SPECTRUM

THE JOURNAL OF THE ILLINOIS SCIENCE TEACHERS ASSOCIATION

SUMMER 1997

SPECTRUM

JOURNAL OF THE ILLINOIS SCIENCE TEACHERS ASSOCIATION
Volume 23, Number 2, 1997

SPECTRUM is published quarterly, in Winter, Spring, Summer and Fall by the Illinois Science Teachers Association, University of Illinois, College of Education, 1310 S. Sixth Street, Champaign, IL 61820. Individual Subscription rates are $25.00 for regular members and $15.00 for retirees and full time students.

Submissions, subscriptions, and inquiries regarding the journal should be sent to:

Diana Dummitt, Associate Editor
ISTA SPECTRUM
University of Illinois
College of Education
1310 South Sixth St.
Champaign, IL 61820
(217) 244-0173 (217) 244-5437 FAX
e-mail: ddummitt@uiuc.edu

The Illinois Science Teachers Association (ISTA) is a state chapter of the National Science Teachers Association, 1840 Wilson Boulevard, Arlington, VA 22201-3000.

ISTA NEWS 1
SPECIAL INTERESTS 6
ARTICLES 8
- Science Education Outreach: Physics Demonstrations, Lectures, and Workshops
- What Illinois Science Teachers Perceive They Don't Know About National Benchmarks and Standards — Implications for Professional Development
- Is It Going to Rain Today? Understanding the Weather Forecast

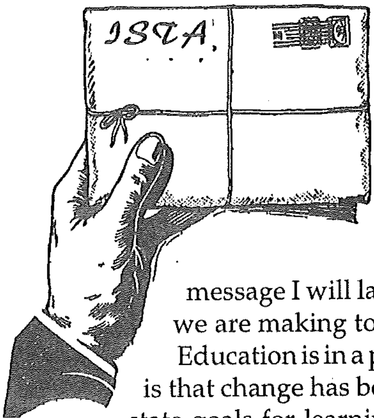
MINI IDEAS 27
EDUCATIONAL MATERIALS 41

Typist: University of Illinois
College of Education
Word Processing Center

Printer: East Central Communications, Inc., Rantoul, IL

Cover: John G. Shedd Aquarium High School Marine Biology Program, Bimini Island, Bahamas.

ISTA NEWS



SUMMER PRESIDENT'S MESSAGE

On March 8 of this year, I began my two-year term as president of our association. You may not be aware that ISTA presidents serve a six-year term: two years as president-elect; two years as president; and two years as immediate past president. Since you elected me as your president more than two and one-half years ago, you may have forgotten what I stand for, and what you can expect of me as I direct our association in the months ahead. In this message I will lay out one of my guiding principles. In future issues, I will explain progress that we are making toward implementing this principle.

Education is in a period of change that began in the 1980s. What has impressed me during this time is that change has been done *to* teachers, not initiated *by* teachers. In Illinois, for example, adopting state goals for learning (and now state standards), the various forms of school accreditation, state assessment (and local performance assessment), and the new effort to adopt teaching standards for pre-service and inservice teachers have come from outside the teaching ranks. Teachers have been brought on board during the implementation phase, after ideas have been proposed and gained acceptance elsewhere. The truth is that politicians, think tanks, and self-appointed reformers are setting the agenda for the reform movement. I believe that teachers—the ones closest and most intimately involved in the teaching and learning process—should be the initiators of change and the advocates for educational reform.

In the months ahead, ISTA will encourage, assist and support teachers who want to take charge of their profession. I believe that there are hundreds of teachers around our state who know how to improve science education for our state's children. I want ISTA to be an organization in which their ideas can be shared, where change plans can be created, and where the resources of the association can support change that is generated at the grass roots level. This process begins with you and in fact cannot be successful without you. Now is the time for teachers to tell the politicians, reformers and state bureaucrats what they can do to truly serve the classroom teacher. Please feel free to contact me by telephone (708/447-6070) or e-mail (ddirks@w-cook.k12.il.us) to share ideas that you believe will improve science education in our state. I want you to take charge of your profession. I pledge that ISTA will provide encouragement, assistance and support in your effort.

Sincerely yours,

Doug Dirks

Announcing
ISTA
Science in the South
Conference
Southern Illinois University
at Carbondale
Student Center
Friday March 13, 1998
See Page 45 for Call for Papers

THE ADVANCE PROGRAM FOR THE 1997 ISTA CONVENTION "SCIENCE: IT PLAYS IN PEORIA" IS AVAILABLE NOW TO ORDER COPIES OF THE ADVANCE PROGRAM CONTACT DIANA DUMMITT AT THE ADDRESS ON THE INSIDE FRONT COVER.

Kevin D. Finson
58 Horrabin Hall
Western Illinois University
Macomb, IL 61455-1396
Kevin_Finson@CCMAIL.WIU.edu

LETTER FROM THE EDITOR

As I've visited with different people over the past few months, I've found that interest in science education has been on the increase. Whenever something begins to become stronger and grow, one consequence invariably seems to be the arising from some quarters resistant to improvements or progress. This is presently true in the case of science education in Illinois, and has been so nationally off and on for at least the last decade. As we involve ourselves in the improvement of science education, we must also be aware of those entities who would work to weaken it. Interestingly, when we hear of attacks on (or movements to) weaken science education, we typically assume such acts emanate from those who do not support education, or at least put education far down the list in importance. The real surprise comes when we discover those acts are often perpetrated by those whom we perceive as colleagues in the educational process. Left unchecked, their activities can ultimately result in the undermining of education in general, and of science education in particular.

Nationally, we've had some close calls. One example involved Congress' attempt to scuttle the Eisenhower Act funding, and then -- when that seemed unlikely -- to shift monies to the states without specific guidelines for their use (eg. a certain percentage being targeted for science education) through block grants. We collectively avoided the loss of the program when many of us contacted our senators and representatives to voice support for the program. Closer to home, I have three examples to share. On the surface, each may seem rather harmless, but in a deeper sense -- and when taken together -- they do not contribute to the type of science education many of us have worked so hard to have in place in our schools. The first example comes from a teacher colleague in central Illinois. This teacher was explaining how it was becoming more difficult to convince her principal to allow certain science activities (field trips, after-school programs, etc.) to continue. The principal's reasoning was that their students' IGAP scores in reading have declined in the past two years, and he directly attributed that decline to the fact that science has been "pushed" so much over the last several years and resulted in less time being spent reading.

The second example stems from conversations I've had dealing with the ISBE's statewide test on science. Actually, this comes in two parts. The first part is the proposal to have a single exit examination for high school seniors, which would include science on the exam. There would be no formative assessment throughout the K-11 years. The exam would be high stakes, with students being required to pass the exam before receiving their diplomas. Although many of us have disliked the IGAP science assessment and various other assessments imposed on us, it is pedagogically indefensible to reduce all K-12 assessment to a single examination at the 12th grade. The second part derives from the volume of work poured into performance-based assessments since the beginning of this decade. Even though great strides were made in the development of performance- based assessments in Illinois, their use has effectively been placed on the back burner by the ISBE. Presently (so I have been informed), the ISBE is working on a writing examination for science. The idea is that students should write about science for their assessment, rather than doing science. Perhaps I'm short- changing the approach, but it seems incongruent with the National Science Education Standards from the NRC and the Benchmarks from AAAS. It seems incongruent with what the National Science Teachers Association has promoted for years, culminating recently in their Pathways documents for both secondary and elementary science.

The third example comes from the state benchmarks (yet to be released as of the time of this writing). Much work and effort was put into developing these benchmarks, involving many people. This will serve as one of the guiding documents influencing education in this state for many years to come. The draft document was released for review and comment (notably, science educators at several universities had to scrounge for copies since the document was not mailed to them), and the final version is due out this summer. I've been informed that, despite reviewers finding some concepts at inappropriate grade levels, despite the science process skills being left out, and despite several other significant errors or omissions, the major changes at this point are limited to semantics -- changes in a word here or there.

If I have been misinformed or have been unduly harsh, I offer my apologies to those involved. Further, these views are mine, not ISTA's. However, consider for a moment the state of science education if (1) there were no longer any Eisenhower funds available, (2) administrators reduced an already-low emphasis on science in their schools, (3) assessing students' science skills and learning was measured only through written examinations, and (4) teachers had to work under the parameters of a guiding document more concerned with politically correct semantics than conceptually and pedagogically sound science instruction. If you don't like what you see, its time to let someone know.

Marilyn Husser, ODE Science Specialist
Oregon Department of Education
Reprinted from *The Oregon Science Teacher*

TIMSS; WHAT ARE THE FINDINGS IN SCIENCE AND WHAT QUESTIONS DO THEY RAISE?

BACKGROUND

The Third International Mathematics and Science Study (TIMSS) is the largest, most extensive international comparison of education ever undertaken. The first release of information occurred on Oct. 15, 1996. That release focused on comparing science and mathematics curriculum and materials. The second release occurred on November 20, 1996 and focused on 8th grade student achievement in science and mathematics. Student achievement results for 4th and 12th grade students will be release later. They will provide a more complete international picture of science and math education.

FINDINGS

Achievement: TIMSS made several findings regarding student achievement, including: U.S. 8th graders score below average in mathematics achievement and above average in science achievement, compare to the 41 nations in the TIMSS Assessment. U.S. students are 11th in science achievement, when placed in rank order. In Science, our 8th graders international standing is stronger in earth science, life science and environmental issues than in chemistry and physics. The U.S. is one of 11 TIMSS nations which there is not a significant gender gap in 8th grade math and science achievement.

Curriculum: TIMSS made several findings regarding curriculum, including: 8th grade science students are likely to take only one science course, either physical, life, earth or general science. U.S. science and mathematics textbooks contain far more topics than was typical internationally, but provided significantly less coverage than the international average for the five most emphasized topics in science and math. Our nation is atypical among TIMSS countries in its lack of a nationally defined curriculum. U.S. 8th graders spend more hours per year in math and science classes than German and Japanese students.

Teachers' Lives: TIMSS made several findings regarding teachers' lives, including: Unlike new U.S. teachers, new Japanese and German teachers receive long-term structured apprenticeships in their profession. Japanese teachers have more opportunities to discuss teaching-related issues than do U.S. teachers. U.S. teachers have more college education than their colleagues in all but a few TIMSS countries.

Student diversity and poor discipline are challenges not only for U.S. teachers, but for their German colleagues as well.

Students' Lives: TIMSS made several findings regarding students lives, including: 8th grade students of different abilities and typically divided into different classrooms in the U.S., and different schools in Germany. In Japan, no ability grouping is practiced. U.S. teachers assign more homework and spend more class time discussing it than teachers in Germany and Japan. U.S. students report about the same amount of out-of-school math and science study as their Japanese and German counterparts. Home factors were strongly related to science achievement in every country that participated. Heavy TV watching is as common among U.S. 8th graders as it is among their Japanese counterparts.

QUESTIONS AND ANSWERS

How can this report be used? It is important to understand the magnitude of the TIMSS Study. The TIMSS curriculum and teacher data are extensive and cannot be explored in a single report. The report is intended to provide data relevant to public discussion about science and mathematics education in the United States and not necessarily to provide the answers to all our questions. A thorough understanding will only be gained by careful consideration and thoughtful review. The danger with reports such as these is the tendency to extract sound bites or to over-generalize the findings.

What curriculum information was used in compiling this report? The report analyzed 491 mathematics and science curriculum guides and 628 textbooks from around the world as well as data collected through questionnaires and classroom observations on teaching practices in the U.S., Germany and Japan. The data on curriculum and textbooks were collected in 1992-93, while those related to teacher practices were collected in 1995.

What is the nature of the science test? Five content dimensions were covered in the TIMSS science tests given to the middle-school students: earth science, life science, physics, chemistry and environmental issues and the nature of science. About one-fourth of the questions were in free-response format requiring students to generate and write their answers. These types of questions, some of which required extended responses, were allotted approximately one-third of the testing time. Chapter 3 of *Science in the Middle Years* contains 25 example items illustrating the range of science concepts and processes addressed by the TIMSS test.

What other data was collected? Because the home, school and national contexts within which education takes place can play important roles in how students learn science, TIMSS collected extensive information about such background factors. The students who participated in TIMSS completed questionnaires about their home and school experiences related to learning science. Also, teachers and school administrators completed questionnaires about instructional practices. System-level information was provided by each participating country.

What countries were involved? Argentina*, Australia, Austria, Belgium, Bulgaria, Canada, Colombia, Cyprus, Czech Republic, Denmark, England, France, Germany, Greece, Hong Kong, Hungary, Iceland, Indonesia*, Iran (Islamic Republic), Ireland, Israel, Italy*, Japan, Korea (Republic of), Kuwait, Latvia, Lithuania, Mexico*, Netherlands, New Zealand, Norway, Philippines*, Portugal, Romania, Russian Federation, Scotland, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand and the United States.

Who are our peers according to 8th grade achievement tests? The five countries directly preceding the U.S< (534) in achievement scores are: Belgium (550), Slovak Republic (544), Russian Federation (538), Ireland (538) and Sweden (535). The five countries directly following the U.S. are: Canada (531), Norway (527), New Zealand (525), Hong Kong (522) and Switzerland (522).

Which countries were in the top six on 8th grade achievement? The top six scoring countries were: Singapore (607), Czech Republic (574), Japan (571), Korea.

What factors may indicate the differences between how science is taught in other countries, that may account for the disparate student performances? The following preliminary observations were made:

- Focus and depth: A report issued in October by TIMSS suggests that U.S. science and mathematics teachers teach too many topics and don't have enough time to cover each topic thoroughly.
- U.S. textbooks covered many more topics than contemporary international texts, but with much less depth.
- U.S. educators have no coherent vision of how to reach today's children and the nation has no commonly accepted vision of education.
- Less preparation time for labs and lessons: U.S. science teachers teach an average of 26 hours per week while Japanese teachers teach an average of 18 hours per week.

You can find more information on TIMSS and the individual reports mentioned by visiting the NSTA Homepage at http://www.nsta.org

Two of the reports are available as indicated below.

A Splintered Vision: An Investigation of U.S. Science and Mathematics Education will be available soon. For ordering information, contact TIMSS, Project Office, 455 Erickson Hall, Michigan State University, East Lansing, MS 48824; (517) 353-7755; http://ustimss.msu.edu

Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curricula, and Achievement in International Context was released in mid November, For a copy, contact the National Library of Education, 555 New Jersey Ave. NW, Washington, DC 20208;800-424-1616. Full text and graphics of the report also appear on the web at: http://www.ed.gov/NCES/timss

* These countries were involved in the TIMSS study, but did not take the science test.

Ed. Note: The Illinois Science Teachers Association is forming a committee to determine how to implement the TIMSS data in our state. If you would like more information on being a part of this important initiative, contact ISTA President Doug Dirks at the address on the inside front cover.

Bill Conrad
bconrad@kiwi.dep.anl.gov.
Found at: http;//www.middleweb.com/mshumor.html

MIDDLE SCHOOL COMIC RELIEF

Thanks to Holly Hatch at the University of North Carolina (hatch@gibbs.oit.unc.edu) for tracking down these "beguiling ideas about science" from the essays, exams, and classroom discussions of students — mostly 5th and 6th graders. And thanks to the originator, somewhere out there in cyberspace. If you have anything to add to the list, let us know: MiddleWeb@middleweb.com

Question: What is one horsepower?
Answer: One horsepower is the amount of energy it takes to drag a horse 500 feet in one second.

You can listen to thunder after lightening and tell how close you came to getting hit. If you don't hear it you got hit, so never mind.

The law of gravity says no fair jumping up without coming back down.

When they broke open molecules, they found they were only stuffed with atoms. But when they broke open atoms, they found them stuffed with explosions.

When people run around and around in circles we say they are crazy. When planets do it we say they are orbiting.

Rainbows are just to look at, not to really understand.

Someday we may discover how to make magnets that can point in any direction.

South America has cold summers and hot winters, but somehow they still manage.

Most books now say our sun is a star. But it still knows how to change back into a sun in the daytime.

Water freezes at 32 degrees and boils at 212 degrees. There are 180 degrees between freezing and boiling because there are 180 degrees between north and south.

There are 26 vitamins in all, but some of the letters are yet to be discovered. Finding them all means living forever.

There is a tremendous weight pushing down on the center of the Earth because of so much population stomping around up there these days.

Lime is a green-tasting rock.

Many dead animals in the past changed to fossils while others preferred to be oil.

Genetics explain why you look like your father and if you don't why you should.

Vacuums are nothings. We only mention them to let them know we know they're there.

Some oxygen molecules help fires burn while others help make water, so sometimes it's brother against brother.

We say the cause of perfume disappearing is evaporation. Evaporation gets blamed for a lot of things people forget to put the top on.

To most people solutions mean finding the answers. But to chemists solutions are things that are still all mixed up.

In looking at a drop of water under a microscope, we find there are twice as many H's as O's.

Clouds are high flying fogs.

I am not sure how clouds get formed. But the clouds know how to do it, and that is the important thing.

Clouds just keep circling the earth around and around and around. There is not much else to do.

Water vapor gets together in a cloud. When it is big enough to be called a drop, it does.

Humidity is the experience of looking for air and finding water.

We keep track of the humidity in the air so we won't drown when we breathe.

Rain is often known as soft water, oppositely known as hail: Rain is saved up in cloud banks.

In some rocks you can find the fossil footprints of fishes.

Cyanide is so poisonous that one drop of it on a dog's tongue will kill the strongest man.

A blizzard is when it snows sideways: A hurricane is a breeze of a bigly size: A monsoon is a French gentleman.

Thunder is a rich source of loudness.

Isotherms and isobars are even more important than their names sound.

It is so hot in some places that the people there have to live in other places.

The wind is like the air, only pushier.

Author Note: If you enjoyed this little bit of comic relief, try the authentic assessment graduation exam!

C. E. Knapp, Professor and Faculty
Coordinator — Outdoor Teacher Education
Northern Illinois University

FORTY-SIX YEARS AND STILL COUNTING

Science educators know the importance of hands-on learning outside the classroom. For many years, they have used day and resident field trips to forests, fields, bodies of water, or other local ecosystems. No longer do scientists educators debate the value of direct investigations and the collection of vital data to support the on-going curriculum,

Since 1951 Northern Illinois University has provided a place for extended residential studies at its 141 -acre Lorado Taft Field Campus. Located 36 miles west of the university's DeKalb campus, Lorado Taft Field Campus is a home-away-from-home for over 6,000 public and private school students and their teachers, 500 pre-service teachers, 800 other NIU faculty and students, and 2400 people from a variety of community groups annually. Taft Campus accommodates about 120 residents in several dormitory-style buildings.

Science teachers may be interested in bringing students to the campus to study at the natural laboratory on the banks of the Rock River for one or two nights or more. They may also want to take graduate-level courses in outdoor and environmental education offered during the eightweek summer session Graduate courses can also be arranged in advance to be taught in local communities.

Another possible use of the facility would be for weekend or summer curriculum-writing workshops and staff development retreats. With a history of over 1,000 graduate degree recipients in outdoor education since the program began in 1962, science teachers may wish to enroll in a master's degree in Curriculum and Instruction with a specialization in outdoor education. This degree can be pursued on a filll or part-time basis. For more information about the multiple opportunities available at NIU's Lorado Taft Campus, contact the Dr. C.E. Knapp (P.O. Box 299, Oregon, IL 61061; Phone (815) 753-0205M32-2111; FAX (815) 7324242.

Julie Kaiser
Illinois Department of Natural Resources

ILLINOIS WILDLIFE AND NATURE VIEWING GUIDE READY FOR SUMMER!

Grab your hiking shoes, field glasses and camera and make your plans now for trips to Illinois parks and natural areas. Don't forget to take along a handy new Illinois guidebook. The eagerly anticipated Illinois Wildlife and Nature Viewing Guide is available for purchase from the Illinois Department of Natural Resources (IDNR). The 144-page book is a tremendous resource for any individual who enjoys exploring our state's natural resources.

The guide highlights more than 90 of the state's most beautiful and educational sites. Each site description summarizes the types of plants and wildlife you can observe, what trails are available for hiking or horseback riding, accessible facilities and interpretive services, directions to the site, noteworthy or historical features and much more. Also included is an illustrated look at six distinctive Illinois habitats and the plants and animals found in each area, full color photographs and several local maps with directions to each site.

Remember, as you travel throughout Illinois with this exciting new book, keep your eyes open for new brown road signs with white binoculars on them. These signs will help lead you to the 94 sites included in the guide.

Authors Mary Judd Murphy and John Mellen are co-owners of Drumlins Biological Surveys, a Midwest consulting firm specializing in the monitoring of wildlife populations, environmental education teachers workshops and interpretive services for agencies and organizations with watchable wildlife or biological reserves. Photographer Michael Jeffords' work has appeared in Illinois Steward, The Nature of Illinois and numerous scientific publications. He is a graduate of the University of Illinois with both an M.S. and Ph.D in Entomology and has been writing and photographing Illinois landscapes for twenty years.

Major sponsors of the Illinois Watchable Project which produced the guide include: IDNR, the United States Forest Service, the United States Army Corps of Engineers, the Max McGraw Wildlife Foundation, the Illinois Audubon Society, the Illinois Department of Transportation and Drumlins Biological Services. Additional contributors include the Wildlife Society, the Professional Association of Conservation Resource Managers and the Illinois Chapter of the American Fisheries Society.

Order your copy from IDNR's Merchandise Sales division for $8.95 plus tax. Call 1-800-720-3249 for more information on this book and other worthwhile products.

Bertram C. Bruce
Michael B. Weissman
Michael Novak

SCIENCE EDUCATION OUTREACH: PHYSICS DEMONSTRATIONS, LECTURES, AND WORKSHOPS

Anyone who spends even a short time helping children learn science soon discovers that they learn in many different ways. It is a challenge to respond to their diverse interests and backgrounds, but without that response, many children may get bored or left behind. A classroom teacher faces the additional challenge of needing to find materials and activities that engage children's thinking across a wide range of science topics.

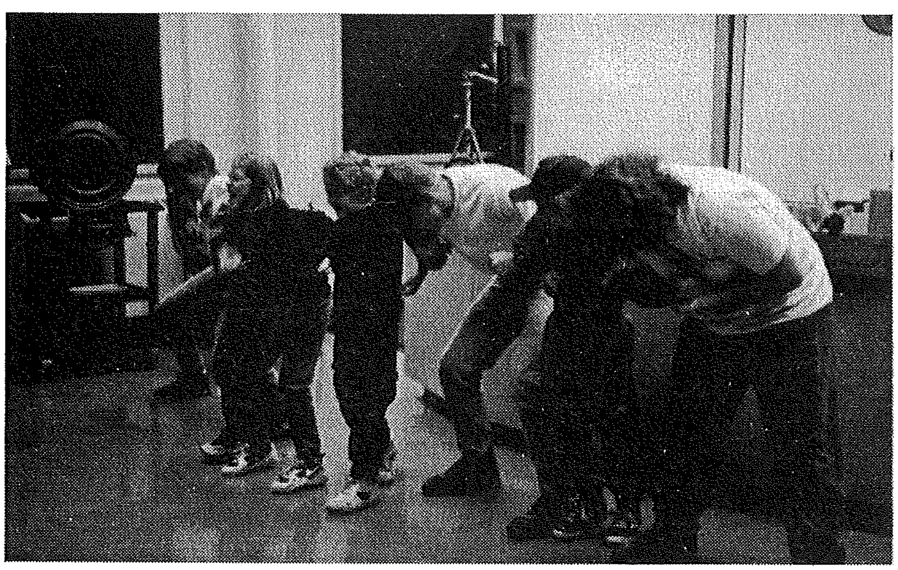
This is where science education outreach comes in. Programs run by universities, museums, science centers, industry, and other organizations can greatly enrich learning for students of all ages, by providing materials and technical expertise few teachers could have. They enhance the curriculum by presenting science in new and exciting ways.

This article reports our evaluation of the popular outreach program of the Physics Department at the University of Illinois, which is designed for teachers and students in grades K through 12. Our evaluation shows some surprising effects of this kind of science education outreach. Thousands of children have benefited, but many teachers could take better advantage of this and similar outreach programs if they knew more about what they can and cannot do. Although our study focused on the Physics Outreach, we believe that the findings have general implications for teachers and others involved in science education outreach.

The University of Illinois Physics Outreach

In recent years there has been a renewed awareness of the need for getting more students to like and understand science. This need is being addressed by a wide variety of outreach programs in a variety of settings, including both schools and community sites. These programs may involve scientists from industry or universities, museums, or university science students. Most emphasize hands-on activities for teachers and children. For example, the Illinois-based *Grow in Science* program has teachers work in a summer science camp to develop better ways of supporting hands-on science learning in the classroom. In another Illinois program, "Project SEARCH" *(Spectrum,* Winter 1994), pairs of undergraduate science majors develop and present hands-on science projects for children at local schools and community centers. Each of these, and other programs throughout the country, operate on the premise that collaboration among scientists and educators is needed in order to address educational needs.

The outreach program of the University of Illinois Physics Department comprises several activities, including Physics Van Presentations, the Saturday Physics Honors Program, and Physics Workshops for Teachers.



Molecular simulation by children at Leal School in Urbana with Greg Rudnick (Physics '96) and Curtis Shoaf (Physics '96).

Physics Van

The goal of the Physics Van (*Spectrum*, Fall, 1996) is to create enthusiasm and stimulate curiosity among students and their teachers, showing them that science is interesting, fun, and that some is already within their grasp. Three or four undergraduates in physics and physics education demonstrate basic physics principles using a variety of instructive and entertaining science demonstrations at elementary and middle schools, summer camps, boys and girls clubs, and other venues. Some of the Van demonstrations can be repeated by children on their own. Teachers receive descriptive material ahead of time and can request special topics to enrich and illustrate their lessons.

Students and teachers participate in the experiments whenever possible. Groups of children working together impersonate solids, liquids, and gases to demonstrate the different relations of the motions of different atoms in these three states of matter. In another demonstration, they experience the sudden push backwards when they hold a fire hose in an experiment illustrating momentum conservation. They compete with an air vortex generator trying to blow out a candle. Even when they cannot participate directly, their attention is held by demonstrations like a nitrogen cannon, which illustrates the power of the expanding gas.

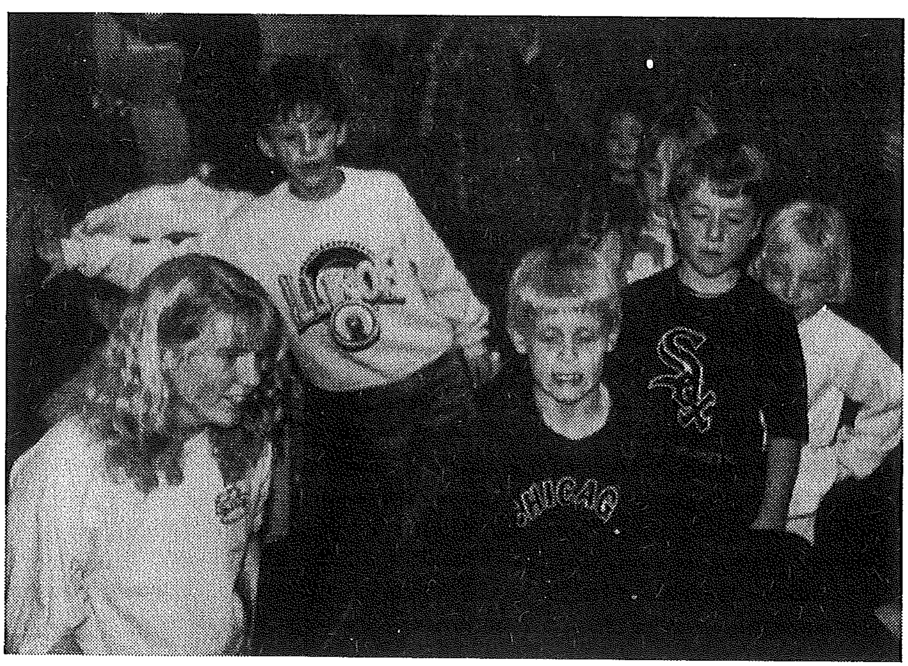
Saturday Physics Honors Program

A second component is the Saturday Physics Honors Program, a series of monthly lectures on modern physical sciences. The lecture series, now in its fifth year, is open to the general public, but directed primarily at high-school seniors. Through the program, high-school and college students and teachers meet world-class researchers in a relaxed, interactive setting, learn about recent advances in the physical sciences, see how physics underlies modern technology, and view its impact on our everyday lives. Topics include the physics of atoms at surfaces; chaos and nonlinear dynamics; black holes and computational relativity; planets, comets and their collisions; severe and unusual weather; atomic clocks and the global positioning system; and earthquakes and active mountain building.

Physics Workshops for Teachers

Physics Workshops for Teachers is a third major component of the outreach program. One set, called Fun with Physics, includes workshops that teach teachers about the physics underlying the Van demonstrations.

Another is Operation Physics (originated by the American Institute of Physics), a national program of in-service workshops intended to enhance grades 3-8 teachers' understanding of and comfort with physics, and to provide them with techniques and activities for teaching. The workshop leaders are local master teachers trained by Operation Physics personnel. The workshop experience is intended to enable teachers to give their students an improved understanding of the physics concepts that apply to everyday events.



$60,000 Question? This boy just pulled a tablecloth from under the plate without pulling the plate off — an inertia demo. Jill Buckley (Physics '97) is looking on.

Workshop activities begin by eliciting participants' conceptions about physical phenomena, then lead into hands-on participatory activities. Each module also includes a discussion of ideas that children are likely to bring with them into the classroom. There are 13 topics: Matter and Its Changes, Measurement, Simple Machines, Magnets and Magnetism, Electricity, Light, Heat, Astronomy, Forces in Fluids, Forces in Motion, Sound, Color Vision, and Energy. The modules are designed so that each requires one day of training.

Evaluation

There have many positive responses to the Physics Department Outreach, but no systematic study of its impact. In order to learn more about what teachers gained from a program like this, we conducted an evaluation, focusing on teachers' perceptions. We interviewed teachers, beginning with standard questions, but following up topics teachers felt were important. In addition, we used survey data and response forms collected from teachers participating in the Physics Honors program or Workshop sessions. The focus was thus on teachers–what they learned and how they valued the various aspects of the program.

Survey Results

The survey of teachers participating in the Physics Honors Program showed a remarkable positive response. Every teacher said that the program was a useful option for their students and that they would like to participate again. One said, "Four of my students who have attended these are enrolled at the UI in science areas...your efforts are greatly appreciated and I look forward to participating in the future." Another said, "I liked the 'magic' problem at the beginning of the program. The students would come back talking about it." Teachers identified several specific aspects of the program:

1. The students are impressed with people on the "cutting edge" of physics applications;
2. The students get to see that physics has many practical applications. They also learn that physicists are not "gray beards in ivory towers" – and they learn about the most current research;
3. Option to challenge those that have a keen interest. You are able to do things we cannot;
4. The Everyday Physics section is excellent;
5. Allows students to learn about current topics from "real" scientists and to see scientists and what they do;
6. Exposure to current topics by people working in them;
7. Exposure to modern topics and chance for students to hear presentation from someone besides daily instructor;
8. They can ask questions of people who are experts in the field;
9. Enrichment alternative for advanced students;
10. Giving gifted students topics often not covered in class, "interest getting" of introductory labs.

There were very few recommendations for changes, despite the fact that several questions explicitly invited these. One teacher suggested the "need to add an informal reception after lectures to allow students to interact with presenter and each other." The biggest problem related to scheduling. As one teacher, said, "Scheduling conflicts constantly arise. We have so many different organizations with so many various events it would be nearly impossible to schedule without conflicts."

Interviews with Teachers

We randomly selected a set of ten teachers for in-depth interviews. The fact that 18 of 24 attendees at one session volunteered to be interviewed is one indication that most saw some value to the program, and the consistency of responses suggests that our interviews did identify issues of common perception among the teachers. It should be noted that there may have been systematic differences between the interview volunteers and others. It is also worth noting that the preliminary response form especially encouraged complaints: "Please let us know what you found to be the high points and low points of the workshop. Do you have any specific suggestions for improvement?"

One teacher who did not wish to be interviewed wrote this on the response form in place of the contact information that would have indicated willingness to be interviewed:

> I am not involved in this field even remotely. I came out of personal interest and growth......I was very impressed with the high level of organization, great hand-outs which matched overheads and can be re-used, and good delivery of speaker. Excellent!

Reactions to Physics Outreach

The interviews revealed generally positive and often surprising responses from the teachers. Like those who responded to the survey, they were very positive about the benefits to themselves and their students from the program. This is noteworthy, in that we were able to follow-up with questions seeking to identify things they did not like.

Desire for more outreach programs. A universal response was that teachers wanted more opportunities like this. For example, the session on Operation Physics highlighted the fact that they would like the Operation Physics summer workshop to be held locally. Every interviewee thought that aspects of the program they were familiar with should be expanded and offered to more teachers, more often.

Responses of non-science teachers. One striking and somewhat surprising result was that non-science teachers seemed to derive much of value the program. For example, a former Drama teacher who now teaches Kindergarten thought that the Physics Van was extremely valuable to both herself and her students. A middle-school English teacher said that the Particle Zoo presentation (part of the Physics Honors Program) was important to her professionally, because it validated her sense of herself as one who can learn new things. She also saw connections between the inquiry process in physics and the writing process she teaches to her students. On her response form she had written:

> I am a lay person – an English teacher – with an abiding curiosity in science (a Ph. D. son in genetics) and "Zen physics" (*The Dancing Wu Li Masters*) sort of knowledge about quantum mechanics. This was an *outstandingly* clear (though *fast*) presentation that helped to fill in gaps in my knowledge gained through occasional "NY Times" Science pages and "Scientific American." Thank you!

Intellectual stretching. A related point is that nearly every teacher commented that they liked being stretched intellectually. It appears that the Outreach Program provides a source of intellectual stimulation for teachers that is sometimes lacking in their day-to-day work activities. This general intellectual stretching result was not one that we had anticipated. In fact, the teachers almost seemed embarrassed to bring it up, focusing initially on direct curricular implications. But it was clear to us that more general benefits were important as well. As an example, one teacher wrote on the response form at the Particle Physics workshop:

> [It was] very well organized and presented. Not my field of study, but I feel I learned and got an overview of the current research. I especially liked having a presenter that is doing cutting edge/state of the art research.

One teacher talked about the value of collaborative problem solving in the Operation Physics workshop, for herself, not just as a teaching technique:

> I remember spending a lot of time thinking about multiple circuits and how to get them to work so that you got the effect. And I really enjoyed that. We really had to think. We had to think not only about how the circuits would work, but what materials to use. But, it was fun to tinker at the time. And it was very nice to have other people tinkering with me at the same time, sharing ideas, sitting and saying, "These people don't know what they're doing," then suddenly I

realize, "Oh! they know more than I do." Absolutely know what they're doing! And learning from them and vice-versa. So it was very nice to be able to work in groups and to utilize other people's minds to do that.

Thus, teachers viewed the presentations as opportunities for them to learn.

Connections to classroom teaching. One teacher connected her experience at the Operation Physics Workshop to her own teaching in this way:

I like those problems very much and I realize more what needs to be done at the school level. It's OK to teach them concepts, but then throw them a real problem. Another said:

Advantage–materials you can use immediately in the classroom without a lot of extra preparation. It's user friendly! It's hands-on. I really appreciate the opportunity.

Recommendations for Changes

The open-ended interview format allowed us to probe for recommended changes in a way that was not possible with the survey. We were thus able to identify recommendations in several areas.

Classroom preparation. A nearly universal theme in the interviews was the need for more preparation before the outreach activities, especially the Physics Van. Teachers felt that the Physics Van was exciting and meaningful for their students. Precisely because of this, they saw the possibility for building upon it, but needed help in doing so. They wanted to have students try activities in the classroom ahead of time or talk about the phenomena they might see. There is a value to the surprise produced by the Physics Van demonstrations that should not be dismissed. Nevertheless, it does seem that more reading, discussions, and classroom experimentation, at least on related topics, could prepare students for deriving the maximum possible from the event.

Classroom follow-up. Similarly, the teachers wanted there to be more follow-up activities to support integration with the classroom. In part, they wanted teaching resources. As one teacher said,

We did have a certain amount of stuff that was hands-on and that was very good. I would like to have more, things I could take home with me and tinker with at home.

Some specific ideas for follow-up included having children send in questions about the demonstrations via email, having follow-up classroom experiments, having suggestions for activities teachers could do, and individual classroom visits by Physics students. One teacher even volunteered to serve on a teacher committee to help develop these activities, perhaps drawing from things other teachers had already developed. Another teacher commented that the Operation Physics workshop did provide materials for follow-up:

He's very excited about his topic and so he passes that enthusiasm on to his teachers. So that something you learned in physics in high school that just seemed like a mundane law of physics and not very exciting, he can make it come alive and make it very exciting, so that all of the sudden you see the wonder and the excitement of how this happens in nature. And you see that it's a common everyday thing that happens every day and yet it's also very unique and wonderful and spectacular. So I liked that....I also like the fact that his program is very geared for a teacher with a low budget. So all the things that the does, all the hands-on things he shows you how to do, he does with very simple, inexpensive, easily available materials. Because it's hard for a teacher to have the time to go out and collect all these things....Too many times, teachers, I think, don't try to do hands-on science because the commercially available things are too expensive and there's no budget for them.

More depth. An intriguing finding was that nearly every teacher asked for more time for the workshop activities and more depth. On the workshop response forms, there was one "low point" comment about the ideas being too complex. Other than that, the only "negative" comments elicited were that teachers wanted more. For example, "Too short. Would have been great if it could have lasted +1 hr. (or more) and go into more detail on quark investigations."

For the Physics Van, teachers wanted to see more on how scientists know about the phenomena presented. They asked to go beyond seeing the nifty effects to talk about what led scientists to develop the theory behind it. They wanted more on how scientific methods led to specific discoveries. They also felt that the reasons behind some demonstrations seemed obscure, e.g., why does the drum produce smoke rings? We see this as an exciting result that validates a basic premise of the Physics Van: By presenting intrinsically interesting phenomena, people will begin to ask more questions: Why did that happen? How does it work? How did you (or someone else) figure this out? What else can we do? And, what does it all mean?

Ironically, the physicists who presented had deliberately minimized theory assuming it would not be popular with teachers and children. But some teachers felt that more depth would have been valuable to them. This may represent an excellent example of the principle that rich, engaging experiences can build the desire for learning as well as provide the basis for further inquiry.

Management concerns. Several concerns or recommendations revolved around student management issues. For example, one teacher from a very large elementary school said that presenting the Physics Van to the entire school makes it difficult for all children to see what is happening. Safety issues were another concern. Some teachers worried that children might conclude that electricity is fun, and anything you might do at home with electricity is a good idea. How does working with the electricity produced by a flashlight battery differ from working with that from a home AC outlet? Another teacher wondered whether her large metal jewelry posed a safety hazard with the Van de Graaff generator. Of course, these safety concerns could be an opportunity for further learning.

Conclusion

The Physics Outreach Program is an excellent example of the value of linking scientists and educators. It clearly provides a number of both anticipated and unanticipated benefits to teachers and students. In its most successful forms, it appears to extend the classroom by providing additional resources and in new things to be curious about. As one interviewee said about the Operation Physics session,

> It's really nice to be able to have materials that are geared for the lower grade levels, rather than having to reinvent the wheel every time. He had some really fun ideas and fun things that I didn't think could be done.

Outreach programs such as this one definitely contribute to classroom science teaching, especially when what happens in the program can be integrated with ongoing classroom learning.

Web References

University of Illinois Physics Department Outreach Program: <http://www.hep.uiuc.edu/~ik/outreach.html>

American Institute of Physics: <http://www.aip.org/>

Print References

Brown, D. E., & Sinclair, M. R. (1993). Grow in science: Explorations in science, learning, and teaching. In P.A. Rubba, L.M. Campbell, & T. M. Dana (Eds.), *Excellence in Science Teacher Education* (pp. 191-202). Yearbook of the Association for the Education of Teachers of Science.

Bruce, B. C., Bruce, S., Conrad, R., & Huang, H. (1997). Collaboration in science education: University science students in the elementary school classroom. *Journal of Research in Science Teaching,* 34(1), 69-88.

Russel, A. A. (Ed.). (1992). *Changing the image of chemistry: Biennial Conference on Chemical Education* [Abstracts]. Washington, DC: American Chemical Society, Division of Chemical Education.

Contact Information

General information about Physics Outreach

Dr. Inga Karliner
Physics Department
University of Illinois-UC
Urbana, IL 61801
karliner@uiuc.edu

Information about Physics Van visits

Prof. Mats Selen
Physics Department
University of Illinois-UC
Urbana, IL 61801
mats@uiuc.edu

Information about the Physics Outreach evaluation

Prof. Bertram Bruce
Curriculum and Instruction Department
University of Illinois-UC
Champaign, IL 61820
chip@uiuc.edu

Susan E. Hillison, Ed.D.
Director of Professional Development
Lee/Ogle Regional Office of Education
7772 Clinton St.
Dixon, IL 61021
phone: 815/652-2054 fax: 815/652-2053
email: shilliso@mail.isbe.state.il.us

WHAT ILLINOIS SCIENCE TEACHERS PERCEIVE THEY DON'T KNOW ABOUT NATIONAL BENCHMARKS AND STANDARDS - IMPLICATIONS FOR PROFESSIONAL DEVELOPMENT

The purpose of this essay is to discuss the knowledge needs of Illinois teachers of science in the areas of science understanding, content, and pedagogy defined by the National Science Education Standards and Project 2061. The results of a survey have been combined with the professional development model recommended by the National Science Education Standards in order to make recommendations for professional development, based not only on the Standards but also the knowledge needs of teachers. The knowledge deficits, and therefore needs, were determined by analyzing the results of a survey sent to a representative sample (n = 1000) of teachers of science in the state of Illinois. The items on the survey were the topics taken from *Benchmarks for Science Literacy* and the National Science Education Standards.

Background Information

Change in science education has been attempted through reform movements since the Progressive Education period. Curriculum and instructional practices have reflected theories, moving from traditional approaches to activity-based, hands-on, inquiry instruction. More recent changes in science education emphasize the theories and practices of constructivism, outcome-based education, alternative assessment, accelerated learning, multiple intelligences, and interdisciplinary/intradisciplinary instruction. In short, science education today is being restructured to accommodate not only the growing information of science, but also new research and advances in learning theory and instructional strategies.

Science education has also responded to the movement for national standards and goals. In response to the challenge of reforming science education, including mathematics and technology, the American Association for the Advancement of Science (AAAS) initiated Project 2061, a long-range, multiphase effort designed to assist the nation in achieving scientific literacy. *Science for All Americans* (AAAS, 1989) was the first publication as a phase of Project 2061. In *Science for All Americans*, Rutherford and Ahlgren describe scientific literacy as being the goal for science education. A scientifically literate person displays an understanding of both the content and process of the numerous disciplines of science, but also an understanding of the interrelationships between and among science, technology, and mathematics. *Benchmarks for Science Literacy* (AAAS, 1993) was published as a companion to *Science for All Americans*. Where *Science for All Americans* answers the question of what constitutes scientific literacy, *Benchmarks* specifies how students should progress toward the recommendation. *Benchmarks* makes recommendations of what students should know and be able to do by the time they reach certain grade levels. The document also explains the contextual basis of the knowledge for each specific benchmark grade. There is also a brief discussion of instructional strategies and teaching methodologies. This discussion will be expanded in the follow-up documents of Project 2061 (AAAS, *Blueprints for Reform*, in press; and AAAS, *Designs for Scientific Literacy*, in press).

The call for national standards in the content areas is a result of a number of events. Approximately five years ago, the President and the National Governors Association announced their unprecedented agreement on national education goals. Leading the way in the development of national standards, the National Council of Teachers of Mathematics (NCTM) developed a set of curriculum standards in 1989. The NCTM has published *Curriculum and Evaluation Standards for School Mathematics* (1989), *Professional Standards for Teaching Mathematics* (1991), and *Assessment Standards for School Mathematics* (1995).

During the past decade, science education was also in the process of moving toward the development of standards. The science standards were slower to develop because of the many different professional organizations associated with science, all of which were working on developing goals, recommendations, guidelines, and frameworks. Besides the AAAS undertaking of Project 2061, the National Science Teachers Association (NSTA) started its *Scope, Sequence & Coordination Project* in secondary-school science, which has recently published its *Content Core* (Aldridge, 1992). By the beginning of the 1990s, many science education leaders were asking how to combine all of this work together to bring about and support a nationwide systemic reform in science education. In the spring of 1991, the president of NSTA, acting on the basis of a unanimous vote of the NSTA Board, wrote to the chairman of the National Research Council (NRC), asking the NRC to convene and coordinate a process that would lead to a set of national science education standards, K-12. As a result of many committees and working groups dealing with curriculum standards, teaching standards, and assessment standards, the National Science Education Standards (NSES) were published in 1994 in draft form, and in 1996 in final form by the National Research Council.

Results of the Study

A survey questionnaire was chosen as the most appropriate and effective instrument to gather data for this study because of the large sample, the numerous items to be included, and the purpose of the study. The survey was developed by summarizing the components related to content and pedagogy from Project 2061 and the National Science Education Standards. Each item was accompanied by numbers related to knowledge levels, ranging from 1 to 4. These knowledge levels were defined on a teacher-developed rubric. The survey was field tested before being mailed to the sample of teachers. The sample consisted of 1,000 teachers, randomly selected from the population based on a number of strata including Educational Service Center Regions, main teaching assignment, and grade level category taught. The sample contained the names of 333 K-4 teachers, 333 5-8 teachers, and 334 9-12 teachers. The teacher respondent was directed to circle the corresponding number related to the knowledge level he or she possessed at that time about the item. The response rate was 31.1%. A sample of the nonrespondents was generated and resent. The nonrespondents of the second sample were interviewed over the phone. The results of the nonrespondents were similar to the results of the respondents of the original sample.

The results of the study showed that the following groups of teachers perceived low knowledge in many areas (over 15) and therefore, have many needs:

K-4 teachers
Elementary (self-contained) teachers
Bachelor's level teachers
Teachers with 0 - 20 years experience

The following groups of teachers perceived low knowledge in some areas (5-15) and therefore, have some needs:

5 - 8 teachers
General Science teachers
Biology teachers
Earth Science teachers
Master's level teachers
Teachers with over 30 years experience

The following groups of teachers perceived low knowledge in few or no areas (less than 5) and therefore, have few or no needs:

9 - 12 teachers
Chemistry teachers
Physics teachers
Physical Science teachers
Post-Master's level teachers

The needs, defined as lack of knowledge, identified by the groups of teachers in this study fall into four categories: strong need (more than 40 groups identifying needs in this category); moderate need (10-40 groups); little need (1-9 groups); and no need. Categories which are conceptually similar have been listed together.

Strong Need (over 40 groups)
Historical Perspectives (55) and History and Nature of Science (10)
Unifying Concepts and Processes (43) and Common Themes (10)

Moderate Need (10-40 groups)
The Nature of Technology (14) and Science and Technology (1)
The Designed World (14)
Science in Personal and Social Perspectives (11)

Little Need (1-9 groups)
The Nature of Science (8)
Mathematical World (8)
Physical Science (8)
Human Society (7)
Life Science (4)
The Nature of Mathematic (3)
The Physical Setting (3)
Science as Inquiry (2)
The Living Environment (1)
Earth and Space Science (1)

No Need (0 groups)
The Human Organism
Habits of Mind
Pedagogy

Recommendations for Professional Development

Good professional development is the essence of a good educational program and an effective professional staff. A professional development program in science education which uses input from a needs analysis along with following the guidelines recommended by the National Science Education Standards should be successful. The following are recommendations based on the results of this study and aligned with the four Professional Development Standards in the National Science Education Standards:

1. To assist teachers with the decision of breadth versus depth and to assist them in interpreting exact meaning of the science concept, the benchmarks, and/or the fundamental concepts and abilities that underlie the standards should be explored with the teachers in a professional development program.
2. A professional development program should be an ongoing program which builds on the major categories of (1) Historical Perspectives/History and Nature of Science and (2) Unifying Concepts and Processes/Common Themes with some focus on (3) The Nature of Technology/Science and Technology, (4) The Designed World, and (5) Science in Personal and Social Perspectives.
3. The method to be used in both preservice and inservice for teaching content should be the method of inquiry.
4. If a professional development program deals with pedagogy, care should be taken to make sure that teachers perceive that the information is needed.
5. Professional development programs should provide adequate time so that opportunities for learning to learn are present.
6. The above recommendations should be aligned with the Professional Development Standards and the resulting program should have the characteristics listed in Standard D of the Professional Development Standards in NSES.

A professional development program which is based on the six recommendations stated above will not only respond to the knowledge deficits, or needs of the teachers of the state of Illinois, but also be aligned with the National Science Education Standards and *Benchmarks for Science Literacy*. Such a program should assist teachers in achieving science literacy not only with their students, but within themselves. In order to move science education towards the year 2000 and beyond, Anderson (1994) has the following comment:

> Delivering quality science instruction in all the sciences, at all levels, is and will continue to be a challenge. That is why we must think "2061" and make improving science instruction a continuous pursuit...That is why science curriculum reform must be made an ongoing evolutionary process as the nation moves to and beyond the year 2000. (p. 53)

References

Aldridge, W. (1992). *Scope, sequence and coordination of school science: The content core*. Washington, DC: National Science Teachers Association.

American Association for the Advancement of Science (AAAS). (1989). *Science for all Americans*. Washington, DC: Author.

American Association for the Advancement of Science (AAAS). (1993). *Benchmarks for science literacy*. New York: Oxford University Press.

American Association for the Advancement of Science (AAAS). (in press). *Designs for scientific literacy*.

American Association for the Advancement of Science (AAAS). (in press). *Blueprints for reform*.

Anderson, H. O. (1994). Teaching toward 2000. *The Science Teacher*, 61(6), 49-53.

National Council of Teachers of Mathematics (NCTM). (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (1995). *Assessment standards for school mathematics*. Reston, VA: Author.

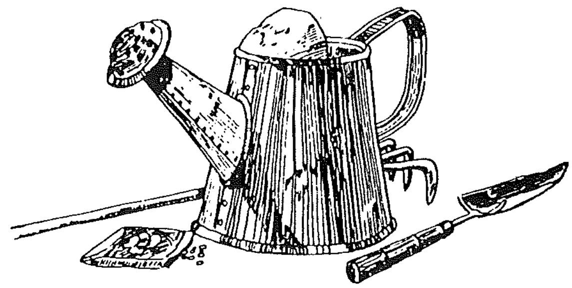
National Research Council (NRC). (1994). *National science education standards*. Draft. Washington, DC: Author.

National Research Council (NRC). (1996). *National science education standards*. National Academy Press, Washington, DC: Author.

Jim Allsopp, Warning Coordination Meteorologist
National Weather Service, NOM
Romeoville, Illinois

R. James Vavrek, Science Teacher
School City of Hammond, Indiana

Ronald L. Holle, Research Meteorologist
National Severe Storms Laboratory, NOM
Norman, Oklahoma



IS IT GOING TO RAIN TODAY? UNDERSTANDING THE WEATHER FORECAST

What's the difference between partly sunny and mostly cloudy?
When is a winter storm watch issued?
What does a 40% chance of showers really mean?

Introduction

The answers to these and other questions about weather forecasts are answered in this educational guide. All of us depend on weather forecasts in planning day-to-day activities, but do we really understand what the meteorologist is telling us? This paper is intended as a resource for science teachers and their students to develop a better understanding of forecasts, especially forecasts of hazardous weather. Then people can make informed decisions about travel plans, sports practices and events, campouts, or other outdoor activities before hazardous weather occurs.

People obtain weather forecasts from a variety of sources, including commercial and cable television and radio. Some broadcasters receive their information from the National Weather Service (NWS), some make their own forecasts, and others obtain their information from private forecasting services. The NWS is the federal agency charged with providing weather services to the nation. It is the official source of watches, warnings, and advisories for hazardous weather. Weather forecasts and warnings can be received directly from the NWS through its nationwide network of NOAA Weather Radio stations on frequencies of 162.400, 162.425, 162.450, 162.475, 162.500, 162.525, and 162.550 MHz.

This weather guide will use terminology as defined by the NWS; forecast products issued by countries other than the US have different criteria. Forecasters outside the NWS may use different terms or place a different meaning on weather terms. This paper has two sections:

- A list of watches, warnings, and advisories issued by the NWS.
- A glossary of weather terms used in forecasts.

The authors have prepared a series of papers for educators covering the topics of lightning (Vavrek et al., 1993a,b; 1994a,b), lightning education (Holle et al., 1995a,b,c), and supercell thunderstorms (Vavrek et al., 1995), as well as posters on avoiding trees at the time of nearby lightning (Howard and Holle, 1994, 1995).

Outlooks, Watches, Warnings, and Advisories

The NWS has developed a multi-tier concept for forecasting hazardous weather. The forecast products range from the outlook for longer time periods to the warning and advisory for immediate situations.

Outlook

An outlook indicates that a hazardous weather or hydrologic event may develop. An outlook is intended to provide information to those who need considerable lead time to prepare for an event. For thunderstorms, daily outlooks give a 24-hour forecast of severe weather potential. Winter storm outlooks may be issued two to five days in advance of a major storm. Outlooks for potential spring flooding from snowmelt are issued a month or more in advance. A hydrologic event includes river floods, flash floods, urban flooding, and small stream flooding. A tropical outlook is issued daily for the North Atlantic Ocean, Gulf of Mexico, and Caribbean Sea concerning conditions that affect the formation of tropical storms and hurricanes.

Watch

A watch is issued when the risk of hazardous weather or a hydrologic event has increased significantly, but its occurrence, location, or timing is still uncertain. A watch is intended to provide lead time for those who need to set their plans in motion. A watch means that hazardous weather is possible in and close to the watch area. You should have a plan of action in case a hazard threatens, and you should listen for later information and possible warnings, especially when planning travel or outdoor activities. Severe thunderstorm and tornado watches currently are issued by the National Severe Storms Forecast Center in Kansas City, Missouri. Within a few years, watches for all weather conditions will be issued by local NWS offices, with guidance from the Storm Prediction Center in Norman, Oklahoma. The only exception will be hurricane-related watches that will continue to be issued by the National Hurricane Center in Miami.

Warnings and Advisories

A warning or advisory is issued when hazardous weather or a hydrologic event is occurring, imminent, or likely. A warning means that weather conditions pose a threat to life or property; people in the path of the hazard need to take protective action. Advisories are issued for less serious conditions than warnings; if caution is not exercised, the hazard can cause significant inconvenience and could lead to a situation that may threaten life or property. Watches, warnings, and advisories are issued for five categories of hazards: severe local storms, winter storms, floods, hurricanes, and nonprecipitation hazards, as described in the next five sections.

Severe Local Storms

Severe local storms are short-lived, small-scale hazardous weather or hydrologic events normally produced by thunderstorms. In and close to the watch area, conditions are considered to be favorable for the development of severe thunderstorms and tornadoes. Watches of this type (Figure 1) are usually valid for about 6 hours. These rectangular areas are often called watch boxes. Within the next few years, watch areas will be issued in the shape of polygons.

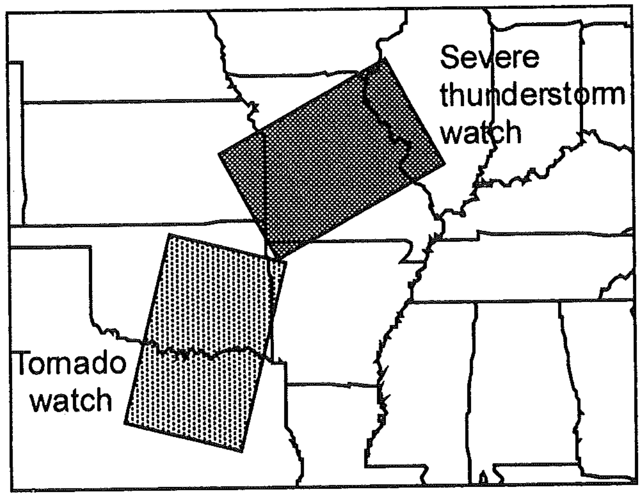
Tornado Watch

Conditions are favorable for the development of severe thunderstorms and tornadoes in and close to the watch area. These watches are usually valid for up to six hours and may cover a significant portion of one or more states.

Tornado Warning

A tornado is indicated by doppler radar or sighted by Skywarn or Emergency Management spotters (law enforcement or fire department officers, and other emergency management volunteers). Tornado warnings are issued on a county-by-county basis, or for portions of counties.

Figure 1. Map showing a tornado watch and severe thunderstorm watch over the central US.



Severe Thunderstorm Watch

Conditions are favorable for the development of severe thunderstorms in and close to the watch area. The watch will normally be similar to a tornado watch in length of time and size of area covered.

Severe Thunderstorm Warning

A severe thunderstorm is indicated by doppler radar or sighted by law officers or spotters. Such warnings are issued on a county-by-county basis. A severe thunderstorm contains one or both of the following:

-Large damaging hail 3/4 inch (1.9 cm) in diameter or larger.

-Damaging winds of 58 miles per hour (26 meters per second) or greater.

Flash Flood Watch

Conditions are favorable for flash flooding in and close to the watch area. Flooding can result from heavy rainfall, ice jams, or dam breaks. These watches are usually for the first 12 to 24 hours of a forecast.

Flash Flood Warning

Flash flooding is occurring or intermittent. A flash flood is caused by excessive rainfall in a short period of time (generally less than 6 hours) that poses a threat to life and/or property. Ice jams and dam failures can also cause flash floods. Flash flood warnings are issued for counties or parts of counties.

Urban and Small Stream Flood Advisory

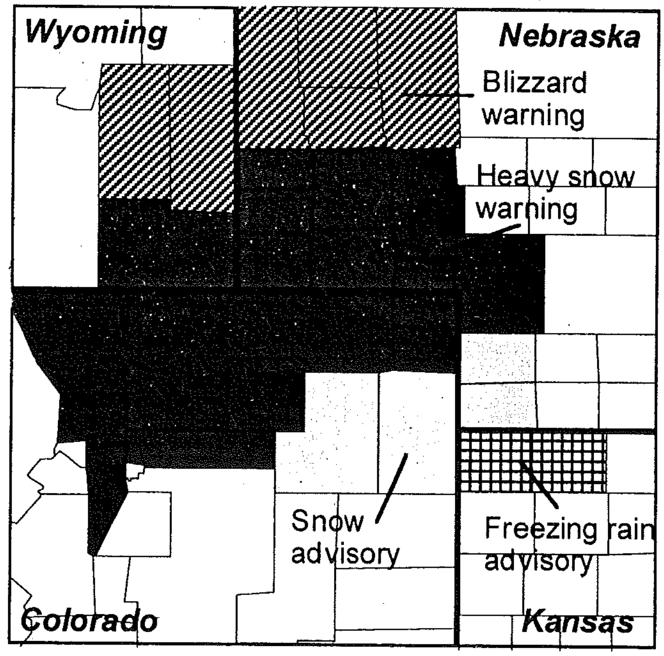
Flooding of streets, low-lying areas, urban storm drains, creeks, and small streams is occurring or imminent. This type of flooding can cause significant inconvenience, but is generally not threatening to life or property.

Winter Storms

Winter storms bring hazardous weather events associated with freezing or frozen precipitation, or combined effects of winter precipitation, strong winds, and cold temperatures (Figure 2). These criteria may vary from region to region across the country.

Winter Storm Watch
Conditions are favorable for hazardous winter weather conditions including heavy snow, blizzard conditions, significant accumulations of freezing rain or sleet, and dangerous wind chills. The watches are usually issued 12 to 36 hours in advance.
Winter Storm Warning
Hazardous winter weather conditions that pose a threat to life and/or property are occurring, imminent, or likely. The term winter storm warning is used for a combination of two or more of the following winter weather events: heavy snow, freezing rain, sleet, and strong winds. The following event-specific warnings are issued for a single weather hazard:
Blizzard Warning
Sustained winds or frequent gusts of 35 miles per hour (16 meters per second) or greater will accompany considerable falling and/or blowing snow. Visibility will be reduced to 1/4 mile (0.4 km) or less for a period of 3 hours or more. There is no temperature criterion in the definition of a blizzard, but subfreezing temperatures and 35 mph winds (16 meters per second) will create dangerous subzero wind chills.
Heavy Snow Warning
Snowfall of 4-6 inches (10-15 cm) or more will occur in less than 12 hours, or at least 6-8 inches (15-20 cm) in less than 24 hours.
Ice Storm Warning
Accumulation of 1/4 inch (0.6 cm) or more of freezing rain will occur, or at least 1/2 inch (1.3 cm) of sleet.
Winter Weather Advisory
Hazardous winter weather conditions are occurring, imminent, or likely. Conditions will cause a significant inconvenience, and if caution is not exercised, will result in a potential threat to life and/or property. The term winter weather advisory is used for a combination of two or more of the following events: snow, freezing rain or drizzle, sleet, and blowing or drifting snow. The following event-specific advisories are issued for these single weather hazards:
Snow Advisory
Snowfall of 2-5 inches (5-13 cm) will occur.
Freezing Rain/Drizzle, Sleet Advisory
Accumulations of less than 1/4 inch (0.6 cm) of freezing rain or freezing drizzle is expected, or less than 1/2 inch (1.3 cm) of sleet.
Blowing and/or Drifting Snow Advisory
Considerable blowing snow and/or drifting of snow across roads will produce hazardous travel.

Figure 2. Map showing warnings and advisories on a county basis on the US High Plains.



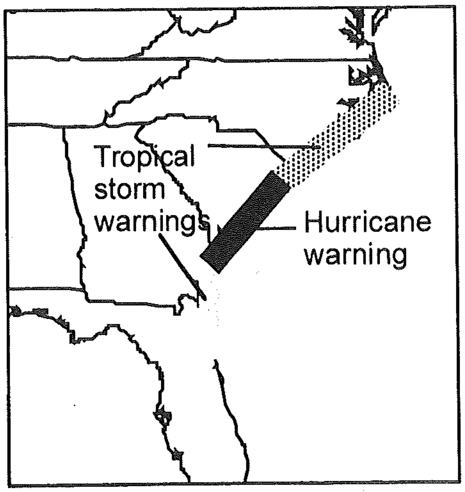
Floods

Flood conditions include those associated with river flooding, coastal flooding, and lakeshore flooding.
Coastal Flood Watch
Coastal flooding is possible in 12-36 hours.
Coastal Flood Warning
This product alerts coastal residents of the inundation of land areas along the oceanic coast caused by sea waters above the normal tide action.
Flash Flood Watch/Warning
See categories under Severe Local Storms.
Flood Warning
It is issued for a stream or part of a stream when flooding is occurring, imminent, or likely.
Heavy Surf Advisory
High surf that may pose a threat to life or property is forecast.
Lakeshore Warning
High waves, beach erosion, and flooding is expected along the shores of the Great Lakes.

Hurricanes

Weather and flood hazards caused by hurricanes and tropical storms (Figure 3) are the following:
Hurricane Watch
Statement for specific coastal areas that a hurricane or an incipient hurricane condition poses a possible threat, generally within 36 hours.
Hurricane Warning
Sustained winds of 64 knots (74 miles per hour, or 33 meters per second) or higher associated with a hurricane are expected in a specific coastal area within 24 hours.
Tropical Storm Watch
A tropical storm, or tropical storm conditions, pose a threat to coastal areas, generally within 36 hours.

Figure 3. Map showing coastal hurricane and tropical storm warnings along the southeast US coast.



Tropical Storm Warning
A warning for tropical storm conditions including sustained winds in the range of 34-63 knots (39-73 miles per hour, or 18-33 meters per second) that are expected for specific coastal areas within 24 hours.

Non-precipitation Hazards

There are other weather hazards not associated with thunderstorms, winter storms, floods, or hurricanes. The exact criteria vary by region of the country.

Dust Storm Warning
Blowing dust and/or sand frequently reduces visibility to near zero.

Blowing Dust/Blowing Sand Advisory
Blowing dust and/or sand reduces visibility to 1/4 mile (0.4 km) or less.

Dense Fog Advisory
Dense fog reduces visibility to 1/4 mile (0.4 km) or less.

Freeze Advisory/Warning
Widespread temperatures are at or below 32°F (0-C) during the growing season. A freeze may occur with or without the formation of frost.

Frost Advisory/Warning
Widespread frost during the growing season generally occurs with fair skies and light winds.

Excessive Heat Watch
Excessive heat and humidity are possible in the next day or two.

Excessive Heat Warning
Heat indices will be extremely high-generally 115-120-F (4649-C) or higher for three hours or more (Table 1). The heat index combines temperature and humidity (see "Other Weather Terms" at end of paper).

Air temp. ('F)	Relative humidity in %																				
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
140	125																				
135	120	128																			
130	117	122	131																		
125	111	116	123	131	141																
120	107	111	116	123	130	139	148														
115	103	107	111	115	120	127	135	143	151												
110	99	102	105	108	112	117	123	130	137	143	150										
105	95	97	100	102	105	109	113	118	123	129	135	142	149								
100	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144						
95	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136				
90	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122		
85	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
80	73	74	75	76	77	77	78	79	79	80	81	81	82	83	85	86	86	87	88	89	91
75	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78	78	79	79	80
70	64	64	65	65	66	66	67	67	68	68	69	69	70	70	70	70	71	71	71	71	72

Table 1. Heat index chart giving apparent temperature for specific values of temperature and relative humidity.

Wind speed (mph)	Air temperature in °F 35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
4	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	32	27	22	16	11	6	0	-5	-10	-15	-21	-26	-31	-36	-42	-47	-52
10	22	26	10	3	-3	-9	-15	-22	-27	-34	-40	-46	-52	-58	-64	-71	-77
15	16	9	2	-5	-11	-18	-25	-31	-38	-45	-51	-58	-65	-72	-78	-85	-92
20	12	4	-3	-10	-17	-24	-31	-39	-46	-53	-60	-67	-74	-81	-88	-95	-103
25	8	1	-7	-15	-22	-29	-36	-44	-51	-59	-66	-74	-81	-88	-96	-103	-110
30	6	-2	-10	-18	-25	-33	-41	-49	-56	-64	-71	-79	-86	-93	-101	-109	-116
35	4	-4	-12	-20	-27	-35	-43	-52	-58	-67	-74	-82	-89	-97	-105	-113	-120
40	3	-5	-13	-21	-29	-37	-45	-53	-60	-69	-76	-84	-92	-100	-107	-115	-123
45	2	-6	-14	-22	-30	-38	-46	-54	-62	-70	-78	-85	-93	-102	-109	-117	-125

COLD

VERY COLD

BITTER COLD

EXTREME COLD

Table 2. Wind chill index giving equivalent in cooling power on exposed flesh. Wind speeds over 40 miles per hour (19 meters per second) have little additional chilling effect.

Heat Advisory
Daytime heat indices will be 105-F (MIFF) or greater and nighttime indices of 80-F (27-C) for two or more consecutive days (Table 1).

High Wind Watch
High winds may develop in the next day or two.

High Wind Warning
Sustained winds will be 40 miles per hour (18 meters per second) or greater for an hour or longer, or gusts to 58 miles per hour (26 meters per second).

Wind Advisory
Sustained winds will be 25 miles per hour (11 meters per second) or greater.

Wind Chill Warning
Extreme wind chills will be -50-F (-46°C) or colder (Table 2).

Wind Chill Advisory
Dangerous wind chills will be -20- to-50-F (-29 to -46-C) as in Table 2.

Weather Forecast Terminology

The basic weather forecast includes the following weather elements: precipitation, probability of precipitation, sky condition, temperature, and wind. Forecasts describe the weather in 12-hour increments such as today, tonight, and tomorrow. Forecasters often use descriptive terms to convey the forecast message. While these terms may be subjective, the NWS attempts to standardize them. Details on precipitation probabilities, sky condition, and wind are provided in subsequent sections.

Probability of precipitation	Expressions of uncertainty	Area coverage
0%	----	----
10%	----	Isolated, few.
20%	Slight chance	Widely scattered.
30- 50%	Chance	Scattered.
60- 70%	Likely	Numerous.
80-100%	----	----

Table 3. Precipitation terms.

Precipitation Probabilities

The probability of precipitation forecast is one of the least understood elements of the weather forecast. The probability of precipitation has the following features:

- The likelihood of occurrence is in percent.
- A measurable amount is defined as 0.01 inch (.025 cm) or more.
- The measurement is of liquid precipitation, or the water equivalent of frozen precipitation.
- The probability is for a specified time period.
- The forecast is for a given point.

A measurable amount of rain usually produces enough runoff for small puddles to form. Terms for uncertainty are in Table 3. For example, if a forecast for a county says there is a 40% probability of showers this afternoon, there is a 40% chance of rain at any point in the county from noon to 6 p.m. The point probability of precipitation is determined by multiplying the chance of occurrence by the expected areal coverage. Two examples giving the same result are:

- If the forecaster was 80% certain that showers would develop but only expected them to cover 50% of the forecast area, there would be a 40% chance that rain would occur at any given point.
- If a widespread area of precipitation with 100% coverage was approaching, but the forecaster was only 40% certain that it would reach the forecast area, this would also result in a 40% chance of rain for any given point.

The following terms of duration imply a high probability (80-100%) of occurrence: **brief, periods of, occasional, intermittent, frequent**.

Term	Predominant or average sky cover (opaque clouds)
Cloudy	90-100%.
Mostly cloudy or considerable clouds	70- 80%.
Partly cloudy or partly sunny	30- 60%.
Mostly clear or mostly sunny	10- 30%.
Clear or sunny	0- 10%.
Fair	Less than 40% cloud cover, no precipitation, and no weather extremes.

Table 4. Sky condition terms.

Sustained wind speed	Descriptive term
0-5 mph	**Light** or **light and variable**.
5-15 mph	----
15-20 mph or 15-25 mph	**Breezy** in mild weather or **brisk** in cold weather.
15-25 mph or 20-30 mph	**Windy**.
25-35 mph or 30-40 mph	**Very windy**.
40 mph or greater	**High, strong, damaging.**

Table 5. Descriptive wind terms.

Sky Condition

The predominant or average sky cover for the forecast period is also given. This percentage of the sky is the amount covered by opaque clouds, the type that do not allow other clouds or blue sky to be visible through or above them. Table 4 lists descriptive terms for sky conditions.

Wind

Table 5 lists descriptive terms often used for wind conditions.

UV Index

Ultraviolet index (UVI) forecasts are issued for 58 US cities daily for solar noon on the following day. The Wl is prepared by the NWS Climate Prediction Center in cooperation with the Environmental Protection Agency and the Centers for Disease Control. Table 6 lists the exposure level in a numerical and descriptive format for the forecast of the maximum exposure to ultraviolet radiation from the sun's rays during the peak hour of sunlight. The higher the number, the greater the exposure of unprotected skin and eyes to ultraviolet radiation.

Ultraviolet index (UVI)	Exposure Index
0, 1, 2	Minimal
3, 4	Low
5, 6	Moderate
7, 8, 9	High
10 and greater	Very high

Table 6. Ultraviolet index exposure.

Other Weather Terms

The preceding sections include the definitions of many hazardous weather features. The following terms are frequently used in weather forecasts and warnings:

Cold air funnel

A funnel cloud that develops from a small shower or thunderstorm. The air aloft is usually cold and other conditions are favorable. Cold air funnels rarely become tornadoes; when they do, they are almost always weak tornadoes.

Crest

The highest level of a flood wave as it passes a point on a river or stream.

Degree day

The amount of heating or cooling needed for a building is measured by using 65-F (18-C) as a baseline. To compute heating or cooling degree days, take the average temperature and compare it to 65-. An average daily temperature of 50-(10-C) yields 15 heating degree day units, while an average temperature of 75-F (24-C) yields 10 cooling degree day units.

Dew point

A direct measure of atmospheric moisture. The dew point is the temperature to which air must be cooled in order to reach saturation, assuming the pressure and moisture content are constant. Relative humidity is the ratio of moisture measured by the dew point to the total possible at a given temperature.

Downburst

A strong downdraft from a thunderstorm resulting in an outward burst of damaging winds on or near the ground. Downburst winds are often 50-100 miles per hour (22-45 meters per second), and in a few cases are 100-150 miles per hour (45-67 meters per second).

Microburst

A small downburst affecting an area less than 2.5 miles (4 km) in diameter with peak winds lasting less than 5 minutes.

Macroburst

A large downburst affecting an area greater than 2.5 miles (4 km) in diameter with peak winds lasting 5 minutes or longer.

Flood stage

The level or stage where a stream overflows its banks, or the stage where the overflow of a stream begins to cause damage.

Funnel cloud

A rotating column of air, extending from a towering cumulus or cumulonimbus cloud, that is not in contact with the ground.

Hail

Hailstones are precipitation in the form of lumps of ice that form during some thunderstorms.

Heat index

The apparent temperature that describes the combined effect of high temperatures and high humidity (Table 1).

Lake effect snow

Snow that occurs to the lee of the Great Lakes when cold air moves across relatively warm waters of the lakes.

Rain versus showers

Rain is a nearly steady and uniform fall of precipitation over an area. Showers are intermittent and/or scattered convective rainfall of varying intensity.

Relative humidity

The ratio of the amount of water vapor actually present in the air to the greatest amount possible at the same temperature. Warm air holds more water vapor than cold air. In contrast, dew point directly measures the moisture content of the air (see above).

Sleet

Sleet or ice pellets are solid grains of ice formed from the freezing of rain or the refreezing of melted snow.

Squall line

A line of thunderstorms or squalls that may extend over several hundred miles.

Tornado

A rotating column of air, extending from a towering cumulus or cumulonimbus, in contact with ground. The column may or may not be visible all the way from cloud to ground.

Waterspout

In general, a tornado occurring over water. Specifically, a waterspout is a small, relatively weak rotating column of air over water beneath a towering cumulus or cumulonimbus cloud.

Wind chill

The apparent temperature that describes the combined effect of wind and low temperature on exposed skin (Table 2).

Conclusions

The weather affects all of us daily. Weather forecasts have improved greatly in the last couple of decades. We must learn to use the forecast information in planning activities, especially during hazardous weather. While a wide range of weather events has been covered, it is up to the reader to determine what weather hazards affect his or her region of the country and to learn what protective actions are required. Preparedness information for hazardous weather can be obtained from your local Civil Emergency Management Agency, American Red Cross, or National Weather Service office.

Acknowledgments
The authors appreciate contributions by the following individuals:
• Rod Becker, Rainer Dombrowsky, Ron Berger, and Bill Alexander, meteorologists at the Warning and Forecast Branch of the National Weather Service in Silver Spring, MD.
• James Purpura, Warning Coordination Meteorologist with the National Weather Service in Norman, OK.
• Jennifer Vavrek, Science Teacher, Spohn School, School City of Hammond, IN.

References

Holle, R.L. R.E. Lopez, K.W. Howard, R.J. Vavrek, and J. Allsopp, 1995a: Lightning hazard education. Preprints, *4th Symposium on Education*, 15-20 January, Dallas, TX, American Meteorological Society, Boston, 9699.

-,-,-,-, and-, 1995b: Lightning hazard education. *The Earth Scientist*, National Earth Science Teachers Association [this issue].

-, -,-, -, and -, 1995c: Lightning hazard education. *The Hoosier Science Teacher*, Hoosier Association of Science Teachers, Inc., Terre Haute, 20, 112-118.

Howard, K.W., and R.L. Holle, 1994: *Lightning Danger!* National Oceanic and Atmospheric Administration, Environmental Research Laboratories, National Severe Storms Laboratory, Norman, OK, 1 pp. poster.

-, and-, 1995: *¡Peligro de rayos!* National Oceanic and Atmospheric Administration, Environmental Research Laboratories, National Severe Storms Laboratory, Norman, OK, 1 pp. poster.

Vavrek, J., R.L. Holle, and J. Allsopp, 1993a: Flash to bang. *The Earth Scientist*, National Earth Science Teachers Association, 10, 38.

-, -, and -, 1993b: Flash to bang. *Spectrum*, Illinois Science Teachers Association, 19, 21-26.

-, -, and -, 1994a: Flash to bang. Reading 10, *Project Earth Science: Meteorology*, P.S. Smith and -, -, and -, 1994b: Flash to B.A. Ford, Editors, National Science Teachers Association, Arlington, VA, 210-219.

-,-, and -, 1994b: Flash to bang=5 seconds per mile. *The Hoosier Science Teacher*, Hoosier Association of Science Teacher, Inc., Terre Haute, 19, 101-110.

-, -, -, J.M. Davies, and D.K. Hoadley, 1995: Supercells-Nature's most violent thunderstorms. *The Earth Scientist*, National Earth Science Teachers Association [this issue].

1997 ISTA Member Survey

On behalf of the Executive Officers and the Board of Directors of the Illinois Science Teachers Association, I would like to invite past and present members of the ISTA to complete the 1997 Member Survey which follows. In an attempt to better serve the needs of ISTA members and *plan for the future direction of our statewide organization,* it is critical that we hear from you!

Please take a moment to thoughtfully complete the survey, stamp and return your comments!

Remember,
don't put off until tomorrow,
that which you can complete today!

Sincerelv.

Debbie Clinebell

Debbie Clinebell,
ISTA Region 5 Director

DEADLINE: AUGUST 15, 1997

1997 ISTA Member Survey

How well is ISTA serving the needs of science educators?

1) What do you feel are the greatest benefits to being a member of ISTA?

2) Does the Spectrum provide you with useful information? Please elaborate.

3) Does the annual ISTA state convention provide you with useful information? Please elaborate.

4) Have you visited the ISTA home page on the Internet? ______
If yes, does the ISTA home page provide you with useful information? Please elaborate.

5) Are you aware of the duties performed by the ISTA Executive Secretary?
(Circle One) Yes No If Yes, please explain.

6) Are you aware of the ISTA awards program available to science educators?
(circle one) Yes No If Yes, please explain.

7) What information, needs, or services could ISTA provide to better serve ISTA members?

8) Would you be willing to pay higher ISTA membership fees to:

Yes No a) provide additional member services?
Yes No b) pay for a full-time Executive Secretary?
Yes No c) support ISTA awards programs?

9) Would you be willing to serve as a Regional Director or Officer for the ISTA?
If yes, please include your name on this survey, or contact :

Diana Dummitt, % SPECTRUM,
390 Education Building, 1310 S. 6th Street,
Champaign, IL 61820

1997 ISTA Member Survey Response Profile

Please Complete

1) Are you a current member of ISTA? Yes No

2) In what ISTA region do you live? 1 2 3 4 5 6
(see the back inside cover of the Spectrum)

3) Are you receiving the Spectrum? Yes No

4) Did you attend the 1996 ISTA convention? Yes No

5) Have you ever received an ISTA award? Yes No

6) What is your current position in science education? (circle one)

student pre-service teacher teacher administrator retired other________________

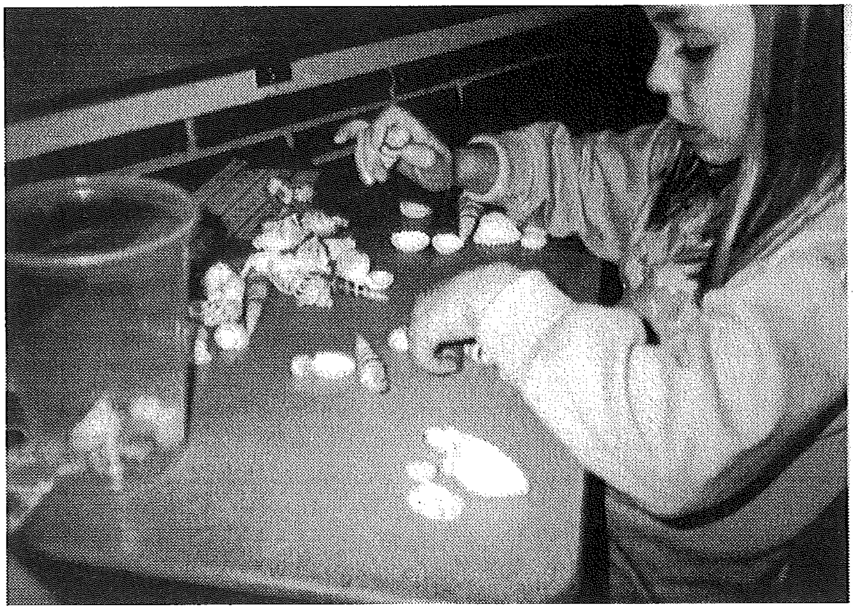
Optional

Name______________________________ Home Phone_______________

Address______________________________ Work Phone_______________

City, State, Zip________________________ Email___________________

Fax ____________________



Daniel Heuser
4511 N. Campbell
Chicago, IL 60625

TOYS IN THE CLASSROOM: DEVELOPING CLASSIFICATION SKILLS THROUGH OBJECT EXPLORATION

Introduction

At age 5, John became very curious about his mother's sewing machine. So one day he placed his finger under the needle, put his foot on the power pedal, and pushed the pedal to the ground. Just before the needle exploded to life, he wondered to himself "How will this feel?"

Classification is a cognitive structure which allows people to organize new objects, people, concepts, or ideas based on like attributes. Without the ability to classify, every new stimulus we encountered would have to be analyzed anew, without the benefit of linking it to known stimuli. Unfortunately for John, he came upon a sewing needle and could not note that it shared the attribute of a sharp point with pins and broken glass, so he did not know that it would hurt when pressed against his skin.

Classification is a skill which schools profess a desire to have their students learn. It is written into curriculum guides ("Students will be able to sort and classify matter") and often has its own place under science or math in the report card. Yet many schools do not have a plan for teaching classification. Activities that are provided often are not research-based and prove to be ineffective. Most teachers can't accurately define classification, much less have the know-how to assess it. So...

Q: How can classification be developed in primary grade students?

A: By playing with toys.

Katie has 50 or so colorful plastic shapes spread out on her desk. She's carefully organizing them into families: the red family, the triangles, and the squares. Lyle has made different piles of bottle caps. The teacher asks: "Can you put them into groups in another way?" Nathaniel's plastic critters are engaged in a war. It's the bugs against the snakes and frogs. Why are the snakes and frogs on the same side? "Because they're both the same," though Nathaniel can't yet verbalize why.

These children are all engaged, working at their own developmental level, and actively learning how to classify. They've never heard the word "classification", but they are all traveling along the developmental continuum towards becoming classifiers.

In September of 1996, I began a study which tested a teaching technique which involved students exploring objects. Was it effective in teaching first graders how to classify? I learned that they were not only helped children develop classification ability, but led toward the development of other science and math skills. Additionally, the sessions were easily manageable and dovetailed well with the study teachers' current science and math curricula. All of this for the teacher, and the kids loved it!

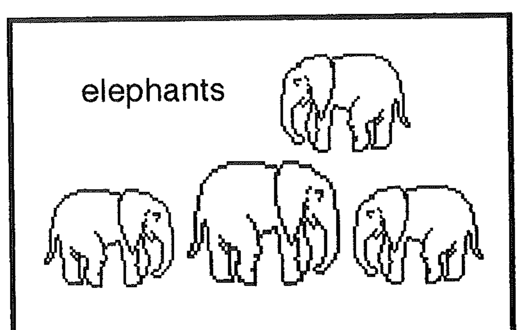


Figure 1 - a collection based on a common attribute: type of animal

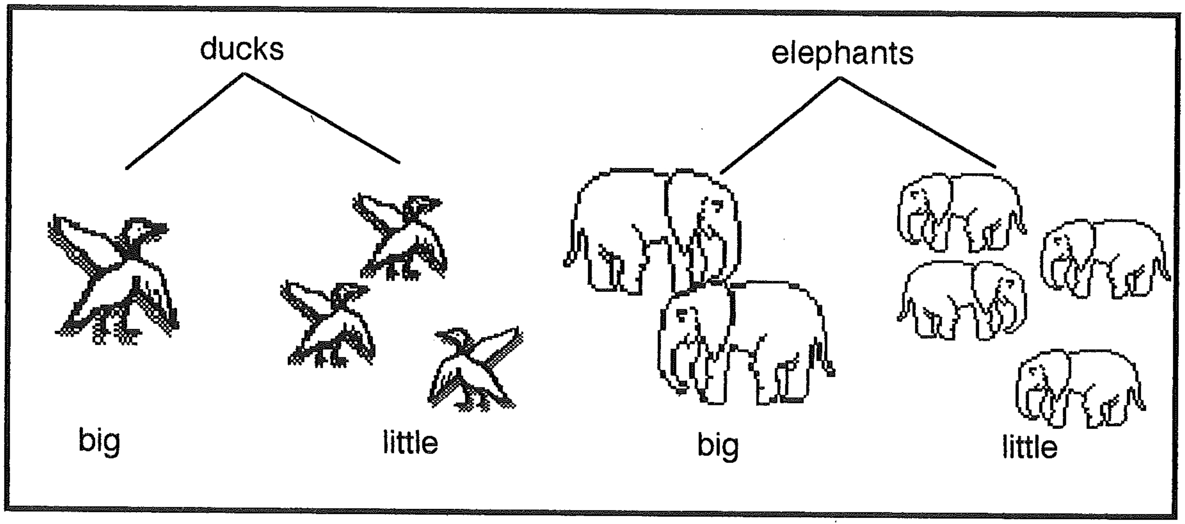


Figure 2- Hierarchical systems among collections.

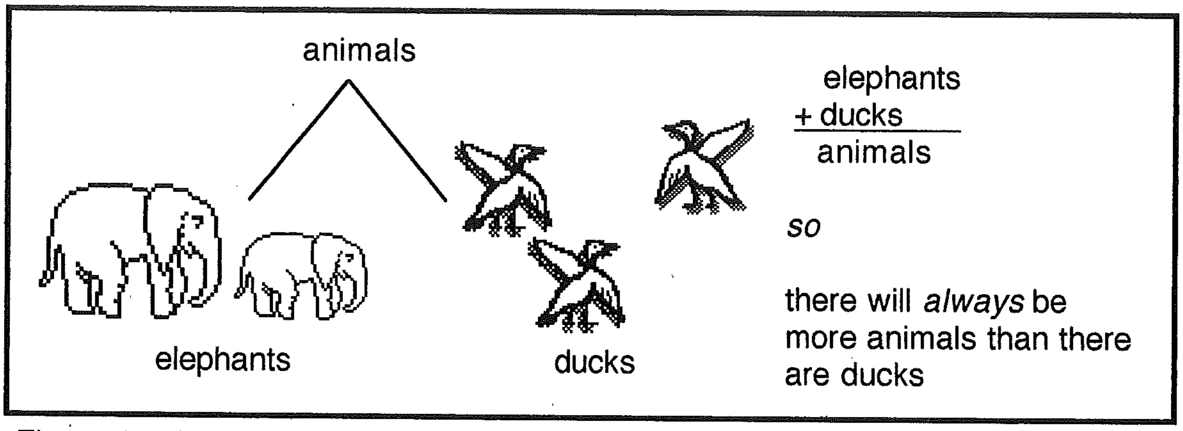


Figure 3 - Class inclusion relationship between a superordinate (animals) and subordinate (elephants and ducks) collections .

What is classification?

A person who can classify can do three things. First, he can make collections based on a common attribute (for example, big and little elephants go together because they are both elephants, as in Figure 1). Second, he can form hierarchical systems among the collections (for example, two superordinate collections, each composed of two subordinate collections, as in Figure 2). Third, he can understand and articulate class inclusion of a hierarchy (qualitative relationships between subordinate and superordinate classes, for example: there are always going to be more animals than ducks, as in Figure 3).

Classification and similar logical thought processes are often referred to as *structures.* Structures are hypothetical mental constructs that humans use to manipulate and act upon data. The more structures a child attains, the further advanced he becomes in his logical thinking. Structures are different than content. Content is facts; structures are the ability to process and use those facts. Phillips illustrated the difference with a computer analogy. The data which is input is content; structures are the software which manipulates and relates the data.

Classification and other structures are the building blocks of logical, scientific thought. Research suggests that children who have well developed classification skills benefit in several ways. Because classification is not content-specific, its benefits are not confined to the science lab, but to other curricular areas as well.

Why Is it Important for children to be able to classify?

First, classification development seems to be linked to development of basic skills which require organization of knowledge. Students' reading comprehension and math concept understanding often increase as classification skill increases. For example, first and second graders are taught that subtracting two consecutive whole numbers will always equal one (such as 9 - 8 = 1). Many teachers feel that every student who can count can apply this rule. Experience tells them, however, that there are skilled counters who cannot consistently use it. The missing skill may be classification. A child not only needs to remember that 9 - 8 = 1, but that other consecutive whole numbers have the similar attribute. See Figure 4.

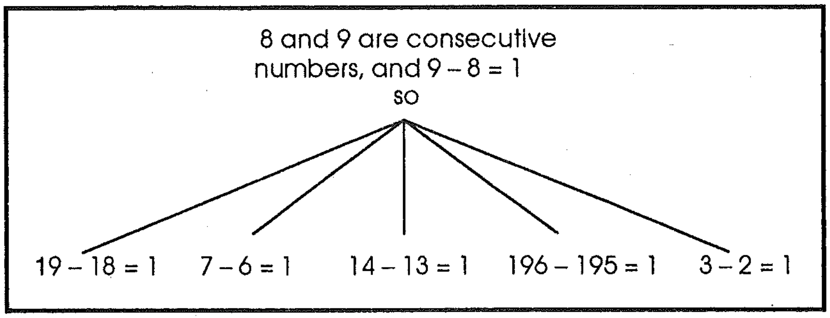


Figure 4 - A hierarchical classification system which allows a person to solve the subtraction of two consecutive whole numbers without refiguring each from scratch.

Second, a child who can classify is then ready to start developing higher level thought processes used to extend and refine knowledge. These processes include more complex classification structures, reading comprehension of inferred, abstract meaning, and transfer of knowledge to other contexts. How can classification help in the transfer of knowledge? As an example, primary students are often taught that plants come from seeds, grow, and may eventually produce seeds of their own before they die. A student who can classify would then be capable of taking that information and generalizing it to all living things, whether butterflies, ducks, or humans. Again, the classification process works by the child recognizing the common attribute among the beings (that they are living), and then generalizing that since plants have a cyclical life cycle and eventually die, so must other things.

Classification is a skill which helps facilitate organization of knowledge, as well as a precursor to higher level thought processes. What can teachers do to encourage classification development in their students?

How Is classification developed (and not developed)? Two phrases stand out in the research of these questions: *developmental* and *constructivism.*

Children must be developmentally ready to learn how to classify. Classification is a structure that depends on several preconditions, including a specific level of physical brain maturation and acquisition of certain precursor structures to exist in a child. Until those preconditions are in place, no amount of quality teaching will help a child classify. Thus it would be foolish to use classification-building activities in a pre-school class, since the majority of 4-year-olds are not yet developmentally capable of classifying.

When these preconditions do come together (this occurs for many children between the ages of 5 and 7), classification learning follows a three stage developmental continuum, as shown in Figure 5. Children in the first stage form graphic collections when presented with a set of objects. A graphic collection consists of designs and patterns, which are dependent on how they are placed in relationship to other pieces. A child in Stage 1 cannot group objects according to a consistent defining set of rules.

Stage 2 children begin to make collections of objects using consistent defining rules, called non-graphic collections. As opposed to graphic collections, non-graphic collections are not dependent on placement relationship to other pieces. Early in this stage, children can note similarities between objects. At first, it is no more than matching big red circles to other big red circles. Later, he can narrow down his thought and choose one attribute (either color, shape, size, type...) to group by. For instance, all the red ones are in one pile whether they're big or little, circles or hexagons. Later in this stage, they can also change the rules and create another legitimate collection, such as grouping all of the small ones together.

Stage 3 classification builds upon the Stage 2 ability to group by several different attributes. Now that a proper scheme has been formed, what qualitative relationships are inherent in the scheme? For example, one child may divide attribute blocks into two groups, naming them "red ones" and "white ones". It is given that if all the shapes are taken away, there will be not red ones left, just as there will always be more shapes then white shapes. A child who can articulate these relationships ("There are more shapes than white shapes, because the shapes aren't just the white ones, they're the red ones too.")

Aside from the developmental nature of classification, research indicates that children need to construct their own classification ability. Teachers can't "teach classification" in the traditional sense of teaching (i.e. talking or reading about it). Instead, students need to build their own classification ability by working with physical objects.

Despite considerable evidence linking students' hands-on exploration of objects to construction of cognitive structures such as classification, many primary school teachers still use direct-instruction techniques (algorithms, worksheets, and whole-class demonstrations) more than objects in teaching classification. Why do many teachers choose such an illogical route towards their students' logical thought development?

There are many reasons given by teachers as to why they use a minimal amount of objects. Among them are the cost of the materials, preparation time, and unfamiliarity with the use of objects. While these are, to a certain extent, valid reasons, they ignore both the developmental needs of primary students, and large bodies of research on the best practices of teaching science and math. Yet, activities where students actively use objects don't have to be unwieldy in the classroom.

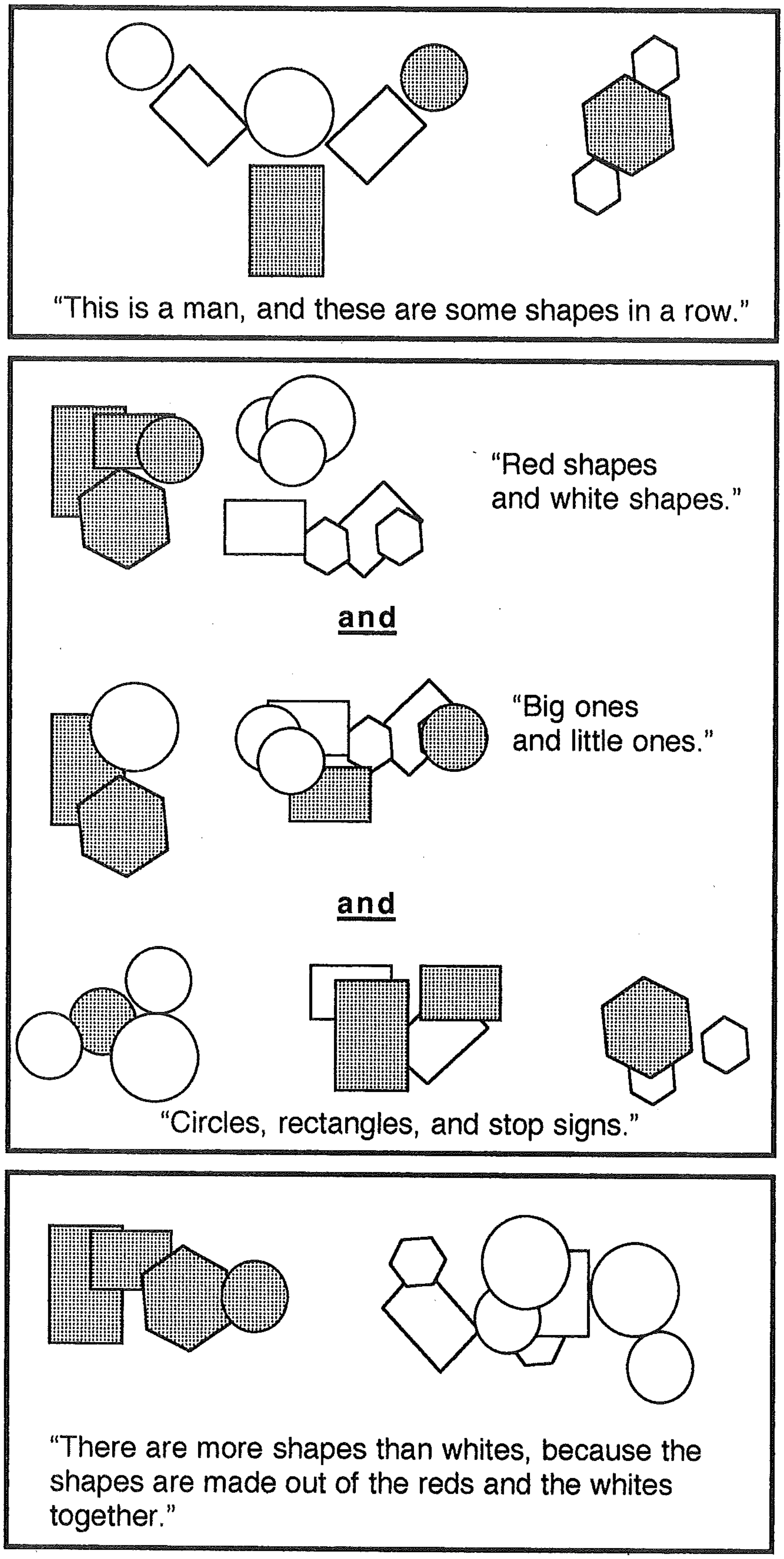


Figure 5 -The three stages of classification growth.

Stage 1 - Graphic collections. These are normally designs or patterns.

Stage 2 - Non-graphic collections. At the end of this stage, children can create different legitimate classification schemes. In this case, he sorted by color, then size, then shape.

Stage 3 - Class inclusion. Children in this stage can understand and articulate the different class inclusion relationships in many sets of objects.

Rules for Collection Time

1. Work only with your own collection.
2. Work only with the objects - put the container under your desk.
3. Don't disturb others by talking too loudly.
4. Be careful not to damage any of the objects, and return them to their containers when you are done.
5. Have fun.

Figure 6 - Some of these rules were brainstormed by the class, others were given by the teacher. They are displayed above the object shelf and read aloud before each session.

What is object exploration?

Object exploration (or as my students call it "collection time") is one object-based teaching method which develops classification. As part of an eight month experimental/control group study, 36 first graders in two experimental classrooms in a suburban Chicago school had "collection time" twice a week. Nineteen students in a control group did not. At the end of ten weeks, the students in the experimental classrooms showed significantly more classification growth than the students in the control group. What's more, both teachers who tested collection time found it to be so valuable *and* practical, that they continued the sessions beyond the end of the study.

So what goes on during collection time? Object exploration is simply when a child picks a set of objects, and then builds, sorts, makes designs, or whatever manipulation is appealing and makes sense to the child. If this sounds familiar, it's because it sounds remarkably like the definition of "play". This connection is not surprising. Educators from Piaget to the National Association for the Education of Young Children have identified play as central to early cognitive development.

The objects available during object exploration time are selected specifically for classification development. Typically, they are sets of 40 or more objects which appeal to children by virtue of their color, shape, or novelty. Each set contains objects which have two to six attributes, such as different colors, shapes, sizes and types. The objects are stored in clear plastic containers or bags, for easy access by the children.

At the beginning of each session, the students are reminded that they can choose any set of objects they like, then pour them out on their desk or the floor, and that they should "work with the objects and find out what you can about them." No other verbal explanation is needed. This simple command tells children that there is not one thing the teacher wants them to do: they have the freedom to do exactly what they want to do with the objects. The only rules are shown in Figure 6.

There is a greater demand for some object sets more than others so each row or table of students rotates as to who gets to pick first. Students then begin working with their objects. Some students are talking, but usually it is to themselves. The range of what students do with their objects is as wide as the range of developmental levels in the class. One child is grouping sailboats by color, another is playing "school" with different sized puffballs representing the students and teacher.

Not all of the students' manipulations involve classification. One student may be totally engaged in making a design with attribute blocks. Is this child wasting time, goofing off when she should be learning how to classify? No. She is doing what she wants, what is important to her, what she is developmentally ready for, and learning another skill to boot. Can you think of a better educational moment? Student's freedom to choose what to do with the objects means they may be developing skills other than classification. For example, students can develop counting skills by counting buttons, a sense of symmetry by making designs, one-to one correspondence by lining up sail boats, verbal skills by reporting on what they've done, or observation skills by examining sea shells. There is also a good amount of language development taking place. Terms such as "more than", "smaller", "longer", "in between", and "closer" are often used.

Students' freedom of choice also acts as a practical opportunity to develop responsibility. The teachers in the study felt that collection time gave children the opportunity to practice such life skills as "take care of your belongings", and "put things away where they belong."

Where is the teacher while the students are involved with their work? He is involved 1) determining, through questioning or observation, what the child had done up to that point, then 2) redirecting, questioning, or doing nothing, based upon that determination. For example, a child had made a graphic collection of seashells, the teacher might ask "Do you want to try something different? Is there a way you can put these into groups or piles, so that the ones that go together are in the same pile?" This line of questioning is designed to lead

the child toward making a non-graphic collection. Another student has organized plastic animals into several groups. "What do you call your groups?" If the child has created a legitimate classification scheme of, say, cows in one group and pigs in another, the teacher then might ask "Is there another way to put them into groups?" encouraging him to set up another classification scheme, like spotted and non-spotted animals. If that student is successful, several class inclusion questions might be asked. "You call your groups 'spotted animals' and 'not spotted animals'. If I take away all of the animals, will there be any spotted animals left? Why not?"

Other situations arise where students have not made legitimate schemes. For example, a child may call his piles reds, blues, and triangles, even though there is a blue triangle in the blues. The teacher might then try to create dissonance in the child by asking "I thought you said this was the triangle pile. Isn't this a triangle in the blue pile? Is there a way you can do it so that each pile only has one kind of thing in it?" The child may then respond by rearranging the groups to form a legitimate scheme. Or he may insist that his way is the right way. This is fine; that is where the child is developmentally, and the teacher showing him the "right way" is both useless for developing classification, and frustrating for the child. A better response is "OK" or "Thanks for showing me!"

How can classification growth be assessed?

First, one way that it can not be assessed: through written tests. In general, written tests are notoriously inaccurate for assessing many primary students, especially if they are just developing writers. For assessing classification growth they are worse, because children just developing classification are doing so at a concrete level. Written tests use symbols; a child can't move drawn objects around on their paper.

Instead, observing students actually using objects is the most accurate assessment, because you can directly observe them classifying. The three stages of classification development always occur in the same sequence. Therefore, observing how students work with their objects will reveal at what developmental stage they are. When asked to arrange their collection so that all the ones that belong together are in the same pile, does the student make a graphic collection? A non-graphic collection, but he is not able to redefine the classification scheme? A complete graphic collection but without understanding of class inclusion?

How can object exploration fit into my science and math program?

Many teachers feel object-based activities are impractical because they are seen as time-consuming and taking away from other parts of the curriculum. This needn't be so. Properly managed, object exploration can fit easily into most primary classroom schedules. Due to its informal nature, object exploration acts as an ideal transition between different activities, and can be made available in learning centers. Children in the study used the objects twice a week for twenty minutes: forty minutes a week. You can adjust exposure to fit your schedule and the interest level of your students.

Both study teachers noted that the children enjoyed "collection time" immensely, and that discipline problems during that time were minimal. The students became well-versed in expected behavior during sessions. As such, the sessions were easy to plan and conduct, with a minimal amount of preparation and clean up time.

Conclusion

If classification is to be developed in primary-aged children, schools need to set and follow up on some goals. First, students must have access to sets of objects, and adequate time to explore them. Second, teachers and parents must be educated to the value of what may appear on the surface to be just "playing around." Third, teachers must have sufficient budgets to purchase needed objects, and sufficient training to recognize the developmental stages of classification,

Object exploration is a first step toward these goals. For the teachers in the study, collection time was a practical addition to their students' day. Collection time was a perfect fit with their philosophies that education should be learner-centered and that activities should be developmentally appropriate. Most importantly, students were happy *and learning*. By having the freedom to pursue whatever they were interested in, and developmentally capable of doing, students produced real, documented classification growth.

References

Arlin, P.K. (1981). Piagetian tasks as predictors of reading and math readiness in grades K- 1. *Journal of Educational Psychology, 73* (5), October, 1981, 71221.

Benson, D.B. (1987). An investigation into the interrelationships of Piagetian logical structures, additive composition, class inclusion, and seriation. (Doctoral dissertation , University of lowa.) *Dissertation Abstracts International,* 48, 2534A.

Berg, C. A. and Phillips, D. G. (1994). An investigation of the relationship between logical thinking structures and the ability to construct and interpret line graphs. *Journal of Research in Science Teaching*: 31(4), April 1994, 323-344.

Boyd, E. and George, K. D. (1971). *The Effect of Science Inquiry on the Abstract Categorization Behavior of Deaf Children. Final Report.* Bureau of Education for the Handicapped. Washington D.C.

Boyle, D. G. (1996). *A Student's Guide to Piaget.* London: Pergamon Press.

Briguier, J.C. (1980). *Conversations with Jean Piaget.* Chicago: University of Chicago Press.

Bruner, J.S. (1960). *The Process of Education.* Cambridge: Harvard University Press.

Camp, D.L. (1975). An investigation of six major logical groupings of concrete operational thought. (Doctoral dissertation, University of lowa.) *Dissertation Abstracts International,* 36, 5176A.

Cohen, H. (1978). The scaling of six topological groupings. *Journal of Research in Science Teaching;* 15, 1978, 115-125.

Cohen, H. (1984). The effects of two teaching strategies utilizing manipulatives on the development of logical thought. *Journal of Research in Science Teaching;* 21 (8), November, 1984, 769-78.

Cohen, H. (1992). Two teaching strategies: their effectiveness with students of varying cognitive abilities. *School Science and Mathematics,* 92 (3), March 1992, 126-132.

Crain, W. (1992). *Theories of Development.* Englewood, N.J.: Prentice Hall.

Dumont, J.J. et al (1980). *Arithmetic Disabilities: The Relation Between Arithmetic and Some Psychological Abilities. A Reanalysis.* Paper presented at the International Congress on Early Childhood Education (Tel Aviv, January, 1980).

Fein, G. and Rivkin, M. Eds. (1986). *The young child at play: Reviews of research. (Vol.4).* Washington D.C.: National Association for the Education of Young Children.

Finley, F.N. and Smith, E.L. (1980). Effects of strategy instruction on the learning, use, and vertical transfer of strategies. *Science Education, 74 (3),* July 1980, 367-375.

Gay, L.R. (1992). *Educational Research: Competencies for Analysis and Application.* New York: Macmillan.

Ginsburg, H. and Opper, S. (1969). *Piaget's Theory of Intellectual Development.* Englewood Cliffs, N.J.: Prentice-Hall, Inc.

Glenview Consolidated School District #34 (1995). *Strategic Plan: A Structure for Systemic Change.* Glenview, Illinois

Glenview Consolidated School District #34 (1994). *Curricular Expectations: First Grade.* Glenview, Illinois.

Haupt, E.J. and Herman-Sissons, T.M. (1981). *Classification and IQ - Alternative Predictors of Math Performance.* Paper presented at the Meeting of the Eastern Educational Research Association (Philadelphia, March, 1981).

Henry, J.A. (1978). The transition from pre-operational to concrete-operational thinking: the effect of discrimination and classification activities. *Journal of Research in Science Teaching,* 15 (2), 145-52.

Hooper, Sipple, Goldman, and Swinton (1974). *A Cross Sectional Investigation of Children's Classificatory Abilities.* ERIC Technical Report No. 295.

Howlett, K. (1973). A study of the relationship between Piagetian class inclusion tasks and the ability of first grade children to do missing addend computation and verbal problems. (Doctoral dissertation; State University of New York and Buffalo).

Inhelder, B. and Piaget, J. (1964). *The Early Growth of Logic in the Child.* London: Routledge & Kegan Paul Ltd.

Johnson, J. E., Ershler, J., and Lawton, J. (1982). Intellectual correlates of preschoolers' spontaneous play. *Journal of General Psychology,* 106, 115-122.

Kofsky, E. (1966). Relationships between language and cognitive skills: Passive-voice comprehension, backward repetition, and matrix permutation. *Child Development:* 44, (4), 741-746.

Kyhl, C. S. (1994). The development of concrete operational classification structures. (Doctoral dissertation, University of Iowa). *Dissertation Abstracts International.*

Lawson, A. E. (1973). (Doctoral dissertation, University of Oklahoma.) *Dissertation Abstracts International,* 34, 3179A.

Lawton, J.T. and Wanska, S.K. (1979). The effects of different types of advance organizers on classification learning. *American Educational Research Journal, 16* (3), Summer, 1979, 223-39.

Leushina, A.M. (English translation 1991). *The development of elementary mathematical concepts in preschool children. (Vol.4,* Soviet studies in mathematics education.) Reston, VA.: National Council of Teachers of Mathematics.

Magnusson, S. (1986). *Assessment of Students' Abilities to Separate and Control Variables under Two Methods of Testing.* Unpublished masters thesis, University of lowa, lowa City.

Marzano, R.J. et al (1988). *Dimensions of Thinking* . Alexandria, VA: Association for Supervision and Curriculum Development.

Marzano, R.J. et al (1992). *Dimensions of Learning* . Alexandria, VA: Association for Supervision and Curriculum Development.

Mcinnes, M.M. (1987). *A Cognitive Approach to Teaching Reading to Spanish-Speaking Adolescents.* A paper presented at the Annual Meeting of the American Educational Research Association (Washington DC, 1987).

Miller, A.A. and Starzec, J.J. (1974). *The Development of Multidimensional Classification in Children.* Paper presented at the Annual Meeting of the Midwestern Psychological Association (Chicago, 1974).

Nickerson, R.S., Perkins, D.N. and Smith E.E. (1985) *The Teaching of Thinking.* Hillsdale, NJ: Erlbaum.

Odegaard, G.E. (1975). An investigation of Piaget's groupings: seriation and projective space. (Doctoral dissertation, University of lowa.) *Dissertation Abstracts International,* 36, 7959A.

Phillips, D. G. (1982). Piaget's model of intellectual development. In R.E. Yager (Ed) *What research says to the science teacher: Volume 4* (pp. 52-64). Washington, DC: National Science Teachers Association.

Phillips, D. G. (1989). *The development of logical thinking: a three year longitudinal study.* Paper presented to the National Council of Teachers of Mathematics (Orlando, FL, 1989).

Phillips, D. G. (1992). *Sciencing: Toward Logical Thinking.* North Liberty, IA: Insights.

Phillips, D.G. (1996). *Structures of Thinking: Concrete Operations.* Dubuque, lowa: Kendall/Hunt Publishing Company.

Piaget, J. (1962). *Play, Dreams, and Imitation in Childhood.* New York: Norton.

Robinson, V.B. (1987). *The Performance of Early Readers and Prereaders on Concrete Operational Tasks: Three Samples.* A paper presented at the Annual Symposium of the Jean Piaget Society (Philadelphia, May, 1987.)

Rubin, K.H. and Maioni, T.L. (1975). Play preference and its relationship to egocentrism, popularity, and classification skills in preschoolers. *Merrill-Palmer Quarterly, 21,* 171 -179.

Sigel, I.E. and McBane, B. (1967). Cognitive Competence and Level of Symbolization among Five-Year-old Children. In J. Hellmuth (Ed), *The Disadvantaged Child.* Vol. 1. (1967); Seattle: Special Child Publications.

Sigel, I. E. and Omsted, P. (1967). *Modification of Classificatory Competence and Level of Representation Among Lower-Class Negro Kindergarten Children.* Office of Economic Opportunity, Washington D.C.

Simpson, B.F. (1972). *Multiple Classification, Class Inclusion and Reading Ability.* National Center for Educational Research and Development. Washington D.C.

Smith-Burke, M. et al (1976). *The Relationship between Class-Inclusion and Reading Comprehension of the Main Idea.* Chicago; Spencer Foundation.

Steffe, L.P. (1976). *Quantitative Comparisons and Class Inclusion as Readiness Variables for Learning First Grade Arithmetic Content.* Project for the Mathematical Development of Children. Tallahassee, FL; Florida State University.

Whyte, J. (1980). *Cognitive Development and the Acquisition of Reading Skills.* A paper presented at the Annual Meeting of the Reading Association of Ireland (Dublin, 1980).

Zemelman, S., Daniels, H., and Hyde, A. (1993). *Best Practice.* Portsmouth, N.H.; Heinemann.

Susan Camasta
Hinsdale South High School
Darien, Illinois
Anne Marie Brooks
Elmhurst College
Elmhurst, Illinois

MODELS OF THE ATOM: ENTERTAINING HISTORICAL VIEWS

When I get to the chapter on electronic structure of the atom in Advanced Placement Chemistry, I give the students a research and writing assignment to review the history behind our current model of the atom. The work they turn in must be in the form of a creative story. I have been doing this for three years, with good results.

This year, I have a student teacher who elaborated on my assignment as below.

The students' work this year was creative, and interesting to grade. One student made a poster using candy and cookies to show a "Sweet History of The Atom" and another wrote and read a news report in the style of Saturday Night Live's "Weekend Update".

Student Abe Hong wrote some Christmas Chemistry Carols that may be of interest to any of you who use these with your students. Manshi Patel wrote"The Cook Book on History of the Atom" and provided some fun analogies to aid in studying models of the atom. Enjoy some excerpts of our students' creative works!

HISTORY OF THE ATOM ASSIGNMENT

Trace the history of the atomic theory from the time of the early Greeks to the present, creatively. Your may do this as either:

A. CREATIVE WRITING. This can be any sort of fictional story or other literary form (poetry or a skit, for example). The facts and people indicated below must be included, but the context should be creative—not a chapter from a traditional history book.

B. MODEL BUILDING. Use whatever materials you want and put together a series of models illustrating the development of the atomic theory. Label
each model with the corresponding theorist's name and that of any other scientists whose work led to its development. For the contributors, in some manner indicate what each person's input was for that particular model. Each person or group listed below must be included; others may also be.

MATERIAL TO BE INCLUDED

Theories and research of: Early Greeks (Democritus, etc.), Dalton, Bohr, Thomson, Lord Kelvin, Schrodinger, Rutherford Details of the theories and research should be adequate to show similarities and differences—the evolution of the atomic theory.

GRADING

This assignment is worth 40 points. Materials will be graded on accuracy, creativity and presentation.

THE COOK BOOK ON HISTORY OF THE ATOM

Written by Manshi Patel, AP Chemistry, Period 4

Dedication—I would like to dedicate this cooking book to the great Greeks, who without their ideas and thoughts could never have advanced the theory of the atoms. To Leucippus of Miletus who is thought to have originated the atomic philosophy. Also to his famous disciple, Democritus of Abdera, who developed and named the building blocks of matter "atomos," meaning literally "indivisible" in about 430 B. C.

He believed that atoms were uniform, solid, hard, incompressible, and indestructible and they were in infinite numbers through empty space until stopped. Differences in atomic shape and size determined the various properties of matter. Even though Democritus thoughts were mere philosophy, it was the beginning of a marvelous revelation.

Dalton's Unbreakable Bread

Ingredients: 3 cups of flour 1/4 teas. of cinnamon 3 cups of sugar 2 teas. of vanilla 2 teas. of baking soda 1 cup of oil 1 teas. of salt 3/4 teas. of nutmeg

Directions: Mix flour, sugar, soda, salt, nutmeg and cinnamon. Combine eggs and vanilla. Add flour mixture to wet ingredients, stir until blended. Pour into two greased and floured 9 x 5 inch. loaf pans. Bake at 350 degrees for 1 hr, or until pick inserted in center of the bread comes out clean. Cool for 10 minutes on rack.

History: John Dalton, a British chemist and physicist converted the atomic philosophy of the Greeks into a scientific theory between 1803 and 1808. He pictured an atom as a hard, unidividable object, just like the type of bread that would be made using this recipe. He also decided that atoms are not infinite in variety as had been supposed and that they are limited to one of a kind for each element. Dalton also said that different element contained different atoms. Just like different types of bread required different ingredients.

He maintained that the molecules of an element form only one compounds. Thus, if two elements form only one compound, he believed that one atom of one element combined with one atom of another element. Dalton's mistaken belief that atoms join together by attractive forces was accepted and formed the basis of most 19th-century chemistry.

Lord Kelvin and Thomson's Famous Regal Plum Pudding

Ingredients: 3 slices of bread pieces 3/4 teas. of baking soda 5 1/3 cups of evaporated mild 3/4 teas. of grounded clove 2 oz. ground beef 1/4 teas. salt 3/4 cup of brown sugar 3/4 teas. grounded mace 1 beaten egg 1/4 cup of orange juice 1/2 teas. vanilla 1 1/2 cups of raisins 3/4 cup of all-purpose flour 1 1/2 cups ground cinnamon

Directions: In a large bowl, soak the bread pieces in the evaporate milk for 3 minutes. and beat. Stir in beef, brown sugar, egg, orange juice, vanilla, and raisins. Stir together with flour, cinnamon, baking-soda, clove, mace, and salt. Stir until combined. Turn mixture into a mold, Place on a rack in a kettle, and boiling water, to a depth of 1 inch. Cover kettle boil gently, steam for four hours. Cool for 10 minutes before unmolding. Serve warm.

History: J.J. Thomson discovered electrons using a cathrode ray tube in 1897. The mass of an electron was very small, merely 1/1,836gh that of a hydrogen ion. Scientists realized that the electron were virtually 1,000 time lighter than the smallest atom. Between 1903 to 1907 Thompson tried to answer where the neutralizing positive charges was placed in the atom, by adapting an atomic model that had been first proposed by Lord Kelvin in 1902.

According to this theoretical system, referred to as the "plum Pudding" model, the atom is sphere of uniformly distributed positive charge about one angstrom in diameter. Electrons are embedded in a regular pattern like raisins in a plum pudding to neutralize the positive charge.

The advantage of the Thomson atom was that it was inherently stable, because if the electrons were displaced, they would attempt the return to their original positions. So he proposed a contemporary model, resembling the solar system, with ring of electrons surrounding a concentrated positive charge.

Rutherford's Cookie Surprise

Ingredients: 11/2 cups of all-purpose flour 1 cup packed brown sugar

1 teas. of baking soda 1/2 cup of sugar 1/2 teas. of salt 2 eggs 1/2 cup of butter 1 1/2 teas. of vanilla 1/2 cup of shortening 1 bag of Jawbreakers

Directions: Stir flour, soda, and salt together. Beat butter and shortening, and both sugars, until fluffy. Add eggs and vanilla, and beat well. Add dry ingredients to mixture, and mix. Take spoonful of dough and place one Jawbreaker inside of it. Place on a greased pan, about 2 inches apart from one another. Heat the oven to 375 degrees, and bake for 8-10 minutes. Serves 72 cookies.

History: In 1903, Ernest Rutherford using his well-known gold foil experiment discovered that the atom contained a tiny, massive nucleus.

The model said that the nucleus is almost all the mass and the rest of the atom is mostly empty space. The cookie surprise represents the nucleus (Jawbreaker) as the most massive and tiny part of cookie, while the rest of the cookies is just dough containing nothing.

The model suggests that the charge on the nucleus was the most important characteristic of the atom, which determined the structure. The nucleus contained a primary positive charge.

Bohr's Chocolate Lover's 7-layer Cake

Ingredients: 7 boxes of Betty Crocker Super Moist Devil's Food Cake Mix 1 cup of water 1/3 cup of vegetable oil 3 eggs

Directions: Beat cake mix, water, oil and eggs in large bowl on low speed for 30 seconds. Beat on Medium speed for 2 minutes. Pour into pan, 15 1/2 x 10 1/2 inch pan. Bake in oven at 350 degrees for 20-25 minutes. Cool for 10 minutes. Repeat these steps seven times for each cake. Stake each on top of one another, spreading chocolate frosting in between cakes.

History: Niels Bohr in 1913 proposed his quantized shell model of the atom to explain how electrons can have stable orbits around the nucleus. The motion of the electrons in the Rutherford model were unstable according to classical mechanics and the electromagnetic theory. To remedy the stability problem, Bohr modified the Rutherford model by requiring that the electrons move in orbits of fixed size and energy. The energy of an electron depends sized of the orbit. The orbits are labeled by an interger, the quantum number n.

The 7-layer cake symbolizes the different energy levels of the electron according to Bohr's model. The first level of the cake is like the ground level where n=1, and so on.

Schrodinger's Swirling Cinnamon Rolls

Ingredients: 2 cups of all-purpose flour 1/3 cup of sugar 1 package of active dry yeast 1/2 cup of butter 1 cup of milk 1 teas. of salt 2 eggs 3 tablespoons of cinnamon 3/4 cups of raisin

Directions: Heat the milk and mix with sugar, yeast and salt. Beat two eggs and mix with flour and milk. Mix until it is formed into dough. Divide in half. Take one, and spread it over a 12 x 8 rectangle pan. Melt butter, and spread over dough. Sprinkle 1/2 a cup of sugar and 3/4 cup of raisin and sprinkle over dough. Roll up the dough and cut into twelve slices. Sprinkle cinnamon on the center of the roll. Place rolls on a 9 1/2 x 1 1/2 round baking pan. Allow the rolls to raise double their size for 30 minutes. Bake at 375 degrees for 20-25 minutes.

History: Erwin Schrodinger established the quantum Mechanical Model, which produced the mathematical wave equation that established quantum mechanics in widely applicable form. This equation could calculate the amplitude of the electron wave at various points in space. He theorized that electrons were contained in "blurry clouds" not in orbit. The "blurry clouds" are more concentrated by the nucleus than at any other point.

The cinnamon rolls represent this theory, because there are large amounts of cinnamon swirls in the center of the roll, like the electrons near the nucleus. The large amounts of cinnamon deposits in the center, reduces as you go farther out. Establishing Schrodinger's theory that the concentration of electrons reduces as you get closer to the outer level of the atom.

Christmas Chemistry Carols

Wonderful Carol Arrangements for the Chemistry Lover

Oh Little Schrödinger Equation

Oh little Schrödinger equation, how wonderful you are;
You redefined quantum mechanics, you're the best of all by far;
You've made your mark in history, you're found in every book;
Your complexity is reassuring, you've got the grace, the looks.

Electron or subatomic particle waves varies in time and space;
As particles move under influence of force—this seems to be the case;
Erwin thought his solutions could be mathematically defined;
To Bohr's old model with hydrogen atoms, his equation was right on the line.

But Erwin's model also can be applied to atoms that are more complex;
Correct energy levels and particle behavior is what his equation detects.
He showed that wave mechanics were similar to those of Heisenberg's matrix;
Ahd firmly established his theory of quantum mechanics.

Joy to the Nucleus

Joy to the nucleus, you have been found!
It was Rutherford's gold-foil experiment!
He shot some alpha particles, right through gold foil;
And some came back at him,
And some came back at him,
As if bullet bounced off a tissue and hit him.

At first he thought that the nucleus and the electrons attract,
Resulting in a stable structure!
According to his model, electrons could move
In any of the infinite orbits,
In any of the infinite orbits,
Allowed by beloved Newtonian physics.

O Come, O Come, Electron

O Come, O Come, electron.
Discovered by the scientist Thompson.
Negative particles came from his cathode ray;
That atoms were made of subatomic particles was his say.
Electrons, electrons, were constituents of all the atoms;
And thus he won the Nobel Prize for physics.

Dr. Kim Pittman
National-Louis University
2840 Sheridan Road
Evanston, IL 60201-1796

WINDOWS ON THE MIND ANALOGIES IN SCIENCE

THE NATIONAL SCIENCE EDUCATION standards (NRC, 1996) provide a useful road map for constructing routes to better teaching and assessment practices. The National Standards encourage student understanding that is actively constructed through individual and social processes. Student-generated analogies can be invaluable tools to help teachers successfully meet this challenge.

The cell is like a factory: the nucleus is the brain or CEO of the company, the membranes are crossing guards, the mitochondria is the powerplant, the ribosomes manufacture, the golgi bodies assemble, the cytoplasm is the floor that holds everything in place, etc. Scientists still make frequent use of analogies. In fact, throughout the history of science, analogies have played an important role in explanation, insight and discovery (Hess, 1966, Hoffman, 1980).

An analogy is drawn by identifying similarities between concepts. In this way, ideas can be transferred from a familiar concept to an unfamiliar one. The familiar concept is called the analog and the unfamiliar one the target. Both the analogy and target share common features, surface features (nouns) or relationships (verbs).

Analogies have been shown to provide visualization of the abstract concept, provoke student interest. facilitate abstract thinking,. link prior knowledge to new knowledge (Duit, 1989).

It is not surprising that science teachers routinely use analogies to explain complex concepts to students. Often, teachers are unaware that they are using analogies-they do it automatically. During their lessons, teachers regularly use expressions such as "It's just like", "It's the same as," "It's no different than," and "Think of it as."

Unfortunately teachers' analogies may do more harm than good (Duit, 1991; Gilbert, 1989; Thagard, 1992; Treagust, Duit, Joslin, & Lindauer, 1992). That is because teachers and authors, lacking guidelines for using analogies, sometimes use them unsystematically, often causing confusion and misconceptions because teacher assumptions about student prior knowledge is often times incomplete.

A better solution is to introduce teachers and students to a strategy for using analogies systematically to explain concepts in ways that are meaningful to students because the strategy allows students to construct new knowledge. The National Science Education Standards strongly support the notion of learning science as an active process and profess that "the perceived need to include all the topics, vocabulary, and information in textbooks is in direct conflict with the central goal of having students learn scientific knowledge with understanding" (NRC, 1996,20-21).

Similar to concept mapping, analogies allow for the identification of students' preinstructional understanding as well as promote cooperative learning, where small groups of students discuss a concept together to produce analogies.

CONSTRUCTING ANALOGIES

It is imperative for science teachers to gain experience in creating analogies before using them as instructional tools with children. The mechanics of creating analogies consist of the following:

1. Select the concepts. List the concepts you believe are most important to understanding the central topic (i.e. protein synthesis).
2. Create a list of the vocabulary terms to be studied. List the words that are germane to the topic (i.e., DNA, ribosome, mRNA, tRNA, amino acids, proteins).
3. Using verbs describe the vocabulary word to the relationship of the word to the entire concept (i.e., controls cell activities, makes, delivers message, etc.) See Figure l.
4. Select a "system" or another content area to use as your analogy. This should be an area that the student has expertise in. (i.e., a message delivered in the school: A principal asks her secretary to tell Teacher A to write a letter home about an upcoming science fair. Teacher A needs to collect information from Teachers B & Ç, and then writes the letter) from which to apply the vocabulary words.
5. Create a listing to describe how the vocabulary words are like a "system", how all the parts equal the whole.

Figure 1

1. DNA	Principal	Controls activities
2. Ribosome	Teacher A	Making final product
3. mRNA	Secretary	Deliver the message
4. tRNA	Teacher B	Provides information
	Teacher C	
6. Protein	Letter	Finished Product

6. In addition, a teacher could add a fourth column titled "Different because". This column would provide the teacher with a window on the mind. It would help prevent misconceptions and it would also allow the teacher to depict erroneous conceptual organization.
7. Students are then asked to illustrate their analogy with labels to describe the relationships.

It is important to note that these steps are intended to serve only as a guide for conceptualizing the mechanics of student generated analogies. The critical aspect of students generating their own analogies is that is a highly individualized process. Students construct a visual representation and an analogy to represent their unique understandings of the concept or topic in question.

If analogies are to be used to assess students' understandings of science concepts, it is imperative for students to feel convertible and successful constructing them. Caution must be used to avoid overwhelming students. Introductory analogies should focus on a limited number of concepts.

Analogy construction is a skill that must be learned in developmentally appropriate ways. Teachers should start by illustrating analogies to their students and slowly teach them to start using analogies spontaneously.

To obtain an assessment of student understanding, teachers should gradually move students toward constructing more expanded analogies. These analogies show the addition of more concepts and illustrates the relationships between concepts within the hierarchy. Analogies have the most inferential power if they are based a "system" similarities are designed around relationships (Gentner, 1989)

SCORING STUDENT ANALOGIES

Teachers using student-generated analogies to determine students' prior knowledge of a science concept would want students to feel comfortable sharing ideas about which they may feel uncertain about.

As an alternative form of assessment, student'generated analogies can be evaluated by teacher-developed scoring rubrics. The Standards recommend the use of scoring rubrics if the performance standards are defined, appropriately refined for the target student population, and then used to differentiate student performance. Scsoring rubrics can be constructed to indicate pass/fail performance (Jensen, 1995). The criteria for developing an analogy scoring rubric may contain many facets, such as the following:

* The type of analogy. According to Gentner (1989), analogies are most powerful if they are based on the underlying relationships. Genter categorizes 4 types of similarity: analogy (use of verbs to describe the similarities) as shown in Figure 2, literal similarities (a combination of verbs and nouns to describe the similarity as shown in Figure 3, a mere appearance (the use of surface features usually described with nouns and/or adjectives) as shown in Figure 4, and an anomaly (the lack of any similarity).
* The number of vocabulary words used.
* Comparison of the first analogy (analogy completed prior to or during instruction) to a final analogy (used as a posttest).
* The number of valid propositions. The teacher should check each proposition for validity- that is, is the relationship scientifically correct or is it inappropriate (does it illustrate a misconception or alternative conception)? Propositions can be weighted equally or differently, according to the degree of importance ascribed to the relationship by the teacher.

There are many other possibilities for assessing student-generated analogies. Students will often get very creative when constructing their analogies. It is also a good idea to have the student illustrate their analogy, it acts as a reinforcement and forces the student to reflect on his/her work.

Making analogies sets the stage for devising new thought patterns. Students start with analogies that make sense and later make analogies that seemingly do not make sense until creativity and new thought patterns have been devised. These new analogies help students to see the concepts in new ways. This gets students thinking and helps them in the areas of critical thinking and problem solving. Sometimes the teacher-generated analogy may be more confusing to the student than the concept, hence, student-generated analogies seem to offer a fresh approach to learning science.

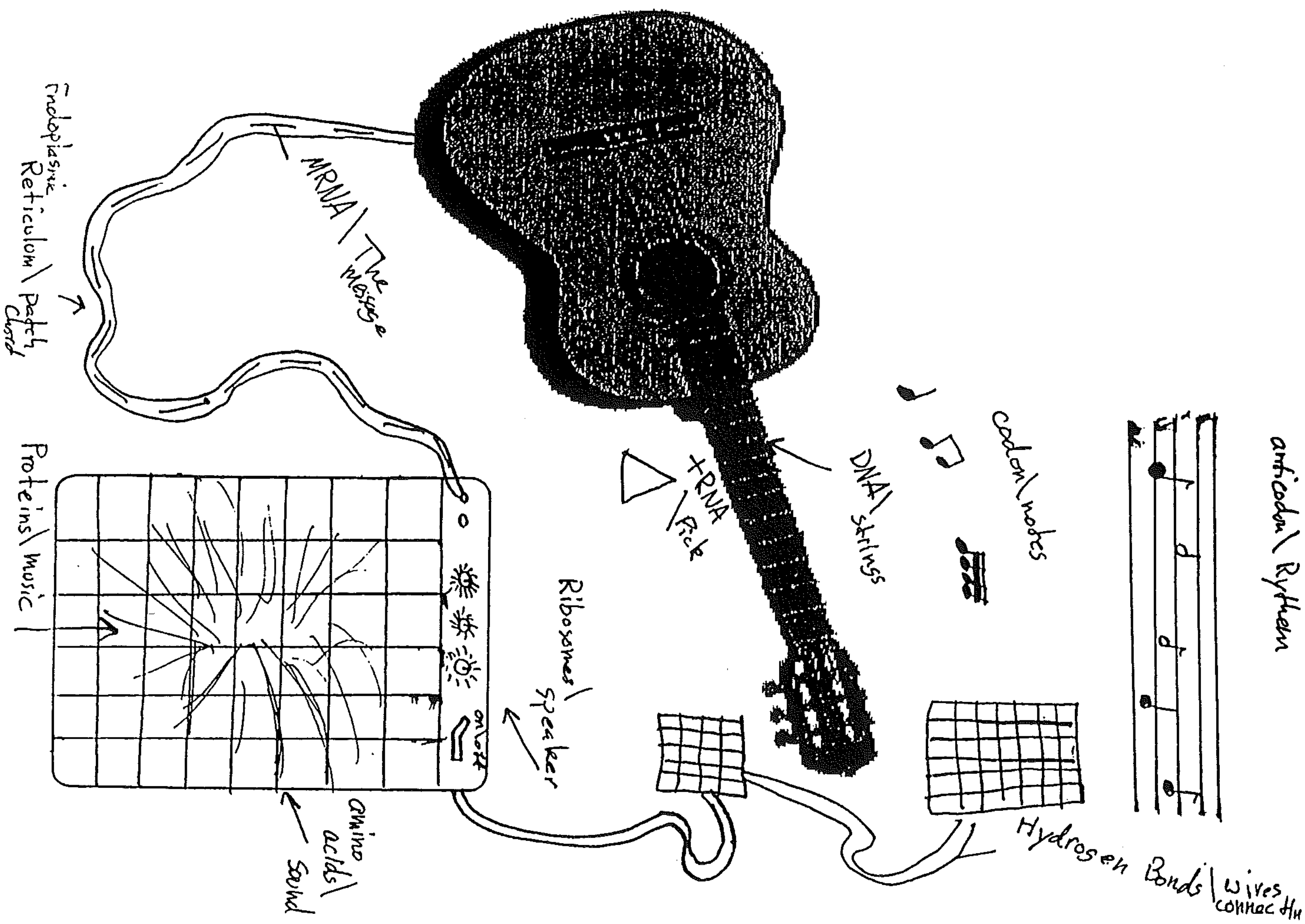


Figure 2 Making Music

Protein Synthesis Vocabulary Word	Student's word	How are they similar?
Anticodon	Rhythm	MAKES basic beat
Codon	Notes	CREATES the rhythm
Amino Acids	Sound	HOLDS the tone together
Proteins	Music	The CREATED Music
Endoplasmic Reticulum	Patch Chord	TRANSLATES
Ribosomes	Speaker	PROVIDES the released sound
mRNA	Message	TRANSPORTED through chord by the hand
tRNA	The pick	PROVIDES the sound MAKES the music complete
DNA	Strings	Original starting point of Music

A student-generated analogy (analogy) from an 8th grade boy.

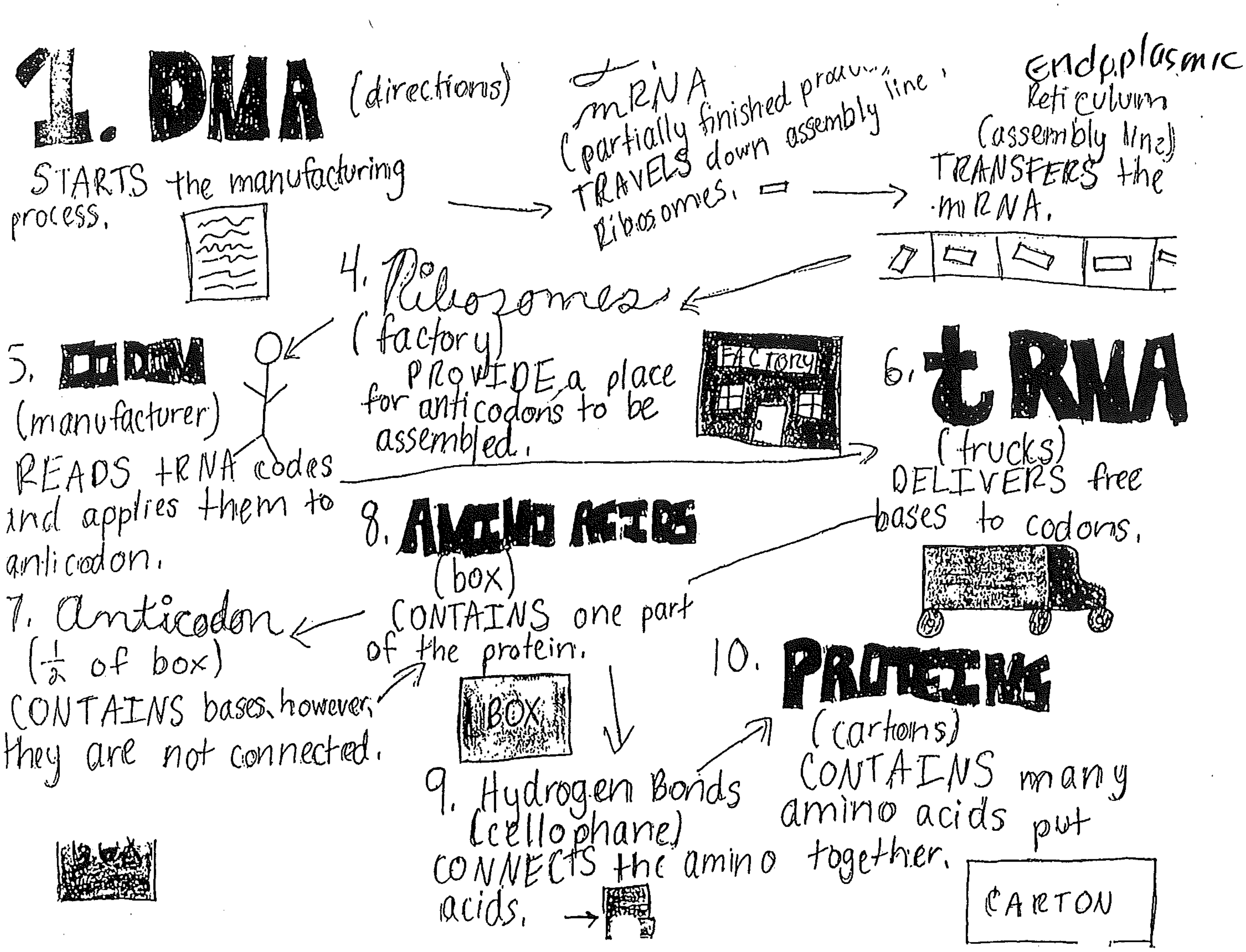


Figure 3 Manufacturing Plant

Protein Synthesis

Vocabulary Word	Student's Word	How are they Similar?
Antocodon	half of box	CONTAINS bases; however, they aren't connected
Codon	manufacturer	READS tRNA codes & applies them to anticodon
Amino Acids	Box	Contains a part of the protein
Proteins	Carton	Many amino acids put together
Endoplasmic Reticulum	Assembly Line	It TRANSFERS the messenger RNA
Ribosomes	Factory	Provides a place for anticodons to be assembled
mRNA	Messenger	CARRIES the message for the product
tRNA	Trucks	DELIVERS parts that are needed to complete the product
DNA	Directions/Order	STARTS the manufacturing process
Hydrogen/Peptide Bonds	Cellophane	WRAPS the product/connects the amino acids together.

A student-generated analogy (literal similarity) by an 8th grade girl.

EDUCATIONAL MATERIALS

SCIENCE TEACHER'S GRAB BAG Reprinted in part from *NSTA Reports!*

A new three-volume series entitled *Frontiers in Astronomy and Earth Science* is now available from ATL Press. The first volume, The Comet Hale-Bopp Book, is a guidebook for junior and senior high students. It offers background information on the science of comets, highlighting the much-anticipated Comet Hale-Bopp, due in Spring 19997 and expected by many to be the comet of the century. The clothbound edition costs $42.95; paperback, $19.95 (plus $5.00 s/h). The second volume, *The CASE for Space*, a resource for elementary science courses, advocates increased public support for space exploration by demonstrating the impact of space activities on the environment, medicine, energy, and other areas. The book provides information about space-related nonprofit organizations that can aid teachers and motivate students. The book is available in clothbound for $42.95 or paperback for $19.95 (plus $5.50 s/h). The third volume in the Frontiers series, *The Earth's Shifting Axis*, a resource for geology and general science courses, examines surges in the Earth's axis and their impact on global evolution, including mass extinctions, earthquakes and volcanoes, shifting of land masses, magnetic pole reversals, and ice and coal ages. With numerous diagrams, this book is available in clothbound for $42.95 or paperback for $19195 (plus $5.50 s/h). To order the books, contact ATL Press, Inc., Science Publishers, PO Box 4563, Shrewsbury, MA 01545; (508) 898-2290; FAX (508) 898-2063; or send an e-mail message to 104362,2523@ compuserve.comm.

What's a parent to do? *Helping with Homework: A Parent's Guide to Information Problem-Solving* shows parents a tested method for helping children of all ages to learn an achieve by applying the "Big Six Skills": task definition; information seeking strategies; location and access; use of information; synthesis; and evaluation. The skills model is applied to sample assignments in science, math, language arts, social studies, and real-life situations, but it may be used in any problem or activity that requires a solution or result based on information.

This handbook costs $20 plus $3 s/h. Phone in your order to 800-464-9107; or send your name, address, and check payable to Information Resources Publications to ERIC Clearinghouse on Information and Technology, Syracuse NY 13244.

Future inventors (grades 3-6) may enjoy *A Head Full of Notions: A Story About Robert Fulton*, who had a talent for making things work and was the creator of the world's first commercially successful steamboat. The illustrated book is available in hard cover ($14.21, ISBN 0-87614-876-3) or paperback ($5.95, ISBN 1-57505-026-9). Contact Carolrhoda Books, 241 First Ave. North, Minneapolis, MN 55401; 800-328-4929; FAX 800-332-1132.

Also from Carolrhoda Books, two new titles from the Building Blocks Books series introduce young readers (K-3) to architecture and engineering through color photography and simple text. *Roads Take Us Home* explores routes from the Appian Way of Ancient Rome, To Native American wooded paths, to modern superhighways. *Bridges Connect* takes readers over, under, and around many famous bridges. Both books are available for $14.21 from the address in the previous item. (Roads-ISBN 1-57505-022-6; Bridges-1-57505-021-8.)

Educators can spark students' interest and imagination with *Cultivating A Child's Imagination Through Gardening*. Designed to enhance creativity and build literacy skills in grades K-6, 45 lessons cover a variety of gardening themes and offer hands-on activities, treat recipes, word play, and supplementary reading suggestions. Order for $19.50 from Teacher Ideas Press/Libraries Unlimited, PO Box 6633, Englewood, CO 80155; 800-237-6124. Request ISBN 1-56308-452-X.

The BioLab series of science simulation software from Pierian Spring Software includes the award-winning BioLab-Fly (formerly Mac Filly), which teaches the basics of genetics using computer-generated fruit flies; and BioLab-Frog (formerly Mac Frog), BioLab-Pig, and BioLab-Invertebrate, which feature simulated dissections. The home/school version of each title costs $49. Lab packets, building site licenses, and district licenses are available. Contact Pierian Spring Software, 5200 S.W. Macadam, Suite 570, Portland, OR 97201; 800-472-8578; http://www.pierian.comm.

Lyrical Life Science vol. 1 & 2 are award-winning sets of audio tapes and texts that teach scientific vocabulary, set to familiar old-times tunes. The texts include the lyrics and guitar chords. Reproducible workbooks are also available. The cost per set of text and tape is $19.95; per set of text, tape, and workbook, $25.50; plus $3 s/h. Contact Lyrical Learning. 8008 Cardwell Hill, Corvallis, OR 97330; (541) 754-3579.

A revised Science of Children: Resources for Teachers is now available from the National Science Resources Center and the Smithsonian Institution. Resources for Teaching Elementary School Science costs $17.95. Contact National Academy Press, 2101 Constitution Ave. NW, Lock box 285, Washington, DC 20055; 800-624-6242; http://ww.nap.edu. Request ISBN-309-005293-9.

Subscribe to *Club Humongous Gazette* for games, drawings, and jokes for grades K-3, plus a "Parents' Porch" page with tips for Mom and Dad and order forms for Mac- and Windows-compatible adventure games. Contact Humongous Entertainment, 13110 N.E. 177th Pl., Suite B101, Box 180, Woodinville, WA 98072; 800-7901-7128; http://www.humongous. com.

A revised and expanded edition of *Children's Books: Awards & Prizes* is now available. A reference book with more than 200 major domestic and international children's book award winners includes new categories. This 500 page hard cover edition of the best in children's literature costs $75 plus $3.50 s/h. To order, send check or money order payable to Children's Book Council, Attn.: Order Dept., 568 Broadway, Suite 404, New York, NY 10012; (212) 966-1990; FAX (212) 966-2073.

Eco-Inquiry, a comprehensive science curriculum, features classroom-tested lesson plans incorporating inquiry methods, activities, and cross-curricular extensions. Also included are assessment tools, resource and materials lists, and illustrated charts. The curriculum costs $29.95, plus $4 s/h for the first book and 50 cents for each additional book. Contact Kendall/Hunt Publishing Co., 4050 Westmark Dr., PO Box 1840, Dubuque, IA 52004.

Help preK-2 students get acquainted with arachnids with *Spinning a Web*, a new early science Big Book. Filled with simple text and close-up color photos of some of the more than 35,000 spider species known to scientists, the Big Book comes with a 16-page teaching guide. *Splinning a Web* and other titles are available for $14.95 each from Newbridge Educational Publishing, PO Box 1876, Murray Hill Station, NY 10156; 800-867-0307.

The Jossey-Bass Book Club for Educators has a no strings-attached policy: Unlike other book clubs they will not send you a book unless you place an order for it, and you need not commit to the number of books you will buy. For a catalog, call Jossey-Bass at 800-956-7739, ext. 776; FAX800-6052665;http://www.josseybass.com.

Taylor & Francis has new books for teaching and learning science. Request their catalog that includes the titles Creativity in Primary Science, Early Explorations in Science, Teaching Science to Language Minority Students, and Explaining Science in the Classroom. Call 800-821-8312.

A new CD-ROM from Gale, DISCovering Science, presents complex scientific concepts in simple terms and includes more than 1,000 biographies; 2,000 photographs; 1,100 glossary terms; 2,685 essays; and 1,000 periodical abstracts. View a free demonstration at Gale's web site, http://www.gale.com, or call 800-877-4253.

The Scientific 100 profiles the greatest scientists who ever lived, giving scholarly assessments of the scientists' major achievements and accurate biographical information with source notes and full bibliographies. *The Scientific 100* is available for $29.95 plus $4 s/h from Carol Publishing, 120 Enterprise Ave., Secaucus, NJ 070094; (201)866-0490.

The Future Lab series of software, including GravityLab, OpticsLab, and Series/Parallel CircuitsLab, features real-time simulations photo realistic environment, including structured laboratory exercises, built-in data sheets and lab questions, and printable lab report forms, All FutureLab simulations can be programmed with an optional switch interface and input switch designed to be run quickly and easily by physically challenged students. Available for $99 per lab plus S$10 s/h, the series can be purchased from Simulations Plus, 40015 Sierra Hwy., Bldg. B-110, Palmdale, CA 93550; (888) 266-9294; FAX (805) 266-9394;http://www.simulations-plus.com.

The teacher training seminars of Kay Toliver, made popular by the 1993 broadcast of the PBS special Good Morning Miss Tolilver, are now on video. Part of a new staff development program called "Teacher Talk," the four videos include unrehearsed footage from Toliver's East Harlem classroom demonstrating practical and easily implemented teaching strategies, activities, and lesson plans. Episodes include Hands-On Math; Mathematics and Communication; Oobleck (from the Dr. Seuss book, a lesson that combines literature, the scientific method, and imagination); and the Math Trail. "Teacher Talk" also comes with a 60-page binder of comprehensive staff development guides that turn each episode into a half-day workshop. The four videos and guides cost $295 plus s/h. Contact FASE Productions, 4801 Wilshire Blvd., Suite 215, Los Angeles, CA 90010; 800-404-FASE; FAX (213) 937-7400; e-mail fasenet@aol.comm.

Seek, find, catch, prepare, and arrange insects to learn about nature with Science with Insects: Pathways to Discoveries and Adventures, a half-hour video for grades 4-ll that teaches about insect pins, relaxing jars, points, labeling, positioning wings, and more. To order, send $39.50 plus $3.95 s/h to Cricket Science, PO Box 6123, Pocatello, ID 83205; or call (208) 232-5548 for more information.

With a StudyWorks CD-ROM— one for science, one for math— students can generate equations with a tool resembling a scientific calculator, edit them, apply different data, and reposition them on worksheets. The CD-ROM also holds a library of hundreds of formulas, tables, and facts in the high school and college curricula. A web browser included the product takes students directly to MathSoft's web site, which has math and science resources, puzzles, discussion groups, and more. Partial access to the web site is permitted through http://www. mathsoft.comm/studyworks. Order StudyWorks ($39.95) on-line, or look for it in major computer retail outlets.

What We Know About: Classroom Management To Encourage Motivation and Responsibility, published by the Educational Research Service (ERS), looks at the many ways teachers can create a productive classroom and enhance learning. Topics include establishing order; helping students develop self-management skills; responding to misbehavior; promoting parental involvement; and implementing a school-wide approach to discipline Purchase it for $18, plus the greater of $3.50 or 10 percent of the total sale for s/h. Order from ERS, 2000 Clarendon Blvd., Arllington, VA 22201; (703) 242-2100; FAX (703) 243-5971.

MECC's interactive science software programs involve students in the learning process and emphasize a conceptual understanding of science processes, principles, and concepts, not just rote memorization of isolated facts. Programs include Odell Down Under, in which kids in grades 3-12 become fish looking for food and avoiding predators in Australia's Great Barrier Reef; Miner's Cave, an experiment in machines—pulleys, levers, ramps, and wheels—and Wood Car Rally, which examines elements of force and motion, both for kids in grades 3-9; BodyScope, a discovery tool for life science (grades 3-8); and Mystery Objects, in which kids in grades 2-4 use "Data Snoopers" to determine the identity of objects by testing for physical properties. Call 800-215-0368 for a catalog and ordering information.

Available from the American Association for the Advancement of Science (AAAS) is *Resources for Science Literacy: Professional Development*, a two-part CD-ROM to help educators prepare their work in the classroom and make the best use of *Benchmarks, Science for All Americans*, and the National Science Education Standards. The resource contains references; workshop activities; research; analyses; and course plans to illustrate science literacy an its application to K12 science education. The CD-ROM and 120-page text are available for $39.95 from Oxford University Press, Order Dept., 2001 Evans Rd., Cary, NC 27513; 800-451-7556

The three volumes of *Astronomy & Space: From the Big Bang to the Big Crunch* contain more than 300 entries focusing on the people, places, and events associated with space study, gleaned from the latest, most current sources. Recommended activities for students and a bibliography of sources for teachers are included. Order from UXL for $79.95 (ISSBN 0-7876-0942-0) by calling 800-877-4253 or see http://www.gale.com/gale.html.

BRANCH

The National Newsletter of Project Learning Tree

PLT

SCIENCE KIT RENTAL PROGRAM

The Museum of Science in Boston has developed 18 Science Kits as part of their Science Kit Rental Program. These hands-on kits can be shipped anywhere in the US, used for five full weeks, and then shipped back to the museum. Each kit contains a teacher's guide, manipulative, books, and other materials to allow students to fully investigate a topic. Kit topics include the earth, natural and physical sciences and are suitable for grades K-8. For a descriptive brochure, rental fees, and an inventory and activity guide, call (800) 722-5487 or visit the web site at: .

TWO SIDES OF FIRE

The Temperate Forest Foundation has developed a 15 minute informational video on the role of fire in a forest ecosystem. Videos are available for $15 for orders of 1-4, $12 for orders of 5-9, and $10 for quantities of ten or more. For ordering information, please contact the Temperate Forest Foundation at 14780 SW Osprey Drive, #355, Beaverton, OR 97007; phone (503) 579-0300; web site: http://www.forestinfo.org

CHLORINE CHEMISTRY EDUCATION

Try using Chlorine and Chlorine compounds as a way of introducing your students to building block chemistry without tackling the whole periodic table at one. The Chlorine Chemistry Council can help by providing assorted activities and materials. For more information contact: Chemistry Education Program, 1901 L Street, NW, Suite 300, Washington, DC 20036; (202) 452-9493. See also the sample activity on page 6.

BANANA SLUG STRING BAND

Having students learn about the environment, science and ecology through music, movement, theater, and puppetry is what the Banana Slug String Band is all about. This musical group had 5 recordings (CD and cassette) available for educators. Songbooks and a full length video, DANCING WITH THE EARTH, accompany each recording. Or you can see them perform live by booking them for your next school assembly or teacher workshop. For ordering recordings contact: Banana Slug String Band, PO box 2262, Santa Cruz, CA 95063; (408) 476-5776, or for booking information call (408) 423-7807.

GRANTS AND GRANT WRITING HELP AVAILABLE

The Eisenhower National Clearing house (ENC) has an entire section devoted to grant opportunities. Their "Professional Resources Section" lists Federal and non-Federal grants, links to grant databases, tips on how to write grants, and lists of places and descriptions of programs that fund educational projects. If interested, log onto: http://web.fie.com/cwa/sra/resource.html

ADDITIONAL RESOURCES

Ant Homes (Teacher's Guide for Grades PreK/K-1 • Life Science), produced and distributed by the Great Explorations in Math and Science (**GEMS**) program at Lawrence Hall of Science, UC Berkeley. The guide contains instructions for direct observation of ants in nature and an ant farm, role playing, cooperative games, art, and strong math connections. A large Ant Nest Poster is included. 116 pp; $15 + $4 sh/h. Order from: GEMS, Lawrence Hall of Science, University of California, Berkeley, CA 95720-5200; (510)642-7771; fax (510)643-0309. Ask for their free catalog!!

Science for Kids launches 10 new children's edutainment **CD-ROM** titles designed for the budget software markets. Each title is a hybrid (Win/Mac) CD-ROM targeted to kids 3-12 years of age and priced at no more than $12.95. Packaging options, including the unique Science for Kids Build-Your-Own™ Multipaks, are available for custom quantity orders. The 10 edutainment titles are: Water!Colors (Ages 3-7); The Water Planet (Ages 5-9); Jimmy Saves the Day! (Ages 3-8); Water Wonder (Ages 6-12); The Learning Arcade: Maps & Globes (Ages 8-15); Amazing Machines (Ages 6-10); The Mystery of Tooltown (Ages 8-14); The Machines Expo (Ages 7-11); CELL Search (Ages 7-11); The Great Search (Ages 5-10). For more information, contact Science for Kids at (910)945-9000 or fax at (910)945-2500.

Free: Harmony Action Packet (K-12) provides information and resources on our nation's natural resources of soil and water. Includes posters and student worksheets. Free. 1995. USDA Natural Resources Conservation Service, Office of Public Affairs, P.O. Box 2890, Washington, D.C. 20013-2890; (800)THE-SOIL.

Insights & Outcomes ($25 + $4 sh/h) is an essential handbook for evaluating the effectiveness of activity-based science and math programs. **Math Around The World** ($24 + $4 sh/h) is a teacher's guide of classroom activities for grades 5-8, based upon mathematics games from around the world. Publications and a free catalog may be ordered from **GEMS**, Lawrence Hall of Science, University of California, Berkeley, CA 94720-5200; (510)642-7771.

Learning About Learning (Teacher's Guide for Grades 6-8 • Life Science), produced and distributed by the Great Explorations in Math and Science (**GEMS**) program at Lawrence Hall of Science, UC Berkeley. The guide contains 10 sessions packed with unique activities that help students gain insight into their own learning. Using the actual work and processes of real scientists, students cross many disciplines and explore key concepts such as learning, health and safety, product testing, animal behavior, ethics, the nervous system, and the brain. 220 pp; $15 + $4 sh/h. Order from: GEMS, Lawrence Hall of Science, University of California, Berkeley, CA 95720-5200; (510)642-7771; fax (510)643-0309. Ask for their free catalog!!

The National Women's History Project distributes resources featuring women in math and science. For their free catalog, contact the National Women's History Project, 7738 Bell Road, Dept. P, Windsor, CA 95492-8518; (707)838-6000.

Secret Formulas (Teacher's Guide for Grades 1-3 • Physical Science), produced and distributed by the Great Explorations in Math and Science (**GEMS**) program at Lawrence Hall of Science, UC Berkeley. The guide contains instructions for popular activities that fill the need for primary level, hands-on physical science. Students investigate the properties of substances and build comprehension of cause and effect. 160 pp; $15 + $4 sh/h. Order from: GEMS, Lawrence Hall of Science, University of California, Berkeley, CA 95720-5200; (510)642-7771; fax (510)643-0309. Ask for their free catalog!!

Stories In Stone (Teacher's Guide for Grades 4-9 • Earth Science), produced and distributed by the Great Explorations in Math and Science (**GEMS**) program at Lawrence Hall of Science, UC Berkeley. The guide contains original earth science activities using actual specimens and inventive clay models. Classification of real rocks and minerals, experiments with crystals, and landform simulations lead to a deeper understanding of rock formation, plate tectonics, and rock cycles. 156 pp; $15 + $4 sh/h. Order from: GEMS, Lawrence Hall of Science, University of California, Berkeley, CA 95720-5200; (510)642-7771; fax (510)643-0309. Ask for their free catalog!!

The Textbook League, an organization providing expert reviews of schoolbooks and other curriculum materials, produces their bimonthly bulletin, *The Textbook Letter. The Textbook Letter*, renowned for its outspoken reviews, its articles about schoolbook affairs, and its warnings about phony "textbooks" and fake "classroom videos," can be found on their Web site: http://www.csulb.edu/~ttl/index.htm.

Free: Things We Can Learn From a Cow and a Worm—a colorful educational poster with activities that cattle and earthworms play in our environment and natural recycling. 5th and 6th grade teachers may obtain a free copy of the poster by sending a letter written on school stationery to: National Cattlemen's Beef Association, Education Department, 444 No. Michigan Avenue, Chicago, IL 60611.

Free: Transforming Ideas for Teaching and Learning Science Education, by the U.S. Department of Education, contains 10 expanded ideas that can enhance your science classroom. Free. Write to the U.S. Dept. of Education, OERI Educational Information, 555 New Jersey Ave., NW, Washington, DC 20208. Publication #065-000-00599-9.

ILLINOIS SCIENCE TEACHERS ASSOCIATION
SECOND ANNUAL SCIENCE IN THE SOUTH CONFERENCE
SOUTHERN ILLINOIS UNIVERSITY AT CARBONDALE
FRIDAY, MARCH 13, 1998

CALL FOR PAPERS

Any science-related topics that would be of interest to K-12 science teachers. Hands-on, applied, and activity-oriented sessions/workshops would be preferred.

DEADLINE FOR SUBMISSION: POSTMARKED BY OCTOBER 22, 1997

Complete (print or type) a form for each workshop. This form may be duplicated.

Principal presenter:

Name______________________________________

Affiliation/School______________________________

Mailing Address________________________________

City, State, Zip_________________________________

Day phone_(_____)______________________________

Evening ___(_____)______________________________

Total Number of presenters_______.

Additional presenter(s) should be listed with all of the above information on back.

Check time preferred: _______ 50-minute session _______ 70-minute workshop

Title of Presentation____

Program Description (exactly how you want it to appear) 30 word maximum:

____

____

____

____

____

Check the Intended Audience: (any or all) ___K-3, ___4-6, ___7-8, ___9-12, ___ Administration

In order to minimize costs, presenters are encouraged to bring their own equipment when possible. Audio Visual Equipment required:____

____

SAFETY: Will you be using chemicals or hazardous materials? _____ If yes, please describe:

____

Principal presenter will receive a complimentary registration and lunch. Additional presenters will receive a complimentary registration but will pay a $10.00 fee for lunch.

Signature______________________________________ Date__________________

Return to: Sandy Rhoads
Division of Continuing Education
Mailcode 6705
Southern Illinois University
Carbondale, IL 62901

(618) 453-5679
FAX: 618-453-5680

INTERESTED IN CONTRIBUTING TO THE ISTA SPECTRUM?

SPECTRUM welcomes contributions from its readers. Won't YOU submit some of your GOOD IDEAS for one or more sections of the SPECTRUM?

ARTICLES
- Thought provoking ideas or commentary about science or science education
- Original research/curriculum development
- Reports of relevant personal experiences

IN FOCUS
IN FOCUS appears in every third issue of SPECTRUM. Topic is chosen by the editorial staff. Submissions are invited.

SPECIAL INTEREST
- Important news for specific audiences
- News from other science organizations

MINI IDEAS
- Instructional pieces
- Demonstrations
- Lab activities
- "Grabbers"

OPPORTUNITIES
Activities for professional and/or student involvement

REVIEWS
Your reaction to science-related books, films, audio-visuals, computer programs, curriculum materials, etc.

MEETINGS
Business and pleasure gatherings for science educators

AWARDS/RECOGNITION
Any legitimate honor bestowed upon educators or students of science

POTPOURRI

FIELD TRIPS/WORKSHOPS
Any relevant offerings by not-for-profit organizations

EDUCATIONAL MATERIALS
Free or inexpensive items offered by not-for-profit organizations

SUBMISSION DEADLINES

Fall	June 1 (to members in September)
Winter	September 1 (to members in December)
Spring	December 1 (to members in March
Summer	March 1 (to members in June)

GUIDELINES FOR SUBMISSIONS
- Copy should be typed or word processed in double-space format. SPECTRUM accepts word processed submissions on disk in either, Macintosh, or IBM format. All submissions on disk should be accompanied by a printed copy.
- Line drawings, glossy black and white photos and/or computer generated graphics are welcome. Receipt of all submissions to ARTICLES, IN FOCUS, MINI IDEAS, REVIEWS and POTPOURRI will be acknowledged by the associate editor.
- Submitted items, including computer disks, will not be returned unless accompanied by a self-addressed, stamped envelope.

YES, I WOULD LIKE TO CONTRIBUTE TO THE ISTA SPECTRUM

I have a good idea that I'd like to share!

Name: ____________________

School or (name) ____________________

Business: (address) ____________________

(city, state, ZIP) ____________________

(telephone) (___) __________

Home: (address) ____________________

(city, state, ZIP) ____________________

(telephone) (___) __________

Title of Contribution: ____________________

I would like may article to appear in:

___ARTICLES
___IN FOCUS
___SPECIAL INTERESTS
___MINI IDEAS
___REVIEWS
___POTPOURRI
___OPPORTUNITIES
___MEETINGS
___AWARDS/RECOGNITION
___FIELDTRIPS/WORKSHOPS
___EDUCATIONAL MATERIALS

Please print my contribution in the following issue(s):

___**Fall** (due June 1)
___**Winter** (due September 1)
___**Spring** (due December 1)
___**Summer** (due March 1)

SPECTRUM welcomes black and white glossy photographs. We can sometimes use color pictures but they must be sharp with high contrast. Please enclose a stamped self-addressed envelope if you want your photos returned.

ISTA REGIONAL DIRECTORS

REGION II
Steve Chelstrom
Orion Middle School
800 12th Avenue
Orion, IL 61273
309-526-3392

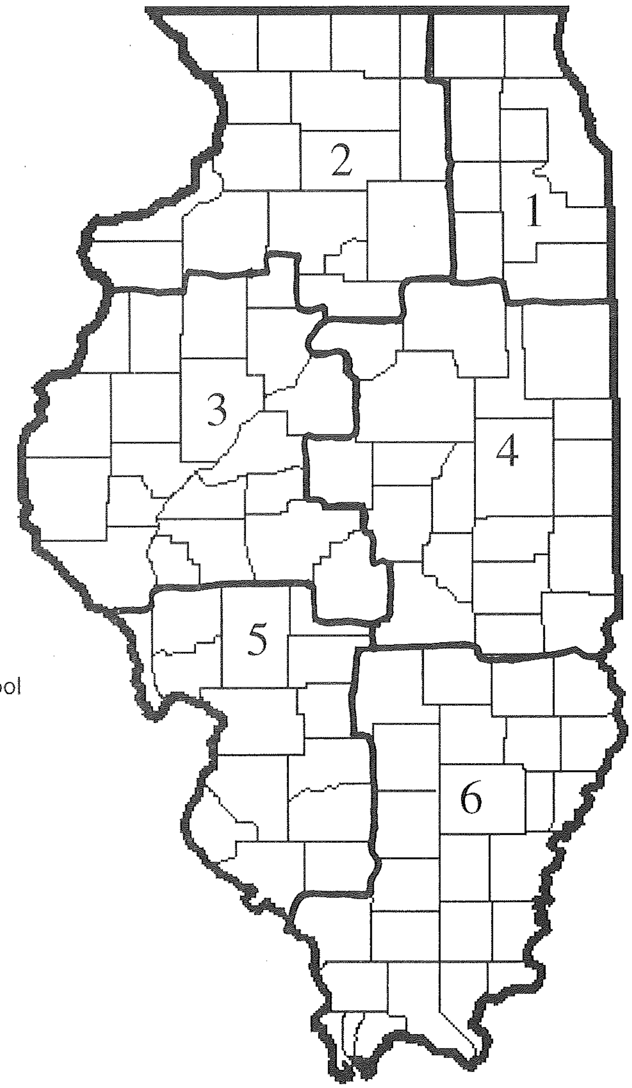
Karen Meyer
Ridgewood Elementary
9607-14 Street West
Rock Island, IL 61201
(309)793-5980
MsKMeyer@aol.com

REGION III
Don Powers
Science Education Center
Western Illinois University
Macomb, IL 61455
(309)298-1258
FAX (309)298-2222
dpowers@ccmail.wiu.edu

Susan Grzanich
Calvin Coolidge Middle School
2708 W. Rohmann Avenue
Peoria, IL 61604
(309)672-6506
SGRZ0209@aol.com

REGION V
Pam Keck
SIU-Edwardsville
Box 1652, Chemistry
Edwardsville, IL 62026
pkeck@siue.edu

Deborah Clinebell
Waterloo Jr. High School
200 Bellefontaine Drive
Waterloo, IL 62298
dclinebe@htc.net



REGION I
Sylvia Gilbert
Rogers Elementary School
7345 N., Washtenaw
Chicago, IL 60645
773-534-2132
sgilbert@megsinet.net

REGION IV
Marilyn Sinclair
Curriculum & Instruction
University of Illinois
1310 S. Sixth Street
Champaign, IL 61820
m-sincl@uiuc.edu

Georgiean Benson
Washington School
100 W. Jefferson
Monticello, IL
gbenson@net66.com

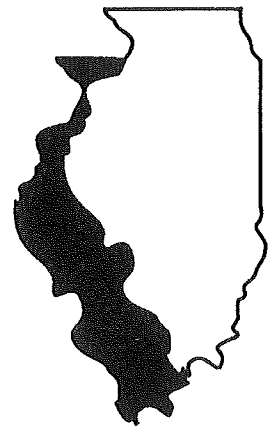
REGION VI
Deborah K. Clark
Benton Middle School
1000 Forrest Street
Benton, IL 62812
(618) 438-4011

Suzanne Asaturian
Carbondale Comm. H.S.
200 N. Springer Street
Carbondale, IL 62901
(618) 457-3371 x 242
FAX (618)549-1686
sasaturian@cchs165.jacksn.k12.il.us

Listing of Counties Comprising Each ISTA Region

Region I	McHenry, Lake, Kane, Cook, DuPage, Kendall, Will, Grundy, Kankakee
Region II	Jo Daviess, Stephenson, Winnebago, Boone, Carroll, Ogle, DeKalb, Whiteside, Lee, Rock Island, Henry, Bureau, LaSalle, Putnam, Marshall, Mercer
Region III	Henderson, Warren, Knox, Stark, Peoria, Hancock, McDonough, Fulton, Tazewell, Schuyler, Mason, Adams, Brown, Cass, Menard, Pike, Scott, Morgan, Sangamon, Christian
Region IV	Woodford, Livingston, Ford, Iroquois, McLean, Logan, DeWitt, Piatt, Champaign, Vermillion, Macon, Shelby, Moultrie, Douglas, Edgar, Coles, Cumberland, Clark
Region V	Calhoun, Greene, Macoupin, Montgomery, Madison, Bond, St. Clair, Clinton, Monroe, Washington, Randolph, Perry, Jersey
Region VI	Fayette, Effingham, Jasper, Crawford, Marion, Clay, Richland, Lawrence, Wayne, Edwards, Wabash, Jefferson, Franklin, Hamilton, White, Jackson, Williamson, Saline, Gallatin, Union, Johnson, Pope, Alexander, Pulaski, Massac, Hardin

ILLINOIS SCIENCE TEACHERS ASSOCIATION
MEMBERSHIP APPLICATION



NAME ______________________________
LAST FIRST

DATE ____________________ REGION (SEE MAP) ______

HOME ADDRESS ______________________________
STREET APT. NO.

____
CITY STATE ZIPCODE PHONE FAX/EMAIL

EMPLOYER ADDRESS ______________________________
STREET

____
CITY STATE ZIPCODE

(HOME ADDRESS WILL BE USED UNLESS OTHERWISE SPECIFIED)

PROFESSIONAL ASSIGNMENT ELEMENTARY _____ JUNIOR HIGH _____ HIGH SCHOOL _____
COLLEGE _____ OTHER _____

REGULAR MEMBERSHIP **$25.00**

ASSOCIATE MEMBERSHIP (RETIREES AND FULL TIME STUDENTS) **$15.00**

SEND FORM WITH CHECK OR MONEY ORDER MADE OUT TO ILLINOIS SCIENCE TEACHERS ASSOCIATION TO:

DIANA DUMMITT
ILLINOIS SCIENCE TEACHERS ASSOCIATION
COLLEGE OF EDUCATION
UNIVERSITY OF ILLINOIS
1310 S. SIXTH STREET
CHAMPAIGN, IL 61820

ISTA SPECTRUM
UNIVERSITY OF ILLINOIS
COLLEGE OF EDUCATION
1310 S. SIXTH STREET
CHAMPAIGN, IL 61820

NON-PROFIT ORGANIZATION
U.S. POSTAGE PAID
CHAMPAIGN, IL 61820
PERMIT #75

*******AUTO**3-DIGIT 625 180 27
GARY L. BUTLER
420 S TOWER RD
DAWSON IL 62520-3392

1. The students are impressed with people on the "cutting edge" of physics applications;
2. The students get to see that physics has many practical applications. They also learn that physicists are not "gray beards in ivory towers" – and they learn about the most current research;
3. Option to challenge those that have a keen interest. You are able to do things we cannot;
4. The Everyday Physics section is excellent;
5. Allows students to learn about current topics from "real" scientists and to see scientists and what they do;
6. Exposure to current topics by people working in them;
7. Exposure to modern topics and chance for students to hear presentation from someone besides daily instructor;
8. They can ask questions of people who are experts in the field;
9. Enrichment alternative for advanced students;
10. Giving gifted students topics often not covered in class, "interest getting" of introductory labs.

There were very few recommendations for changes, despite the fact that several questions explicitly invited these. One teacher suggested the "need to add an informal reception after lectures to allow students to interact with presenter and each other." The biggest problem related to scheduling. As one teacher, said, "Scheduling conflicts constantly arise. We have so many different organizations with so many various events it would be nearly impossible to schedule without conflicts."

Interviews with Teachers

We randomly selected a set of ten teachers for in-depth interviews. The fact that 18 of 24 attendees at one session volunteered to be interviewed is one indication that most saw some value to the program, and the consistency of responses suggests that our interviews did identify issues of common perception among the teachers. It should be noted that there may have been systematic differences between the interview volunteers and others. It is also worth noting that the preliminary response form especially encouraged complaints: "Please let us know what you found to be the high points and low points of the workshop. Do you have any specific suggestions for improvement?"

One teacher who did not wish to be interviewed wrote this on the response form in place of the contact information that would have indicated willingness to be interviewed:

> I am not involved in this field even remotely. I came out of personal interest and growth......I was very impressed with the high level of organization, great hand-outs which matched overheads and can be re-used, and good delivery of speaker. Excellent!

Reactions to Physics Outreach

The interviews revealed generally positive and often surprising responses from the teachers. Like those who responded to the survey, they were very positive about the benefits to themselves and their students from the program. This is noteworthy, in that we were able to follow-up with questions seeking to identify things they did not like.

Desire for more outreach programs. A universal response was that teachers wanted more opportunities like this. For example, the session on Operation Physics highlighted the fact that they would like the Operation Physics summer workshop to be held locally. Every interviewee thought that aspects of the program they were familiar with should be expanded and offered to more teachers, more often.

Responses of non-science teachers. One striking and somewhat surprising result was that non-science teachers seemed to derive much of value the program. For example, a former Drama teacher who now teaches Kindergarten thought that the Physics Van was extremely valuable to both herself and her students. A middle-school English teacher said that the Particle Zoo presentation (part of the Physics Honors Program) was important to her professionally, because it validated her sense of herself as one who can learn new things. She also saw connections between the inquiry process in physics and the writing process she teaches to her students. On her response form she had written:

> I am a lay person – an English teacher – with an abiding curiosity in science (a Ph. D. son in genetics) and "Zen physics" (*The Dancing Wu Li Masters*) sort of knowledge about quantum mechanics. This was an *outstandingly* clear (though *fast*) presentation that helped to fill in gaps in my knowledge gained through occasional "NY Times" Science pages and "Scientific American." Thank you!

Intellectual stretching. A related point is that nearly every teacher commented that they liked being stretched intellectually. It appears that the Outreach Program provides a source of intellectual stimulation for teachers that is sometimes lacking in their day-to-day work activities. This general intellectual stretching result was not one that we had anticipated. In fact, the teachers almost seemed embarrassed to bring it up, focusing initially on direct curricular implications. But it was clear to us that more general benefits were important as well. As an example, one teacher wrote on the response form at the Particle Physics workshop:

> [It was] very well organized and presented. Not my field of study, but I feel I learned and got an overview of the current research. I especially liked having a presenter that is doing cutting edge/state of the art research.

One teacher talked about the value of collaborative problem solving in the Operation Physics workshop, for herself, not just as a teaching technique:

> I remember spending a lot of time thinking about multiple circuits and how to get them to work so that you got the effect. And I really enjoyed that. We really had to think. We had to think not only about how the circuits would work, but what materials to use. But, it was fun to tinker at the time. And it was very nice to have other people tinkering with me at the same time, sharing ideas, sitting and saying, "These people don't know what they're doing," then suddenly I