and the Earth through hands-on activities. The stories and activities cover such topics as creation, fire, and seasons, in addition to plants and animals, death and life, and unity of Earth. (Author/YK) ENC-018124

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 www.fulcrum-books.com
 \$19.95 per book (paperback)

Louis Pasteur

Series: Giants of Science
 Grades 5-8
 2001
 Contributor(s): Beverley Birch

Part of the Giants of Science series, this book includes descriptions of Louis Pasteur's experiments along with the impact they had on industrial and medical processes. Additionally, the book emphasizes the struggles that Pasteur endured in the pursuit of knowledge and highlights the critical role of his work in redefining immunology. (Author/RJD/JG) ENC-019998

Ordering Information
 Blackbirch Press, Inc., PO Box 9187, Farmington Hills, MI 48333
 (303) 277-1623 / Fax: (800) 726-7112 / Toll-free: (800) 992-2908
 www.blackbirch.com
 \$19.95 per book (hardbound)

Margaret Mead

Series: Giants of Science
 Grades 5-8
 1999
 Contributor(s): Michael Pollard

Part of the series named above, this book is a clear and concise account of the life and times of Margaret Mead. It includes background details of her early life and the society she lived in, as well the story of her education and the development of her career in ethnography. Also included are descriptions of her field work and the hardships and prejudices she overcame. (RJD) ENC-016474

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 Blackbirch Press, Inc., PO Box 9187, Farmington Hills, MI 48333
 (303) 277-1623 / Fax: (800) 726-7112 / Toll-free: (800) 992-2908
 www.blackbirch.com
 \$19.95 per book (library binding)

Moonbear's Pet

Grades PreK and K
 1997
 Contributor(s): Frank Asch
 Publisher: Simon and Schuster Books for Young Readers

In this story, Bear finds an animal in a pond and takes it home to be his pet. Over time, the pet named Splash grows and develops into a frog. During the transformation, Bear and his friend Little Bird argue over whether Splash will become a bear or a bird, until they find out that Splash has become a species of his own. (Author/JG) ENC-020236

Ordering Information
 Intercontinental Books, PO Box 218, Paramus, NJ 07563
 (303) 277-1623 / Fax: (201) 967-9830 / Toll-free: (888) 866-6631
 \$15.00 per book (hardbound)

Seashore Surprises

Series: Reading Rainbow
Grades Pre-K-3
1992

Contributor(s): Andreas von Einsiedel, Angela Royston, Cecily Truett, Charlotte Zolotow, Jill Gluckson, Kathy Kinsner, Larry Lancit, Mark Mannucci, Mary Budd Rowe, Megan McDonald, Orly Berger, Ronnie Krauss, Rose Wyler, S.D. Schindler, Steven James Petruccio, Tony Buttino, Twila C. Liggett, and Wendell Minor

In this video, host LeVar Burton uses the book *Seashore Surprises* as a reference guide for beach combing in southwestern Florida. Two local naturalists help him explore plant and animal life at the edge of the sea, including mangroves, oysters, and sea squirts. The teacher's guide contains activities that address the concepts of counting, estimation, and measurement. (Author/LCT) ENC-005738

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gpn.unl.edu
\$10.00 per teacher's guide
\$45.95 per video

Six Easy Pieces

Grade 9 and up
1995

Contributor(s): Matthew Sands, Paul Davies, Richard Phillips Feynman, and Robert B. Leighton

Taken from a series of lectures delivered by Nobel Prize winner Richard Feynman, this book introduces the general reader to fundamental aspects of physics, covering such topics as atoms, basic physics, and the relationship of physics to other topics. Throughout the book, Feynman presents each topic without equations or technical jargon, and illustrates key concepts using examples drawn from daily life or antiquity. (Author/YK) ENC-017925

Ordering Information
Perseus Books, c/o Westview Press, 5500 Central Avenue, Boulder CO 80301
(212) 207-7057 / Fax: (300) 449-3365 / Toll-free: (800) 386-5656
www.perseusbooks.com
\$13.00 per book (paperback)

Snowflake Bentley

Grades K-3
1998

Contributor(s): Jacqueline Briggs Martin and Mary Azarian



This story follows the lifelong quest of Wilson Bentley, a self-taught scientist, to capture the images of snowflakes in all their various patterns, shapes, and sizes. The book documents his perseverance in trying to capture the images of snowflakes in drawings and photographs before they could melt. (Author/LEB) ENC-020063

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Houghton Mifflin Trade and Reference Division, 181 Ballardvale Street, Wilmington, MA 01887
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www.hmco.com
\$16.00 per book (hardbound)

Tales of the Shimmering Sky

Series: Tales Alive!
Grades Pre-K-8
1996

Contributor(s): JoAnn E. Kitchel and Susan Milord

The 10 stories in this book integrate folk literature with activities, projects, and information about the sky. Drawn from all over the world, the stories reflect people's self-image and their perceptions of the sky. (Author/JSR) ENC-014013

Ordering Information
Williamson Publishing Customer Service, PO Box 185, Charlotte, VT 05445
(802) 425-2102 / Fax: (800) 304-7224 / Toll-free: (800) 234-8791
www.williamsonbooks.com
\$12.95 per book (paperback)

What Happens When...?

Series: Cartwheel Books
Grades 3-8
1996

Contributor(s): John Farndon, Mike Harnden, and Steve Fricker
Publisher: Cartwheel Books



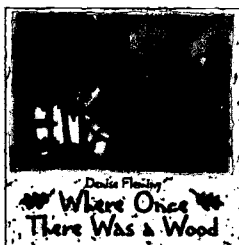
This tradebook tells the stories behind some of the daily activities that we take for granted, such as producing a newspaper, handling sewage, and delivering flowers. Each process is represented by a detailed illustration and explanatory text that describes each step. (Author/LCT) ENC-019554

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Scholastic, Inc., PO Box 7502, Jefferson City, MO 65101
(802) 425-2102 / Fax: (800) 560-6815 / Toll-free: (800) 724-6527
www.scholastic.com
\$17.95 per book (hardbound)

Where Once There Was a Wood

Grades Pre-K-2
1996

Contributor(s): Denise Fleming



This picture book explains that the construction of a housing development robs wildlife of land that once belonged to them. The book suggests ways to convert the reader's backyard into a refuge for animals and explains that wild creatures need to have space, shelter, water, and food. (Author/JR) ENC-016837

Ordering Information
Henry Holt and Company, Inc. 115 West 18th Street, New York, NY 10011
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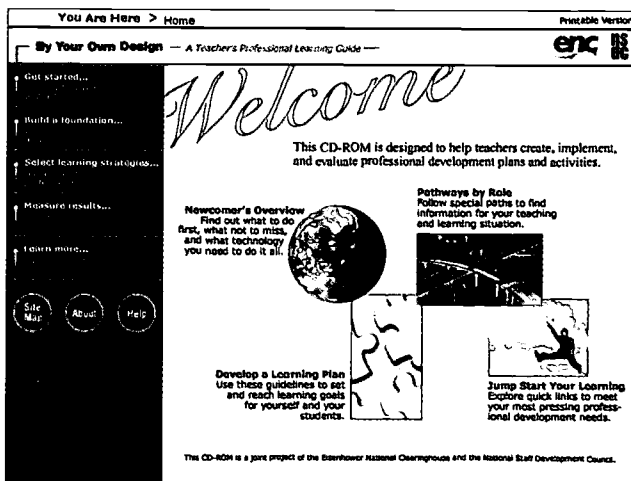
Remember that CD-ROM you received with the January issue of *ENC Focus*? When the school year is over, maybe you'll have a bit more time to explore it. That's why ENC is offering a free online course through ENC Online this summer.

The course will support and extend the content of *By Your Own Design: A Teacher's Professional Learning Guide*. If you did not receive the CD—or can't recall exactly where you stored it—the *Guide* is also available online (www.enc.org/pdguide).

The course has several goals, including

- to help you learn about and use everything in the *Guide*;
- to facilitate your creation of a meaningful professional learning plan;
- to give you an opportunity to learn about and try a variety of professional learning strategies; and
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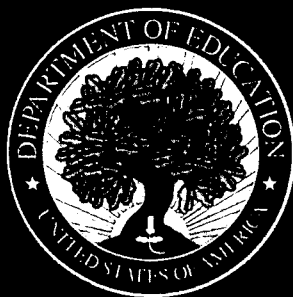
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