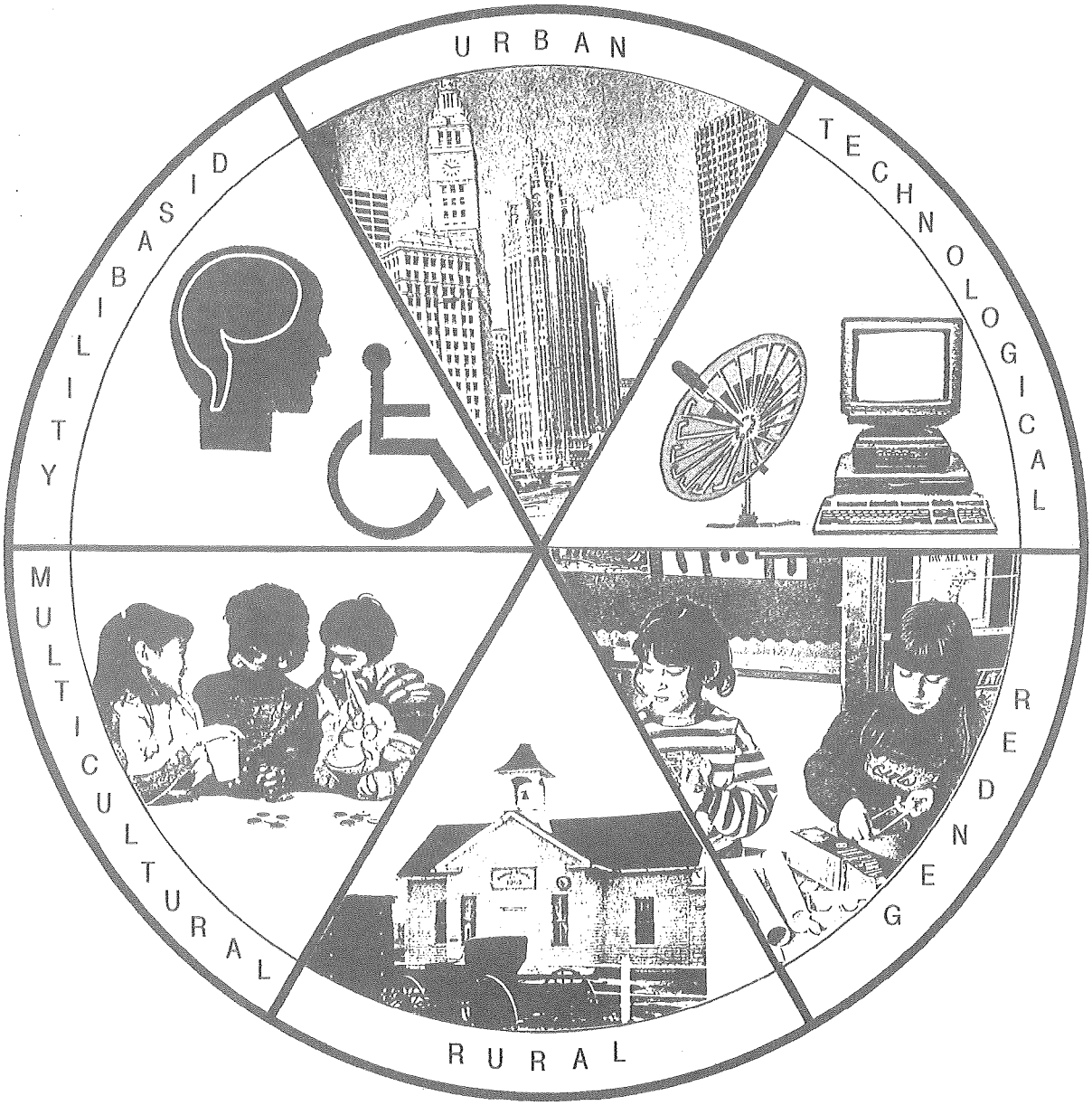
SPECTRUM

THE JOURNAL OF THE ILLINOIS SCIENCE TEACHERS ASSOCIATION

THE FACES OF EQUITY IN SCIENCE EDUCATION



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ISTA NEWS

SCIENCE IN THE SOUTH

JANUARY 24, 1997

General Information

The conference is being held on Friday, January 24, 1997 in the Southern Illinois University Student Center. Registration will begin at 8:00 am in the Gallery Lounge. The program will begin with concurrent sessions from 9:00 am until 12:10 pm when lunch begins. The program will conclude at 2:00 pm after lunch and the keynote presentation.

Registration

The $35.00 registration fee includes conference materials refreshments, lunch, and 1997-98 ISTA membership. Onsite registrants are welcome — we will try to accommodate you for the luncheon.

Exhibits

Educational and technological vendors will be on hand to present the latest innovations.

Program

Over fifty concurrent sessions and workshops are scheduled. Each session or workshop is targeted for a particular grade level. There are programs for K-3, 4-6, 7-8, and high school. Many hands-on workshops are also scheduled on diverse topics such as health, environment, telecommunications, microbiology, hydroponics, chemistry, entomology, and use of the Internet.

Luncheon

Southern Illinois University at Carbondale Chancellor Dr, Donald L Beggs will welcome teachers to the luncheon. ISTA Presidential Awardees Mary Sue Kerr, Washington School, Belleville, and John Baird, Quincy High School, will share their successes and tribulations.

Don't miss this opportunity to meet other science teachers and learn new methods for making science interesting to all your students. For more information about the conference contact the Division of Continuing Education at (618)536-7751

Name _____ SS# _____

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Registration Fee: $35 Hydroponics Workshop: $45 Make Checks Payable to SIUC I am Enclosing $_____

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EQUITY IN SCIENCE EDUCATION

All photos in this section are provided courtesy of Rosamond Hilton and were taken during the 1996 ISTA Convention at the Merchandise Mart, Chicago.

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Earlier this year, we introduced in the *Spectrum* a new intermittent feature: invited papers. The first was written about constructivism by Dr. Robert Yager of the University of Iowa. As the editorial staff deliberated about initiating an invited paper feature, our discussion led to also trying our hand at thematic issues from time to time. This *Spectrum* represents our first effort in putting together such an issue, with the theme focusing on equity issues in science education. This theme arose as a result of the submission of a manuscript on gender issues in the science classroom. That article appeared in the Fall 1996 issue ("Subtle Biases in Science Classrooms: Prescription for Change," by Becky Meyer Monhardt). We felt the topic important enough to expand upon, but we did not wish to delay printing that particular article. Consequently, this thematic issue of this *Spectrum* is largely comprised of short invited papers dealing with various facets of equity (more on that later). Our desire is to plan future thematic issues, perhaps one per year, and announce them enough in advance that we can build those issues from reader submissions rather than relying on invited papers. Most likely, we will construct thematic issues with a mix of reader submissions and invited papers. At the present time, we are announcing the next thematic issue for summer 1997 on inclusion issues in science teaching. Since it takes us about six months to put together a thematic issue, the submission deadline is **January 27, 1997**.

CALL FOR PAPERS!!

The editor of the Spectrum invites all interested persons to submit manuscripts for thematic issues of the journal. Following are the themes for each issue and due dates for submissions. Please let us hear from you!

1997 (TBA)
Inclusion Issues in Science Teaching
Submission Deadlline: January 27, 1997

1997/1998 (TBA)
Environmental Issues in Science/Science Teaching
Submission Deadline: June 1, 1997

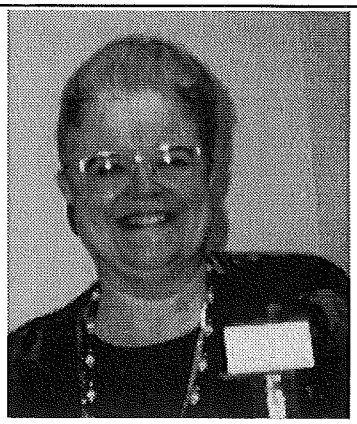
Submissions can be made directly to the editor, Kevin Finson via U.S. mail (Department of Elementary Education and Reading, Western Illinois University, Macomb, IL 61455
e-mail (Kevin_Finson@CCMAIL.WIU.edu)
OR to Diana Dummitt (U.S. mail at 110 Education Building, 1310 S. 6th Street, University of Illinois, Champaign, IL 61820 orddummitt@uiuc.edu).

We'd like to hear from you concerning your thoughts on all of this. Do you desire thematic issues? If so, what themes would you like us to pursue? How often should the *Spectrum* do a thematic issue? Remember, this is your journal. We are striving to improve it and make it more useful for you. If we miss the mark, let us know. You can contact either Diana Dummitt or me at the addresses listed on the inside front cover.

Now, about this equity stuff. What is equity? Why should we be concerned with it? At its basic level, equity means making the playing field more level for everyone. It does not necessarily mean "dumbing down" the curriculum or making things simpler. True equity involves challenging learners, but challenging them in ways they can grapple with the problems presented. Imagine for a moment that you suddenly found yourself placed in a classroom in Russia, but you could only speak English. Would you be at a disadvantage? Your likely poor performance on classroom tasks would reflect a problem with language differences more so than your knowledge and skill levels

Often, we tend to limit our thinking of equity issues to gender or race. As this issue of the *Spectrum* illustrates, equity has many more facets of which we should be aware. Although we simply do not have the space to deal with every facet of equity, we've included some notable ones for you in this issue: gender, ethnicity (multicultural), urban and rural, disabilities, and technological. As noted in the paragraph above, language (both English/non-English and scientific jargon level) is another facet of equity, as are culture, class, etc. If we as science educators wish our students to succeed at their highest potential, then we must be cognizant of both subtle and not so subtle ways we make science more difficult than it need be. We need to consider where our students are (pedagogically), where they came from (educationally), and how we can best enable them to learn and succeed with science.

Mary M. Atwater
The University of Georgia



EQUITY AND MULTICULTURAL SCIENCE EDUCATION: WHAT'S THAT ALL ABOUT?

Introduction

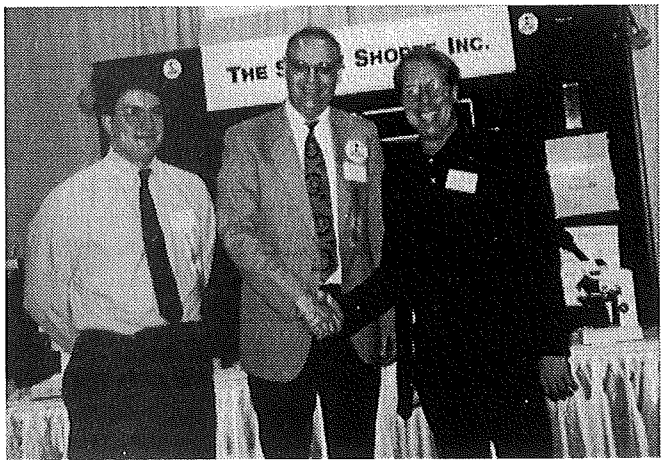
If K-12 science teachers are to follow the national science education standards, then many of them will teach differently in classrooms so that more meaningful science learning can occur (National Research Council, 1996). Presently, many teachers interact with students who look different from the teacher and each other, speak differently, view the world differently, hold different values, beliefs, and ideas, and think differently. Other science teachers look at their students and view them as belonging to a regionally homogeneous group that will need the knowledge and skills to interact with people from all over the world.

Equity is one of the many educational issues that science teachers must consider when planning, presenting, and assessing their instruction. Equity is defined generically as "the quality of being fair or impartial"; in legal terms it means "the application of the dictates of conscience or the principles of natural justice to the settlement of controversies" or a system of jurisprudence or a body of doctrines and rules developed in England and followed in the United States, serving to supplement and remedy the limitations and the inflexibility of the common law (*Webster's Encyclopedic Unabridged Dictionary of the English Language*, 1989, p. 482). According to Secada (1994), there are two types of justice. One kind is based on written laws and codified ordinances; the other one is unwritten. Equity, one of the unwritten justices, goes beyond written laws or codified ordinances and takes care of defects in the law to promote justice. If equity is about justice, then what is equality?

Equality is the state of equal; corresponding in quantity, degree, value, rank, ability, etc. (*Webster's Encyclopedic Unabridged Dictionary of the English Language*, 1989, p. 481). To be equal can also mean "evenly balanced or proportioned" (p. 481). Hagopian (1994) believes that equality exists in a polyethnic and a multicultural society when cultural and ethnic groups are valued positively, are insured fundamental conditions of protection and services which enable them to develop their full abilities, and actually have unimpeded chances to vie for positions of power and class that fashion the conditions of life. For example, the same number or percentage of students from the various ethnic and cultural groups will be found in the various science tracks in classes if equality is to be maintained.

In order for different cultural and ethnic groups to be equal, these groups must have access to the same amount of power. The unequal distribution of power leads to the oppression of one group over another. Young (1992) explicated the five faces of oppression which is the employment of control or power in a distressing, cruel, biased, or unjust manner. Oppressed groups of people are unable to develop and enhance their abilities and to voice their wants, thoughts, and feelings in meaningful ways. One can oppress another group through (1) exploitation, (2) marginalization, (3) powerlessness through differential status of groups, (4) cultural imperialism as it relates to structures, institutions, and resources, and (5) violence and intimidation.

According to Secada (1994), educational equity refers to "scrutiny of social arrangements that undergird schooling to judge whether or not those arrangements are consistent with standards of justice" (p. 22). Thus, equity is a concept that is involved in the continuing dialogue of multicultural science education. Multicultural science education is a field of disciplined inquiry devoted to the development of policies and practices so that all students have the opportunity to learn quality science. Multicultural science educators investigate issues related to class, culture, disability, ethnicity, language, life styles, race, power, discrimination, and oppression (Atwater, in-press). This article will focus on the issues related to the instructional policies and practices of science teachers that influence students' opportunities to learn quality science.



Equity Issues Related to Science Teaching and Learning

Science teaching is a very complex endeavor, and its complexity escalates as the diversity in students increases. Even if teachers perceive that there is little diversity among their students, teachers still have the awesome task of attempting to prepare these students to function in the 21st century in which science, technology, information, and culture will have a daily impact on their occupational and personal lives. Lynch, Atwater, Cawley, Eccles, Lee, Marrett. Rojas-Medlin, Secada, Stefanich, and Willetto (in press) have delineated seven issues that science teachers must consider in providing all students an equitable opportunity to learn quality science. They include the following: social forces including world views and culture; allocation of educational resources (human and material); students, their families and communities; school and classroom organization; science curricula; pedagogy; and assessment and evaluation. The author will focus her discussions on the first two issues.

Social Forces IncludingWorld Views and Culture

Curriculum and instructional theorists emphasize the impact of social forces on a community's or nation's educational system. Both voluntary and involuntary immigration has changed the complexity of science education in this country. The long-held European American tradition of individualism and meritocracy have helped mold this nation's educational system. Several groups of people who have succumbed to the barriers and obstacles have been deemed by many as incapable of learning science. It is well documented that females and people of color (Blacks, Latinos, Native Americans, and some Asian groups) take fewer courses in science and mathematics; however some of these groups like Blacks have a more positive attitude toward science than Whites. When teachers are faced with this trend they can either take a proactive role or maintain the status quo. One White science teacher who taught in a rural high school whose student population was 52% Black took a proactive role for physic classes. She recruited two Black male students to her physics class so they could experience success as did their White counterparts. Both students were successful and continued their science studies in college.

Many science teachers believe that students must speak English well in order to understand scientific concepts. Therefore, few are aware of techniques to assist these students in learning science. A high school science teacher acknowledged the Spanish background of her students by attempting to say good morning to the two Mexican-American students in her classroom; however, she did not attempt to have these students answer questions in class even when they raised their hands and did not encourage these students' interactions with the other White students in class. The Mexican-American student population was increasing in this teacher's school because of the poultry industry; but the school system did little to help its science teachers to learn ways to provide these students with the opportunity to learn quality science.

Female students and students of color are many times considered intellectually inferior in scientific reasoning and share common coping and passive-resistance mechanisms: silence, accommodation, ingratiation, evasiveness, and manipulation (Maher, 1987; Fordham, 1993). Science teachers can help their students to discern methods of oppression and understand the idea that society is a mental construction, not an immutable reality: so that students can act to change those constructions. By acting on their science knowledge and skills, students learn more about the complexities of society and themselves (Giroux, 1986).

How do we get more of the existing science teaching force to understand the social forces impacting on science education and respond in a just manner? And even a more daunting question is how do we educate future K-12 science teachers to understand these social forces and fight against the negative social forces so that their students will learn quality science?

Allocation of Resources (Human and Material!)

In order for students to learn science, they must do science! Consequently, science students need teachers who understand science principles, laws, and theories and are able to apply their understanding to real life problems. In addition, these teachers must understand their students as developing human beings who are influenced by culture, language, disability, and class. Teachers must value all of their students and believe that their students can learn quality science if they are going to be successful in selecting science curriculum materials and science activities and assessing and evaluating their students.

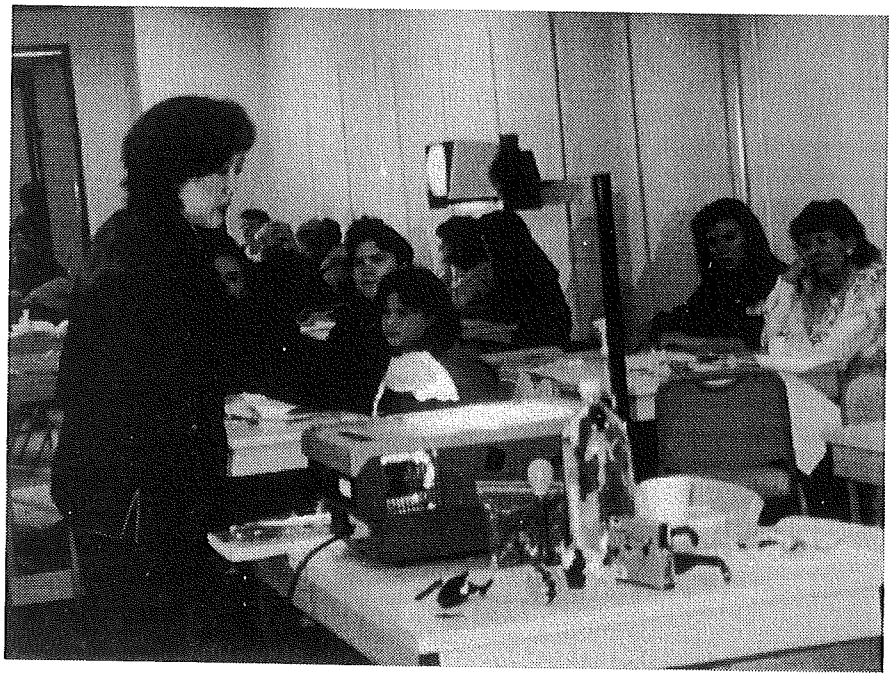
Budgets are tight for science materials, especially at the elementary level. Which students should have the opportunity to work with scarce science equipment and supplies? Should it be only the gifted students and the very advanced students? A principal in a rural elementary school was concerned about the availability of computers. Only students

in Title II were eligible to use the computers, however she wanted to provide an opportunity for her gifted students to use the computers. Her quest was to find a legal way to accomplish this goal even though most of the students in her school received free or reduced lunches. In middle schools, should teachers continue to purchase science materials for the earth science classes so that the eighth graders will have the opportunity to do science before they go to high school? If so, what will the sixth grade teachers use in their science classes? Unfortunately, tracking continues to be a practice in high schools. In many high schools, the majority of the students are tracked into the "low level" classes. Science teachers and administrators ask these questions: Should we spend the bulk of our money for these science classes? If we do, then what will be the success rate of students taking advanced placement courses?

The science teachers and administrators in these scenarios ask questions about reaching a balance in resource allocation. Does one focus on equality or equity? If the decision is to focus on equity, then who should determine what is equitable and how does one determine it? These are not easy questions to answer, especially when the solutions will determine who obtains a quality science experience.

Conclusions and Challenges

Teachers and other science education stakeholders will continue to grapple with the impact of social forces and allocation of resources on science teaching and learning. Even when answers are found, these answers do not remain to be the "right" answers because students and their needs change. Science education researchers and policy writers should not provide the solutions to these challenges; however, they can continue to ask questions, seek answers through research, and recommend policies and practices. Science teachers must ultimately meet these challenges in their classrooms. Therefore, more science teachers must become involved in multicultural science education research and policy if we are going to become more knowledgeable about better instructional policies and practices that will ensure an equitable opportunity for students to learn quality science. It behooves all stakeholders in science education to continue to discuss equity in science teaching and learning if the next generation of high school graduates are to be science literate.



References

Atwater, M. M. (in-press). Social constructivism: Infusion into multicultural science education research. *Journal of Research on Science Teaching*.

Fordham, S. (1993). "Those loud Black girls": (Black) women, silence, and gender" passing in the academy. *Anthropology and Education Quarterly* 24(1), 3-32.

Giroux, H. (1986). Radical pedagogy and the politics of student voice. *Interchange*, 7(1), 48-69.

Hagopian, E. C. (1994). Cultural pluralism, multicultural education and then what? *Multicultural education*. 1(5), 10-13, 38.

Lynch, S., Atwater, M. M., Cawley, J., Eccles, J., Lee, O., Marrett, C., Rojas-Medlin, D., Secada, W., Stefanich, G., & Willetto, A. (in press). *An equity blueprint for Project 2061*. Washington, DC: American Association for the Advancement of Science.

Maher, F. A. (1987). Toward a richer theory of feminist pedagogy: a comparison of "liberation" and "gender" models for teaching and learning. *Journal of Education. 169*(3), 91-100.

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

Secada, W. G. (1994). Equity and the teaching of mathematics. In M. M Atwater, K. Radzik-Marsh, and M. Strutchens (Eds.), *Multicultural education: Inclusion of all* (pp. 1938), Athens, Georgia: The University of Georgia.

Webster's Encyclopedic Unabridged Dictionary of the English Language (1989). New York: Gramercy Books.

Young, I. M. (1992). Five faces of oppression. In T. E. Wartenberg (Ed.), *Rethinking Power* (pp. 174-195). New York: State University of New York Press.

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Iris M. Riggs
California State University, San Bernardino

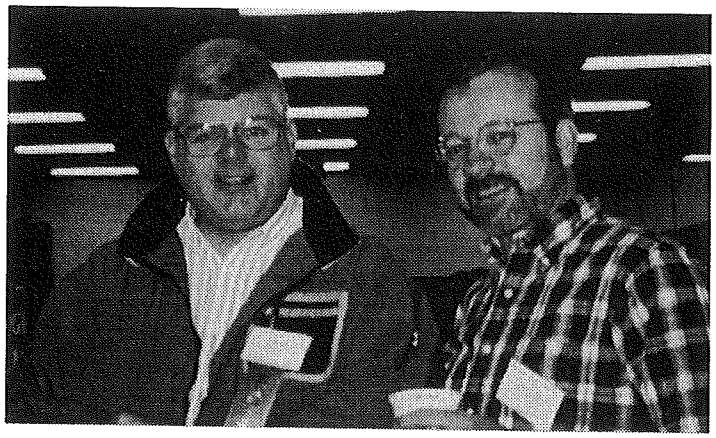
ACHIEVING GENDER EQUITY WITHIN THE SCIENCE CLASSROOM: FACTORS TO CONSIDER

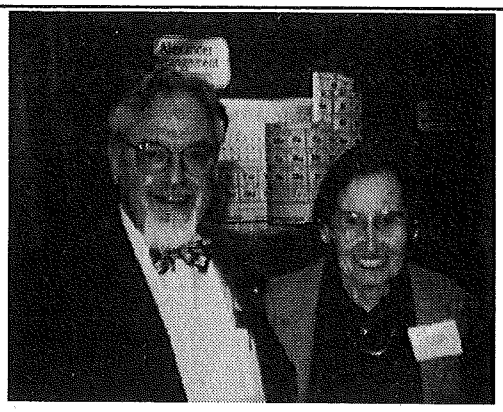
Concern continues related to the achievement differences between males and females, especially in regard to math and science. Most recently, *The AAUW Report: How Schools Shortchange Girls* (1992) and Sadker and Sadker (1994) reported that the status of females' education has improved little over the last decade.

Within the science classroom, inequities have also been well documented (Bazler & Simonis, 1991; Bianchini, 1993; Tobin, 1988). It is time to move beyond simply lamenting the inequitable educational results of females. This article will focus on specific actions that science teachers can take to promote the science attitude and learning outcomes for their female students.

Actively Involve Students in Science Activities and Dialogue

While most science teachers would agree that in order to learn science, students must do science; female students often are less actively involved than male students--even within the most active of classrooms (Kahle, 1990; Tobin & Garnett, 1987). Teachers are in error when they assume that students have access to materials and are engaged in dialogue simply because they have received directions. Instructors must take the time to communicate the importance of involvement if learning is to take place. They need to teach what active involvement means and let students know that they will be monitored to assure that it is taking place. It is most helpful to let students know what is expected in both words and deeds. When the expected behavior is observed or not observed, the teacher should be prepared to follow-up with appropriate consequences. Students can also learn to protect their own rights to involvement. This is not a skill that all have, but with guidance of the teacher, it can be developed over time. Lesson plans might include objectives for addressing equity in addition to those which deal with science concepts. Throughout each lesson, teachers might provide time to focus students on their own level of involvement. Discussion and journal entries might prompt students to reflect on their participation and create goals for future learning.





Equalize Teacher/Student Interactions

Related to student level of participation are the actions and words of the teachers within the science classroom. Research continues to report that males dominate within the whole group discussion of the science class (Hynd & Guzzetti, 1995). For example, in teacher-led discussions, boys are spoken to more frequently and asked more higher level questions (Becker, 1991; Hall & Sadker, 1982). Teachers also tend to offer more response to males' comments in a discussion of scientific concepts (Jones & Wheatley, 1990).

While teachers may view males as naturally more verbal about their science thinking, they must be prepared to equalize student verbal involvement within their classrooms. This is especially critical within science. In order to promote students' comprehension of science concepts, teachers and their students need to be aware of the students' personal theories and how they compare to scientific theories (Alvermann & Hynd, 1989).

Teachers might implement several strategies to equalize verbal participation. First of all, guidelines for discussions might be developed and posted so that all students know that verbal interaction is expected and necessary for learning. Potential speakers need to signal and be recognized prior to speaking to allow for ample wait time and to prevent domination by a minority of students.

Videotape or audiotape might be utilized to monitor the frequency and quantity of student interactions. It can also prove helpful in self-monitoring of teacher response to student comment. Based upon analyses, teachers might make a special effort to provide opportunities for students with limited input. They may also communicate what they have learned with their students and prompt students to share their perspectives and goals for future involvement. In fact, teacher change, in and of itself, may not be enough to achieve equitable outcomes within the classroom. Students need to reflect upon the social dynamics of the classroom and their own role within it (Guzzetti & Williams, 1996).

Implement a Science Curriculum that Connects to Students' Lives

Much of the literature suggests that science curricula and texts often do not include readings or activities which relate to female students' lives (Bianchini, 1993). The most equitable science programs have been designed to address this weakness. Female students will enthusiastically persist in science if they see the relevance to their own lives (Blake, 1993; Rosser, 1990). Short of adopting new curriculum, what can individual science teachers do to make science more relevant to all students, including females? Initially, teachers need to get to know their students' interests through the use of interest inventories, interviews, or journal entries. Analysis of the results should be utilized to plan instruction which relates to students' interests and experiences.

When implementing the required curriculum, science instructors can begin by finding out what students know and their questions related to the upcoming topic. This information can be posted throughout the unit and returned to as questions are addressed. Continually focusing on what students believe they know and their questions can help the students make personal connections with the learning while the instructor is able to better connect future Earnings to past experiences. Student involvement within hands-on experiences or labs can be utilized to provide students with preliminary experiences prior to readings and lectures. This foundation can serve to stimulate students' thinking and motivation.

Utilize Role Models to Promote an I Can Attitude

If students are to visualize themselves as scientists, role models which are similar to themselves are most helpful (Sumrall, 1995). In-the-flesh role models may be the most powerful influence of students. Involving scientists of both genders in the education of students may be possible through classroom visits and field trips. If access to female scientists is limited, slightly older female students who are engaged in science can be a reasonable alternative. In fact, known peers may even have a greater influence than the unknown scientist. They can provide a realistic model of someone doing science that is within the reach of students. The near future may have more meaning and impact than the long range possibilities.

In addition to living role models, the science classroom should be filled with a variety of visuals which portray science being done by all types of people. Unfortunately, science textbooks cannot be relied upon to present diverse images (Guzzetti & Williams, 1996; Sadker, Sadker, Fox, & Salata, 1993-94). Snapshots of the students themselves can easily become part of the remedy.

Additionally, verbal samples utilized by the teacher during instruction need to have a balance of both female and male scientists. When directions are being given, gender should be alternated so that male students' names are not the only ones used within examples.

Promote a Cooperative Environment

Studies have shown that female students often do not thrive in an individualistic, competitive learning environment (Baker & Leary, 1993; Blake, 1993). Science teachers might reflect upon the number of cooperative learning opportunities they provide their students and seek to incorporate ample opportunities for group learning.

Science investigations provide the perfect opportunity for partners or groups of students to work together. Again, simply arranging students in close proximity to others does not assure that all students will equally have access to learning (Bossert, 1988-89). Cooperative behaviors must be taught over time and monitored by the teacher and students. As Jones (1985) suggested, assigning differential roles to each group member can promote participation. Providing students with role nametags can facilitate the teacher's and students' monitoring of role implementation (Jones, 1985).

In addition to group investigations, teachers might employ simple strategies to increase the amount of student to student talk throughout science instruction. For example, when engaging in lecture or oral reading, periodically students might be encouraged to turn to their partner and state one important statement or one question they have about the passage just read. This could occur as often as every 10-15 minutes.

Science journals, too, can become more cooperative in nature if student groups are allowed to create one journal entry for the period. Individual entries can become more interactive if writing time is followed by sharing time in which students articulate their written thoughts. Journal read-arounds also promote students' learning and can be followed by peer developed written responses.

Measure Students' Attitudes and Achievement

Although most teachers would report that they have similar expectations for both their male and female students, research suggests that teacher actions within the science classroom indicate otherwise (Kahle and Meece (1994). As a measure of gender outcomes, science teachers should seriously consider monitoring both attitudinal and achievement outcomes of their students. Periodic attention to outcomes can facilitate the teacher's attention to implementation of equitable teaching strategies. Pre and post tests can inform both teacher and student action. The Draw-A-Scientist Test (Chambers, 1983) and teacher-created attitude surveys can provide evidence of change over time. Students might also share their thoughts regarding science and equity through journal entries, interviews, and/or discussion groups.

Conclusions

Past research efforts have provided ample evidence to suggest that female students are not reaching their potential in science learning. Though societal beliefs and actions certainly play a part in the complicated picture of female science learning, research does give direction which can guide teachers as they strive for more equitable outcomes within the science classroom. Teachers can make steps toward positive change by considering implementation of specific actions for equity within the science classroom. Continued study of student attitudinal and achievement outcomes can provide them with critical feedback on the progress of their science program.

REFERENCES

Alvermann, D.E., & Hynd, C.R. (1989, November). *The influence of text and discussion on* the *learning of counter-intuitive* science concepts. Paper presented at the National Reading Conference, Austin, TX.

Baker, D., & Leary, R. (1993, April). *Letting girls speak out; Equity, school, and social influences on career choice.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Atlanta, GA.

Bazler, J A., & Simonis, D A. (1991). Are high school chemistry textbooks gender fair? *Journal of Research in Science Teaching,* 28, 353-362.

Becker, J.R. (1981). Differential treatment of females and males in mathematics classes. *Journal for Research in Science Teaching,* 28, 353-362.

Bianchini, J. (1993, April). *The high school biology textbook A changing mosaic of gender, science and purpose* Paper presented at the annual meeting of the American Educational Research Association, Atlanta,

Blake, S. (1993). Are you turning female and minority students away from science? *Science and Children,* 30, 32-35.

Bossert, S. (1988-89). Cooperative activities in the classroom. *Review of Educational Research,* 15, 225-252.

Chambers, D.W. (1983). Stereotypic images of the scientist: The Draw-A-Scientist Test. *Science Education,* 67, 225-256.

Guzzetti, B.J., & Williams, W.O. (1996). Gender, text, and discussion: Examining intellectual safety in the science classroom. *Journal of Research in Science Teaching,* 33, 5-20.

Hall, R. & Sadker, B.R. (1982). *The classroom climate: A chilly one for women? Project on the status of women.* Washington, DC: Association of American Colleges (ERIC ED 215 628).

Hynd, C.R., & Guzzetti, B.J. (1995). *Teachers texts, and culture: The influence of context on students' conceptual change in science.* National Reading Research Center, Athens, GA. Manuscript in preparation.

Jones, M.G., & Wheatley, J. (1990). Gender differences in teacher-student interactions in science classrooms. *Journal of Research in Science Teaching,* 27, 861-874.

Kahle, J.B. (1990). Why girls don't know. In M.B. Rowe (Ed.), *What research says to the science teacher* (Volume 6). Washington, DC: NSTA

Kahle, J.B., & Meece, J. (1994). Research on gender issues in the classroom. In D.L. Gabel (Ed.), *Handbook of research on science teaching and learning* (542-557). New York: MacMillan Publishing.

Rosser, S.V. (1990). *Female friendly science.* New York: Pergamon.

Sadker, M. & Sadker, D. (1994). *Fabling at Fairness: How Our Schools Cheat Girls* Simon and Schuster, New York, NY.

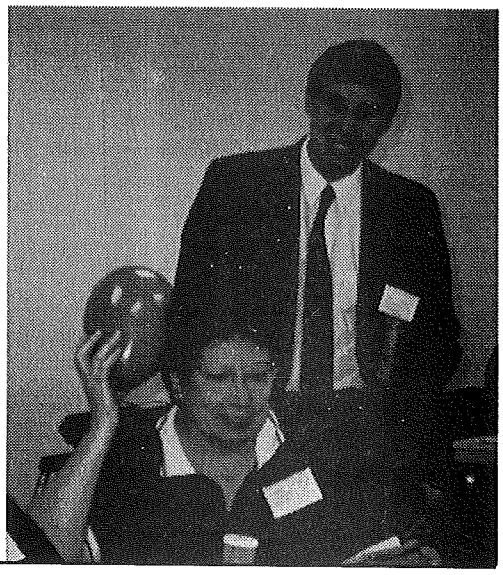
Sadker, M., Sadker, D., Fox, L., & Salata, M. (1993-94). Gender equity in the classroom: The unfinished agenda. Me: *College Board Review,* 170, 1 4-2 1 .

Sumrall, W.J. (1995). Reasons for the perceived images of scientists by race and gender of students in grades 1-7. *School Science and Mathematics,* 95, 83-89.

Tobin, K. (1988). Differential engagement of males and females in high school science. *International Journal of Science Education,* 10, 239-252.

Tobin, K., & Garnett, P. (1987). Gender related differences in science activities. *Science Education, 71, 91-103.*

Wellesley College Center for Research on Women. *How Schools Shortchange Girls: The AAUW Report* Washington, DC: American Association of University Women Educational Foundation.



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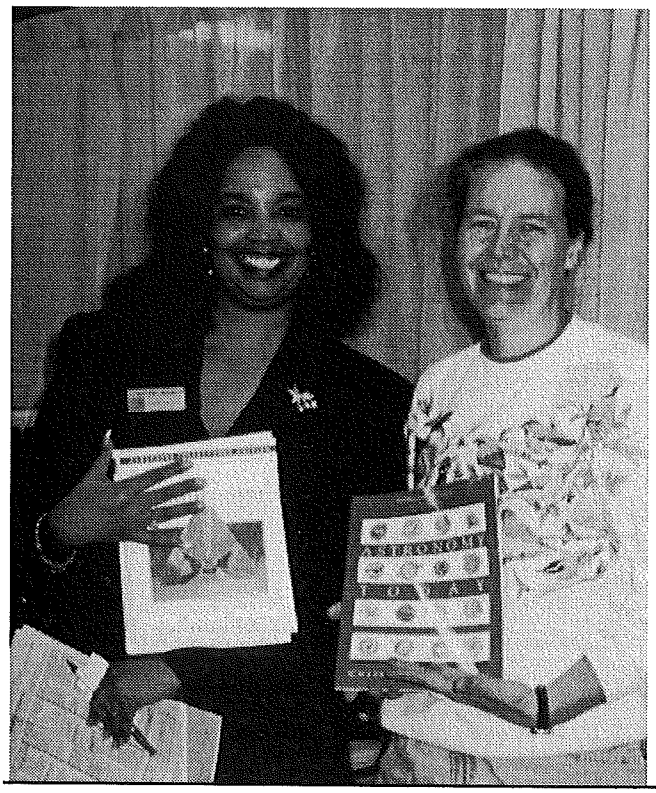
EQUITY ISSUES IN THE USE OF COMPUTER AND TELECOMMUNICATIONS TECHNOLOGIES IN SCIENCE TEACHING

As computers and telecommunications networks are increasingly used to enhance science teaching and learning, what considerations are important in trying to ensure that all students, regardless of geography, socioeconomic status, gender, race/ethnicity, disability, or language proficiency, reap the benefits? In particular, what are the implications of the recent trend toward broader, more flexible, and more "user-friendly" student and teacher access to the Internet through the World Wide Web? There are reasons to believe that these technologies have the potential to contribute to solving equity problems, but there is also the real possibility that they will broaden the already wide gulf between the "haves" and the "have nots." In most ways, the plight of science education in this area in 1996 is only a special case of a continuing set of problems which have been recognized across many subject matter areas since the advent of school microcomputers in the early to mid-1980s. The good news is that not all of the most promising solutions boil down to money. The not-so-good news is that some of them, at least in the short run, can be a drain on what most teachers consider to be their most precious personal and professional resource: Time.



It is often useful in thinking about educational technology issues to recognize and differentiate between the importance of a school's raw access to electronic technologies themselves (hardware, software, and network connectivity) and of the more subtle issues of how and in what contexts they are actually used by teachers and students. As a parallel, consider the results of research on more familiar electronic technologies in the home environment. Studies have repeatedly shown, for instance, that equal or even higher proportions of poor African-American or Hispanic (vs. white, middle-class) children have home access to television, videocassette recorders, and video game computers, but use them for different programs and in substantially different cultural contexts. Studies have also documented vast differences in quantity and quality of use of home microcomputers between boys and girls with equal access

The most obvious kind of technology-related inequities among schools and science classrooms stem from relative differences in funding. Public school districts with a limited tax base and/or less historical emphasis on education (most often in urban and rural settings) often have less money to spend per student, teacher, classroom, or school. In many cases such districts also spend a smaller proportion of available funds on academic materials because of inefficiencies of scale, higher building, renovation and maintenance costs, or a greater need to fund school-based programs to deal with broader social and health problems in the community. In addition, commonly-published statistics like student-to-computer ratios or proportion of schools or classrooms "on line" usually underestimate inequities, since poorer schools, due to budget constraints, often buy inferior quality materials, fail to maintain equipment, retain obsolete hardware, or grossly underestimate the cost of software or ongoing services (such as monthly telephone line or Internet service provider charges) sufficient to make significant use of a hardware investment. This phenomenon is already familiar to many science teachers with regard to laboratory equipment, or even textbooks

The most popular innovative financial solution currently being tried by some districts (whether financially strapped or not) is to lease computers and software licenses from annual operating funds. This provides teachers and students with more up-to-date materials and allows administrators or individual teachers flexibility, based on their ongoing experience with students, in rejecting low-quality materials or replacing them with those that better fit with their curriculum or teaching priorities. The usual practice of purchasing computers and software from a capital budget often results in hardware becoming obsolete long before its amortization period is over and often necessitates a long-term, district-wide commitment to software which may prove largely useless to many teachers

Another approach to maximizing access to technology with a limited budget is to de-emphasize the traditional practice of concentrating computers in one or a few "lab" classrooms. These rooms are often available to science teachers only on a very limited basis and are extremely unlikely to be appropriate for many science-related activities. The same number and kind of computers can be distributed more equally to individual classrooms or (even better) flexibly allocated in small clusters to teachers who need them for the duration (several days or weeks) of a particular unit or project

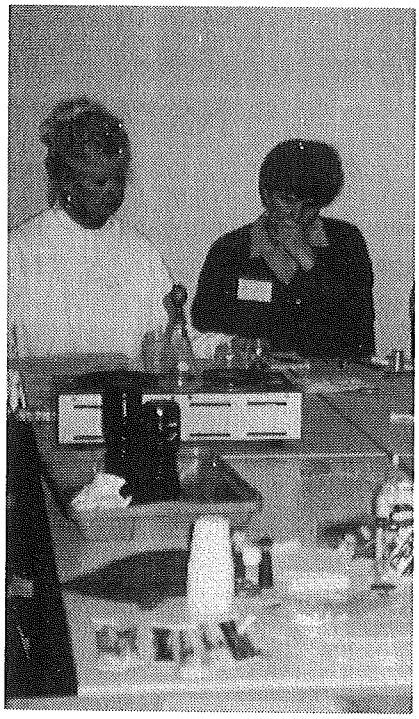
Besides increasing the frequency of access for many students, this approach can have an indirect and potentially positive effect on the substance of the tasks which a diverse student body is asked to perform with the aid of the technology. More consistent access to a relatively smaller number of computers per classroom can make a virtue of necessity because of the kinds of software and classroom interactions whose use it limits or facilitates

Historically, even in the few schools or classrooms lucky enough to be able to provide "hands-on" access to computers for all students, a strong pattern of inequitable kinds of use has often emerged. Students categorized as lower-achieving (often disproportionally economically disadvantaged and/or members of racial/ethnic minority groups) most often used computers for unimaginative, inflexible, "drill and kill" tutorial programs, while higher-achieving students often worked on programming or other projects involving open-ended "tool" software which demands, and therefore presumably helps to develop, higher-order thinking skills. What both of these approaches have in common is an emphasis on intensive, individual student interaction with the computers themselves (versus with other students or teachers), and on logical, linear, hierarchical thinking (versus a more intuitive and holistic cognitive style). Both of these characteristics of such computer-based activities have been documented in many studies to be ineffective and unmotivating for many students, and for female students in particular. In order to achieve equity in situations in which only one or a few computers are available per classroom, teachers and software designers must facilitate student activities which emphasize using the power of the computer to manage, mediate or motivate small-group or whole-class tasks which involve all students in active, socially-based decision-making, using higher-order thinking skills, while away from the computer itself.

Increasingly, courseware companies are developing packages of instructional materials (especially in the category of interactive simulations) in which: 1) a "transparent" user interface allows students and teachers to concentrate on the substance of the program rather than the mechanics of controlling the computer; 2) software and related video materials incorporate high-quality multiple representations (hypertext, analytic graphics, richly artistic graphics, sound) of scientific phenomena; 3) data from coordinated "wet" labs or accompanying print materials are a truly integral resource for accomplishing the learning tasks enhanced by the computer; 4) specific cooperative learning strategies are supported. All of these characteristics can help teachers to create a classroom environment in which a greater diversity of students are both willing and able to become actively engaged, at a challenging level, in computer-enhanced science activities

What about computer and telecommunications networking ("telecomputing")? Current widely available technologies represent a mixed blessing, from the point of view of equity, on both the low end (electronic mail) and the high end (the World Wide Web)

The idea of students and teachers communicating from their classroom with other students, teachers, and scientists has great appeal in many ways. In general, a school science curriculum which includes sharing ideas and data from a common research project and debating conclusions with peers and mentors outside of the classroom is widely seen as a more "authentic" modeling of actual practice in the scientific community. Model science-related curriculum units in this mode are very well established, and in some cases complete packages are commercially available from software catalogs. In particular, the use of text-based communication (such as standard electronic mail, newsgroups, or real-time "chat lines") has the potential to have a democratizing effect. In e-mail exchanges with strangers, no one knows your gender, race, age, disability, or other aspects of your background except to the extent that you choose to reveal them, and so the substance of your ideas can be judged on their merit alone. In cases in which, after a sustained and substantial e-mail exchange has occurred, participants do find out some of the personal characteristics of their correspondents, stereotypes might be debunked, prejudices broken down, or, alternatively, members of groups of people underrepresented in science may be pleasantly surprised and lose any feeling of isolation by discovering people like themselves with similar interests.



The limitations imposed by text, however, are often noted to be ill-suited to the cognitive styles or cultural norms commonly ascribed to female or racial/ ethnic minority students. For this reason, the multimedia capability which the World Wide Web and related technologies add to electronic interaction might make it a more flexible and therefore useful medium for use by a diverse body of students. Although the use of the Web in science classrooms is in its infancy, early research has shown strong indications that, at least in terms of immediately observable patterns of student behavior, the days when all available keyboards and mice are monopolized by white males are numbered. As noted in many recent articles, in the hands of creative and resourceful teachers the possible applications of the Web for science teaching are nearly endless

Ironically, the explosion of telecomputing technology (of which the World Wide Web is only the most high-profile example) may mean that the present time may be an unusually propitious one for technology-poor schools to catch up with more fortunate ones. In the past, higher-budget schools have often found that large amounts of powerful hardware too often turned out to be "dressed up with nowhere to go," due to a lack of appreciation of the importance of software selection and of professional development opportunities for teachers. Sufficiently powerful computers and networking infrastructure are expensive at the outset, but do not so much need to be supported by highly specific software which teachers and students must learn painstakingly how to use. Increasingly, useful and free resources are not only plentiful on the Web but easily located using truly easy-to-use browser software and increasingly effective search engines. It may be possible for the current "have nots" to leapfrog over the mistakes and tribulations of the "haves" by short-circuiting the technological learning curve

Unfortunately, however, even if access to technology becomes more equitable in school, the newest technologies may make inequities in the home environment of the students more important than ever. In the past it has often been noted that more wealthy students (and teachers) gained an unfair advantage from the fact that they had access to computers at home. Aside from allaying any initial general fear of the computer, however, this particular inequity has probably had little effect on differential learning in science classrooms, because the hardware and software used were likely to be different. More fortunate children are very unlikely to use computer-based lab equipment or science simulations with significant educational content while at home, and, ironically, their typical home computer hardware is likely to be newer and more powerful than that available at school. Internet service, however, is more uniform - except for differences in data transfer speed, World Wide Web access is World Wide Web access (indeed, many of the more popular sites are more likely to be available for remote connection during the evening and night hours than during the school day). Today and in the near future, wealthier students are more likely to have use of essentially identical resources at home and at school, putting the "have nots" at a truly substantive disadvantage

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OPTIONS FOR EQUITY IN RURAL SCIENCE EDUCATION

Equitable science duration is essential to prepare all citizens for effective living in a civilization that is increasingly dependent upon science and technology. This is an especially important issue in many rural and small school arenas, where there may be greater than average variations in teachers' qualifications and learners' backgrounds and needs. However, the problem of equity is indigenous to rural, urban, and suburban schools alike, and extensive reform is needed in all these areas. Where, then, should the rural educational community look for leadership in the current quest for equity?

Traditionally, we have looked to the larger metropolitan schools, with their centralized administration and specialized staffing, as the preferred model. This was reflected in a trend toward consolidation of rural and small school systems, which ranks among the most frequently implemented educational policy options of the 20th century (Herzog and Pittman, 1995)). However, Pipho (1995) noted the trend is shifting: "One of the reform proposals seen in urban schools today is the notion that the schools need to become much smaller and more personal" (p. 103). Smaller and more personal classes are typical of rural education. This, and the following observation on the history of educational innovation, suggest that rural schools should look in a new direction—within themselves—for insight on options for reform:

> Many so-called 'innovations' being championed today were born of necessity long ago in the rural schoolhouse. Cooperative learning, multigrade classrooms, intimate links between school and community as the focus of study, older students teaching younger ones, site-based management, and close relationships among teachers and students—all characterize rural and small school practices. (Stern, 1994, p. 1)

Clearly, rural schools are facing many problems, and serious reforms are needed. But it would be sheer folly to attempt those reforms without realizing the inherent resourcefulness of the genre.

Leadership born of necessity is the legacy of rural and small schools. Faced with the necessity to teach under fiscal and physical circumstances that are far from ideal, rural school teachers and administrators were forced to innovate—to accomplish what must be done to the best of their ability with what they have. All schools benefited as some of the more productive rural innovations became recommended practice in urban and suburban systems as well, but the source of those benefits has been largely obscured by the prevalence of literature decrying the condition of rural education. Appreciation of that legacy of leadership will require radical reinterpretation of how and why we should educate the nation's youth—and such a reinterpretation is in the making. It will also require redirection of teacher education to more adequately meet the needs of rural and small school teachers and administrators.

The Changing Perception of Educational Purpose

The traditional perception of how and why we should educate the nation's youth has been attributed to the cultural impact of the Industrial Revolution, and the promotion of industrialization and urbanization has been a predominant factor in the design of formal education (DeYoung & Lawrence, 1995). The Industrial Revolution ushered in an unprecedented era of technological development and productivity, and families were attracted by employment opportunities in the emerging industrial centers. A strong industrial enterprise was appreciated as a source of prosperity and national prestige, and those educational practices that would assure a continuing supply of competent employees were promoted.

Early in the 20th century, there was widespread consensus that application of the industrial tenets of centralization, specialization, and technological efficiency was the one best system for school development, and the notion that "bigger is better" quickly became a predominant factor in school development (Tyack, 1974; Theobald & Nachtigal, 1995). What soon came to be known as the industrial/factory model of schooling was rapidly implemented in urban areas, but efficient application of the idea was not possible among the numerous rural school systems scattered across the nation. Consolidation of rural and small schools was championed "as the necessary precondition for the proper implementation of the factory model of education" (Sher, 1995, p. 144).

Proponents of consolidation cited a verity of factors including cost savings, increased socialization through larger student bodies, more specialized teaching staffs, and less isolation of teachers in specific subject areas. This sounded the death knell for many rural and small schools. But little research information is available on the actual benefits of consolidation. Stern (1994) observed, and opponents have challenged the practice on the basis that a monetary value cannot be placed on "such strengths of rural schools as the involvement and support of parents and the community, individualized instruction, and widespread student participation in school activities made possible by small school and class size" (p. 43).

Rather than consolidate, some rural districts adopted alternative strategies including partial reorganization to facilitate cooperation among otherwise autonomous neighboring school systems, area cooperatives to share services, school/community partnerships, and telecommunications (In 1989, the Office of Technology Assessment observed that rural and small schools have been in the forefront of innovation in instructional technology and distance learning.) As these and other innovations that were initially developed in rural education gain in popularity in metropolitan areas, the factory model is losing ground: "Virtually all reformers...loathe the industrial/factory model of schooling" (Sher, 1995, p. 143).

Many factors, Including the urban depression brought about by massive layoffs associated with industrial automation and downsizing, have contributed to a changing attitude toward school structure and purpose. Whereas children were perceived as materials to be shaped for productive employment in the factory model (how often we were reminded that we must get a diploma so we could get a good job), the new trend is toward helping them prepare for effective living as self-actualizing individuals with lifelong learning needs. Similarly, whereas teachers were traditionally perceived as skilled laborers or technicians responsible for shaping students to externally conceived standards with industrial efficiency, they are now more commonly viewed as professional responsible for facilitating meaningful learning experiences that are sensitive to students' needs, interests, and individual learning styles. These trends represent a radical reinterpretation of how and why schools should educate the nation's youth, and they reflect several innovations that originated in rural education.

The Challenge for Rural Education

Rural education has, out of necessity, been the harbinger of effective change as it created principles and practices that enabled it to do what had to be done with what was available. Paradoxically, the concept of consolidation that was conceived to foster the now questionable industrial/factory model is still widely promoted in some circles as the cornerstone of rural school reform. Overcoming the influence of that near-defunct tradition is a critical challenge for rural educators.

Consolidation was once enthusiastically promoted as the means to more equal opportunity for rural and small school students. But as Herzog and Pittman (1995) noted, it has not resolved the problem of educational inequality: "Rural schools are still smaller and poorer that nonrural schools" (p. 116). Yet consolidation is still promoted by some advocates of rural school reform, and rural educators must guard against the pitfalls of this externally imposed tradition as they contemplate reform for equity. Perhaps Theobald and Nachtigal (1995, p. 135) said it best: "The work of the rural school is no longer to emulate the urban or suburban school, but to attend to its own place."

Attending to its own place should be quite comfortable for rural education, because that has been the key to the survival of many rural school systems. Rural educators will still face many ongoing problems that have beplagued rural education over the years, of course, as they seek to assure that rural science education is on an even keel with the best. These include problems of remote geographic location, limited instructional resources, need for multiple preparations, professional isolation of teachers, low student enrollments, relatively poor student and teacher attitudes and morale, and limited student motivation. However, reforms that would prompt equitable science education for rural students could also solve many of those problems.

Arena for Enhancement of Rural Equity

Five areas of opportunity for reform of rural education are outlined below, with attention to how they may relate to the problems mentioned in the previous paragraph. Rural educators may recognize some of these already in place within their school systems. If so, this confirms the speculation that rural schools may look with confidence to their own legacy of leadership for inspiration and direction.

Integration of Curriculum and Instruction

The need for integration of science has been long recognized and widely discussed (Neurath, Carnap, & Morris, 1955; Hurd, 1991), and it is advocated by most of the major current initiatives for reform including *Project 2061* (American Association for the Advancement of Science, 1990), the National Science Teachers Association's *Scope, Sequence, and Coordination* (NSTA, 1993), and the *National Science Education Standards* (National Research Council, 1996), The current interest was precipitated by the failure of the discipline-specific science instruction that has prevailed in most schools, rural and non-rural alike, to meet the needs of the vast majority of students. Hurd (1991) echoed a widespread concern when he described the typical science curriculum of today as out-of-touch with the nature, history and social relevance of science. "Science and technology have merged to become an integrated system," he declared; and as a result, "the subject matter of traditional science courses is functionally inert outside of class (p. 33).

Integration of the various science disciplines is a logical first step toward improvement of rural science education, and it is an equally logical step toward equity in science learning. An understanding of the connections among the various disciplines is necessary for effective science education, but research revealed that rural students typically receive only limited science instruction. However, Finson, Fitch, Lisowski, and Foster (1996) found that "a large number of teachers had to integrate subjects if science was to be taught at all, and such efforts were made on their own initiatives" (p. 122). Integrated instruction, including that already used out of necessity in some rural arenas such as that described by Finson et al., will help to insure rural students' understanding of interdisciplinary connections and also illuminate the relationships between the lessons and their own lives. When that relationship is made plain, Charron (1991) found in a study of a rural county system, "the pupils were more motivated and remembered the material better" (p. 681).

Prather (1996) described geology and earth/space science as ready vehicles for integrating the physical, life, and environmental sciences around topics of current public interest. However, the scope of integration advocated by Paul DeHart Hurd (1991) extends beyond the sciences to include all academic subject areas: "The reform movement of the 1990s calls for...a conceptual convergence of the natural sciences, mathematics, and technology with the social and behavioral sciences and the humanities into a coherent whole" (p. 35).

Vars (1991) and Fogarty (1991) described numerous models for curricular integration ranging from those that may be adopted as an initial departure from a traditional discipline-specific situation to the sort of inclusive models called for by Hurd. "A faculty can easily work with [the various models] over time to develop an integrated curriculum throughout the school," Fogarty (1991, p. 65) declared, but the goal should not be a replica of any existing model. Rather, a unique program should be designed as necessary to meet the needs of the particular school and its students. This type of reform must centrally involve teachers, and it cannot be accomplished if they are isolated within their own specific disciplines. Integrated instruction must engage teachers within different specializations in a common effort.

Inherent in the quest for integration is a means to the relief from a sense of professional isolation, which is among the most prevalent concerns expressed by rural teachers (Baird, Prather, Finson, & Oliver, 1994; Carlson, 1992). The natural connections among the various subject areas will become evident as teachers work together. As they find kinship in those disciplinary overlaps, the teachers will open new avenues for fulfilling professional dialogue. "*Good* science teachers have more in common with say, *good* English teachers, and vice versa," Jackson (1983) noted, "than either does with mediocre or poor teachers within their own specialties" (p. 161-162).

A review of literature on curricular and instructional integration revealed widespread agreement that schools must be willing to let go of many old practices. Examples include the discipline-specific approach to secondary science (Brunkhorst, 1991), grade-specific instruction (Drake, 1991), the notion that there is a specific scientific method that should be taught (Hurd, 1991), and schedules that disrupt learning by shuffling students to other locations (Eisener, 1991). The idea that lessons must adhere to a particular format or predetermined set of objectives must also be displaced by more flexible perceptions of the pureness of education (Prather, 1995).

Successful transition to integrated teaching must also centrally involve students. This should present little difficulty for rural schools, where close teacher-student relationships are already typical. Since many rural secondary school teachers (like most elementary teachers) already teach several subjects and are accustomed to multidisciplinary preparations (Baird et al., 1994), they should be able to make the transition more easily than those accustomed only to single-subject preparations. For some schools the transition may be easier than for others, of course, but effective integration of science with other subjects should be considered within the reach of any rural or small school system. In any case, it may be approached as a low-risk option with high potential for enhancement of rural equity. The effectiveness of curriculum integration has been examined in more than 80 studies, Vars (1991, p. 15) reported, and "in nearly every instance, students...have performed as well or better on standardized achievement tests than students enrolled in the usual separate subjects."

Collaborative Exchange Programs

"Isolation, the lack of concentrated numbers of students, and limited resources have historically plagued education In rural areas" (Fletcher and Cole, 1992, p. 31), and rural school systems typically suffer from economic deprivation (Sher, 1988; Stern, 1994. Collaboration has been adopted as an alternative to consolidation on many occasions to cope with these problems. Fletcher and Cole (1992) described the development of rural collaboratives to pool resources while retaining each system's autonomy and close relationship to the community it serves. Field (1988) reported that 25 rural elementary school teachers collectively researched and wrote a seven-volume science activities manual to enable them to implement hands-on-science teaching in their classrooms, thereby overcoming a problem of outdated and inadequate curricular materials. Cooperating with a university, 27 rural school systems developed a local team leadership development program that provided instruction for thousands of in-service elementary teachers (Prather, Hartshorn, and McCreight, 1988). Rhoton, Field, and Prather (1992) explained that local team leadership development may provide an effective alternative to employment of a science specialist in cases where such a position may not be economically feasible.

Two or more neighboring school systems may practice selective faculty development to overcome the problem of subject socialization. A school with only a physics teacher and biology teacher, for instance, could arrange biannual faculty

exchanges with a school having only a chemistry teacher and earth-space science teacher and thereby enable each school to integrate all areas of science into its curriculum. (Very small schools may require biennial exchange programs.) Collaborative acquisition of instructional materials may also enable the partners to acquire and share expensive equipment or other items that would otherwise be beyond the reach of either school.

Electronic Technology

Rural schools are leading innovators in instructional technology and distance learning (Office of Technology Assessment, 1989). Many concerns cited by proponents of consolidation, such as limited student access to information and professional isolation of teachers, may be overcome through innovative use of the Internet. Distance learning technology has resolved many problems of in-service teacher enhancement. The high cost of incorporating electronic technology into classroom instruction is a daunting challenge for rural schools, but an eight-state survey by Baird, et al. (1994) revealed that rural teachers have about equal access to computers in their classrooms; and they make approximately the same use of them as their nonrural counterparts. Finson et al. (1996) reported that more than 60% of rural teachers in one study indicated that they used microcomputers in their classrooms nearly 100% of the time. Again, it appears that rural schools are exercising leadership as they seek to incorporate electronic technology into classroom instruction and teacher enhancement.

Constructivism

Constructivist learning is a topic of great interest among teachers and researchers in all fields of education. Although research is needed to validate many claims ascribed to it, constructivism is clearly student centered; and that is its major contribution to the current dialog on science education reform. It lends credibility to a variety of non-traditional curricular and instructional practices including closer teacher-student relationships, student-centered instruction with balanced emphasis on content and process, curriculum-life connections rather than textbook-driven curricula, emphasis on the relation of science to technology and society, and preparation of students for life-long science learning

All this holds great promise for rural equity. For instance the emphasis on a close teacher-student relationship, a hallmark of rural schools, turns smaller class sizes (a rural school characteristic that has been traditionally considered a liability) into an educational asset. Typically; rural teachers must teach in several subject areas, with many teaching outside their fields of certification (Baird, et al., 1994). But with constructivism, developing interdisciplinary skills—often a necessity in schools with limited faculty specializations—becomes an ideal to be encouraged.

Many rural school science teachers, already conditioned to the necessity for innovation and calculated risk taking, should find the opportunities inherent in constructivism to be quite welcome: These include integration of subjects, decreased dependency on textbooks, planning student-centered rather than subject-centered lessons, redesigning the classroom for hands-on/minds-on teaching methods, sequencing content across grade levels, developing alternative assessment methods, and closer school-community relationships. The latter opportunity can be especially important for successful reform in rural areas, where a sense of personal identification with the schools is typical (Charron, 1991; Herzon & Pittman, 1995; Stern, 1994).

Reform of Teacher Education

Teachers function at the front lines of the educational battlefield, and resolution of any educational issue must ultimately be approached at the level of teacher education. This is especially the case with issues facing rural teachers, who are typically called upon to teach in several subject areas and outside their fields of certification. The budgetary problems characteristic of rural schools require them to improvise to compensate for the lack of adequate instructional materials, and the closer community relationships of rural schools require them to be more involved in community affairs. These conditions generate unique needs including interdisciplinary academic preparation, additional skills in lesson planning and preparation, and understanding of small community mores as they relate to teacher expectations. Rural systems rely heavily on in-service training to help teachers meet those needs. But help is needed much earlier, beginning in the first stages of teacher preparation.

Rural teachers represent a large segment of the teaching community and rural school systems experience high attrition rates. Therefore many new teachers enter the rural teaching arena every year, but few teacher education institutions make any provisions for their unique needs. Assertive action is needed, in the form of rural school-university partnerships, to identify and implement reforms that would better prepare teachers for service in rural schools. Once equity is established in teacher education, it is reasonable to predict that student equity will be nurtured in the fertile environment of practical innovation that characterizes rural schools.

Conclusion

Substantial reform is warranted for equity of rural science students, and reform of teacher education is a logical first priority. Reform involves risk, however, and caution is called for to avoid the risk of overreaction that has characterized many past reform efforts. In her presidential address at the American Educational Research Association (AERA) meeting in 1994, Ann Brown made a very relevant point. We have made enormous advances in our understanding of learning and learner development in this century, she observed; why are these advancements not reflected in changed school practices? Because "we repeatedly throw out babies along with bathwater," she speculated, "when we should build cumulatively" (Brown, 1994, p. 4).

Immediate action for substantial change is necessary for the advancement of rural education. Discontinuation, if not outright reversal, of the tradition of consolidation and the

factory model of schooling it fosters appears to be an advisable option. In considering such action, however, it is important to remember that some of the more productive of past rural school innovations were drafted over the years in an effort to make the factory model work. Those should be identified and their potential reexamined to assure that the best traditions of rural education were not thrown out with the bathwater, so to speak, but retained for possible use with whatever new innovations may be tried.

Rural education has made many contributions and it will be important to build upon the best of those in the quest of equity for rural students. Necessity has made thoughtful and determined risk-takers of many rural teachers and school officials, and "in recent years, rural performance has risen on selected national assessments so it now approximates the national mean" (Stern, 1994, p. 3). Given its legacy for leadership born of necessity, there is reason for much hope in the future of rural education.

References

American Association for the Advancement of Science (1990) Science for all *Americans: Project 2061*. New York: Oxford University Press.

Baird, W. B., Prather, J. P., Finson, K. D., & Oliver, J. S. (1994). Comparisons of perceptions among rural versus nonrural secondary science teachers: A multistate survey. *Science Education 78*(6), 555-576.

Brown, A. L. (1994). The advancement of learning. *Educational Researcher 23*(8), 4.

Brunkhorst, B. (1991). Every science, every year. *Educational Leadership, 49*(2), 36-38.

Carlson, R. V. (1992). What does it mean to work in a rural setting? A study of influences. *Journal of Rural and Small Schools, 5*(1), 41-47.

Charron, E. (1991). Classroom and community influences on youths' perceptions of science in a rural county system. *Journal of Research in Science Teaching, 28*(8), 671-687.

DeYoung, A. J., & Lawrence, B. K. (1995). On Hoosiers, Yankees, and Mountaineers. *Phi Delta Kappan, 77*(2), 105-112.

Drake, S. M. (1991). How our team dissolved the boundaries. *Educational Leadership, 49*(2), 20-22.

Eisener, E. W. (1991). Should America have a national curriculum? *Educational Leadership, 49*(2), 76-81.

Field, M. H. (1988). A chronicle of changes for elementary science in Tennessee. *Education, 108*(4), 419-426.

Finson, K., Fitch, T., Lisowski, M., & Foster, G. (1996). The status of science education in K-6 Illinois schools. *School Science and Mathematics 96*(3), 120-127.

Fletcher, R., & Cole, J. T. (1992). Rural educational collaboratives: An economic and programmatic viewpoint. *Journal of Rural and Small Schools, 5*(1), 30-34.

Fogarty, R. (1991). Ten ways to integrate curriculum. *Educational Leadership, 49*(2), 61-65.

Herzog, M. J., & Pittman, R. B. (1995). Home, family, and community: Ingredients in the rural education equation. Phi Delta Kappan, 77(2), 113-118.

Hurd, P. D. (1991). Why we must transform science education. *Educational Leadership, 49*(2), 33-35.

Jackson, P. (1983). The reform of science education: A cautionary tale. *Daedalus, 112*(2), 143-166.

National Research Council of the National Academy of Sciences. (1996). *National Science Education Standards*. Washington, DC: National Academy Press.

National Science Teachers Association. (1993). *Scope, sequence, and coordination of secondary school science, Vol. 1: The content core, a guide for curriculum designers*. Washington, DC: National Science Teachers Association.

Neurath, O., Carnap, R., & Morris, C. (Eds.). (1995). *International encyclopedia of unified science. Vols. I and II*. Chicago: The University of Chicago Press.

Office of Technological Assessment. (1989). *Linking for learning: A new course for education*. (OTA-SET-430). Washington, DC: U.S. Department of Education, Office of Research and Improvement.

Pipho, C. (1965). Urban school problems and solutions. *Phi Delta Kappan, 77*(2), 102-103.

Prather, J. P. (1996).Geology education and the problem of scientific enlightenment. *Science Educator 5*(1), 7-11.

Prather, J. P. (1995). Rationale for an integrated approach to teaching science in the rural school. Chapter five in Otto, P. B. (ed.), *Science Education in the Rural United States: Implications for the Twenty-First Century* (pp. 37-58). Columbus, Ohio: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (1995 Yearbook of the Association for the Education of Teachers in Science).

Prather, J. P., Hartshorn, R. L., & McCreight, D. A., (1988). A team leadership program: The elementary science education institute (ESEI). *Education, 108*(4), 454-462.

Rhoton, J., Field, M. H., & Prather, J. P. (1992). An alternative to the elementary science specialist. *Journal of Elementary Science Education, 4*(1), 14-25.

Sher, J. (1995). The battle for the soul of rural school reform. *Phi Delta Kappan, 77*(2), 143-148.

Sher, J. (1988). Why rural education has not received its 'fair share' of funding, and what to do about it. *Journal of Rural and Small Schools, 2*(2), 31-37.

Stern, J. D. (1994). *The condition of education in rural schools*. Washington, D.C.: U.S. Department of Education Office of Educational Research and Improvement.

Theobald, P., & Nachtigal, P. (1995). Culture, Community, and the Promise of Rural Education. *Phi Delta Kappan, 77*(2), 132-135.

Tyack, D. (1974). *The one best system*. Cambridge, MA: Harvard University Press.

Vars, G. F. (1991). Integrated curriculum in perspective. *Educational Leadership, 49*(2), 14-15.

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EQUITABLE SCIENCE FOR STUDENTS WITH DISABILITIES

Throughout the 1980s and into the 1990s, students with exceptionalities have been mainstreamed in general education classes with increasing frequency. National policies on mainstreaming, the Regular Education Initiative (REI), and inclusion have all served as impetus for the promotion of the general education classroom as the least restrictive environment. This, of course, has different meanings depending upon the exceptionality to be addressed. Subsequently, teachers have been faced with a bewildering variety of adjustments to make learning meaningful and appropriate for all students.

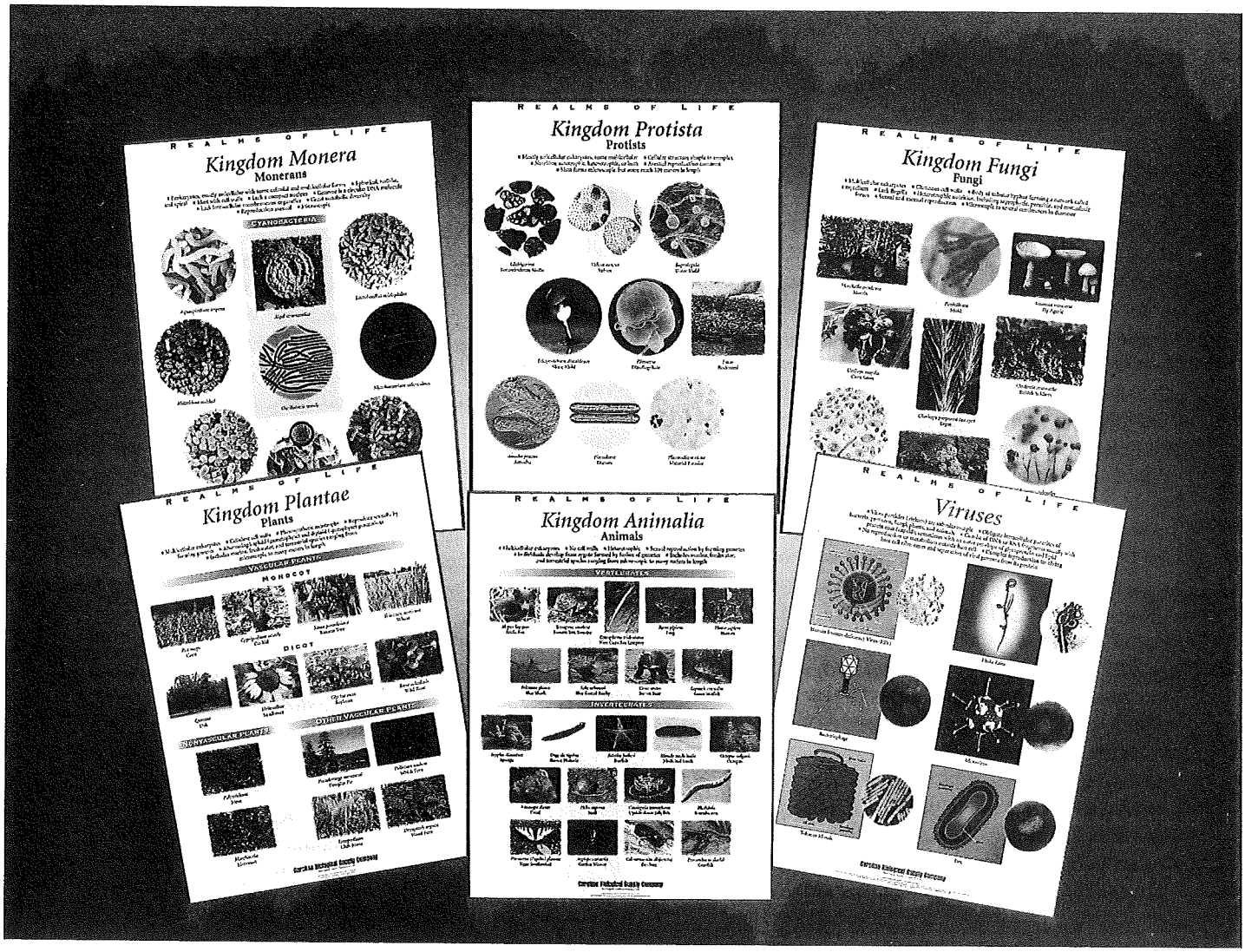
Historically, the disabilities at the forefront of inclusion policies have been of the physical variety. However, as the last one and a half decades has demonstrated, teachers must also concern themselves with non-physical disabilities such as learning disabilities and behavioral disorders, among others. By definition, full inclusion requires teachers to make their classrooms and the activities/materials used within their classrooms to be relevant and functional for students possessing virtually any of a number of disabilities. Barriers to effective mainstreaming of disabled students have been identified as including lack of time (Williams & Algozzine, 1979), inadequate materials, teachers' lack of necessary skills, and negative teacher attitudes toward mainstreaming (Hudson, Graham & Warner, 1979). Efforts to address these issues have been made, albeit inconsistently, over the past two decades. Atwood and Oldham (1985) reported that in inquiry-oriented settings, 55% of teachers responding to one survey ranked science as the easiest subject with which to integrate exceptional students. Positive elements of science instruction were identified by teachers as including concrete hands-on activities, less need for language skills, high levels of group interaction, and science's provision for individual differences and success. Moreover, mainstreaming students with disabilities has a positive effect on other students. Richardson (1994) reported that general education students seemed to learn more and learn it better when working with students having disabilities.

Around 1980, the Center for Multisensory Learning at the Lawrence Hall of Science (University of California-Berkeley) developed a set of science materials and activities called SAVI/SELPH: Science Activities for the Visually Impaired and Science Enrichment for Learners with Physical Handicaps. Among the materials specifically designed for use with SAVI/SELPH were braille-printed metersticks and volume measures, magnetized cups for ease of handling, and so forth (MacDougall, Schnur, Berger, & Vernon, 1981). MacDougal et al. (1981) observed that fifth grade students with learning disabilities working with hands-on materials (such as SAVI/SELPH) behaved more positively and with less frustration than was the case in non-hands-on classroom sessions. However, the SAVI/SELPH materials were not specifically designed for use with students having other than visual or physical impairments. Scruggs and Mastropieri (1994) described how use of a microscope was adjusted to meet the needs of students with disabilities. Tunnicliffe (1987) described science equipment modifications for students with physical and visual impairments. The Americans With Disabilities Act has addressed virtually everything from the provision of braille room signs to height specifications for laboratory tables.

Relatively few studies are reported in the literature concerning the modification of science activities specifically for use with students who are learning disabled (LD) or behaviorally disordered (BD). Only occasionally do science teachers speak of adjusting materials to address the needs of students with disabilities. Wielert and Sheldon (1984) offered suggestions on how to modify curricula to meet the needs of students with mild retardation. An NSF-sponsored program designed to help high school special education teachers update their science knowledge and share their teaching strategies and ideas for teaching science was conducted at Southern Illinois University-Carbondale in the mid-1980s (Sullivan & Petersen, 1986), and a two-year Illinois Scientific Literacy-sponsored project designed to help teachers in grades 3-8 retool science activities and assessments for use with both learning/behavioral disabled students and regular students was conducted at Western Illinois University from 1994 through 1996 (Finson, Ormsbee, Jensen, & Powers, 1996).

Students with LD and BD have average or above average intelligence, but tend to be academic underachievers for a variety of reasons (Hallahan & Kauffman, 1986), including (but not limited to) difficulty processing information in one mode or another, not responding to the typical incentives offered in the educational environment, and needs for consistent structure in the classroom along with individualized behavior management plans (Morgan & Jenson, 1988; Lerner, 1993). Similarly, students possessing physical disabilities often prove to be at or above average in intelligence. Although stricken later in life, the noted theoretical physicist Steven Hawkins is an example of such an individual. Students whose needs are not addressed in science instruction and who are not appropriately and actively engaged in learning science will typically fare poorly in science. And the root cause cannot be pinned on lower ability or intelligence.

The most recent *Annual Report to Congress on the Implementation of IDEA* (U.S. Department of Education, 1995) reported that 75% of the 4.6 million students with disabilities in this nation's schools received some or all of their instruction in general classrooms. If science educators truly believe that all students should become scientifically literate, such as is promoted in the *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993) and the National Science Education Standards (National Research Council, 1995), then science instruction cannot be delivered only for the typically achieving



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student. Besides the large number of exceptional students, the U.S. Department of Education figures also reveal a significant population of students who are "at risk" with respect to science literacy.

Adapting science activities and materials to address the specific learning difficulties encountered by students with disabilities has not been, in science education or general education, a high priority. As a result, few commercially-prepared science activities exist that are suitable for disabled populations in mainstreamed settings. In addition, for such activities to be readily acceptable to general classroom teachers, they must be suitable for the divergent needs of the general student population as well. If science teachers are to modify their instruction, they must recognize the merit of doing so and be knowledgeable of manageable strategies to successfully undertake those activities. But how do science teachers begin to deal with this complex issue? Collaboration between general and special education teachers has been proposed as one means of providing the most appropriate education for all students (Idol, Nevin, & Paolucci-Whitcomb, 1993) and is likely an effective avenue through which students with disabilities can become more scientifically literate.

Most teacher education programs do not include collaboration of this nature in their preservice or inservice programs. Science educators at the collegiate level need to become more aware of specific needs of students with disabilities and how to guide preservice and inservice teachers in learning to address these needs through science activity and material modification. Collaboration between collegiate science and special education faculty is critical if this is to be accomplished. For those science teachers already in the field, collaborative efforts with special education faculty in their own schools may be the best place to begin. This should not suggest that science teachers yield their science teaching to special education teachers. The suggestion is for science teachers to work with special education teachers to learn about characteristics of various disabilities and how to best teach to students possessing those disabilities. The solutions derived may be as simple as reformatting worksheets and exams (larger print, more white space, etc.), or providing braille markers on metersticks. But such solutions can make all the difference in the world to disabled students.

The implications for modifying science instruction for disabled students are clear. Many science activities used in classrooms are in need of modifications to address the needs of special populations. Not to do so will likely result in a continuation of the status quo, keeping science a difficult subject for students with disabilities to master, reducing the likelihood of such students becoming scientifically literate, and in effect steering too many such students away from science as a potential career.

References

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

Atwood, R.K. & Oldham, B.R. (1985). Teachers' perceptions of mainstreaming in an inquiry oriented elementary science program. *Science Education*, 69 (5), 619-624.

Finson, K.D., Ormsbee, C.K., Jensen, M., Powers, D. (1996). Science activities retooling for special education project. Macomb, IL: Western Illinois University. (Report to the ISBE Scientific Literacy Office.)

Hallahan, D.P. & Kauffman, J.M. (1986). *Exceptional children.* Englewood Cliffs, NJ: Prentice-Hall.

Hudson, F., Graham, S. & Warner, W. (1979). Mainstreaming: An examination of the attitudes and needs of regular classroom teachers. *Learning Disability Quarterly*, 2, 58-62.

Idol, L., Nevin, A., & Paolucci-Whitcomb, P. (1993). *Collaborative consultation* (2nd ed.). Austin, TX: Pro-ed.

Lerner, J.W. (1993). *Learning disabilities: Theories, diagnosis, & teaching strategies* (6th ed.). Boston, MA: Houghton-Mifflin.

MacDougall, A., Schnur, R., Berger, C., & Vernon, D. (1981). The use of activity-centered science activities to facilitate the mainstreaming of elementary school children with special needs. *Science Education*, 65 (5), 467-475.

Morgan, D.P. & Jenson, W.R. (1988). *Teaching behaviorally disordered students: Preferred practices.* New York: Merrill.

National Research Council. (1996). *National science education standards.* Washington, D.C.: National Academy Press.

Richardson, M. (1994). We all learned together. *Science Scope*, 17 (6), 68-70.

Scruggs, T.E. & Mastropieri, M.A. (1994). Refocusing microscope activities for special students. *Science Scope*, 17 (6), 74-78.

Sullivan, M.J. & Petersen, B. (1986). *Recognizing the superior science teacher of the handicapped.* Carbondale, IL: Southern Illinois University. (ERIC Document Reproduction Service No. ED 271 301)

Tunnicliffe, S-D. (1987). Science for pupils with special needs — Activities for physically and visually impaired pupils. *School Science Review*, 69 (247), 277-285.

Wielert, J.S. & Sheldon, D.S. (1984). Make science accessible to all your students. *The Science Teacher*, 51 (4), 56-58.

Williams, R.J. & Algozzine, B. (1979). Teachers' attitudes toward mainstreaming. *The Elementary School Journal*, 80, 63-67.

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ARTICLES

Donald C. Dosch, Susan C. Styer, Raymond Dagenais, John Eggebrecht,
Norman J. Merozak, Margaret N. Park, and David Workman
Illinois Mathematics and Science Academy

DEVELOPING SCIENTIFIC CAPACITY IN ALL LEARNERS: INTEGRATED SCIENCE AND THE SCIENCE CONTENT STANDARDS

Introduction

The 21st century will hold great opportunities for people who can recognize and act on them. One of the key enablers will be a developed and practiced scientific capacity. Science curriculums are designed to include varying degrees of breadth and depth of the content considered most worthy. Integrated Science at the Illinois Mathematics and Science Academy (IMSA) represents a strategy to address the need to develop scientific capacity in alignment with the expectations outlined in the *National Science Education Standards* (1996), the *Benchmarks for Scientific Literacy* (1993), and the *Illinois Science Content Standards* (1996) as well as other important outcomes.

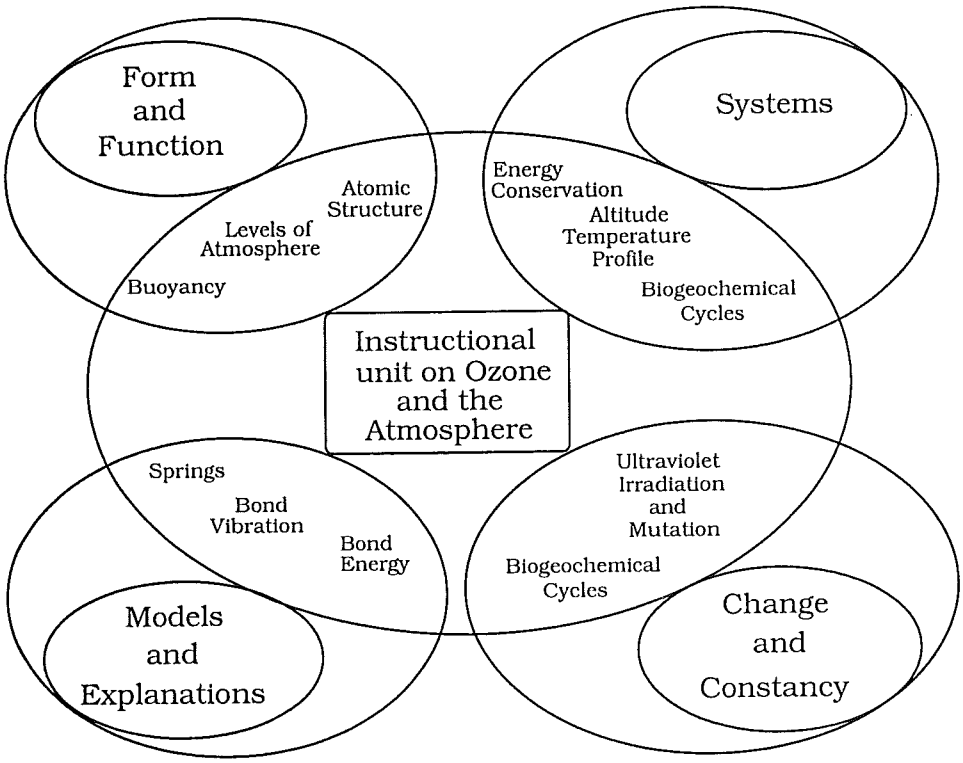


Figure 1. Factual and conceptual outcomes are displayed as clustered around an instructional unit on ozone and the atmosphere, but also clustered by the one unifying concept detailed in the Illinois state science education goals with which they align. The instructional unit is depicted in a box in the center of the figure. The four unifying concepts are depicted at the four corners.

An integrated core science curriculum has been offered as an alternative to the disciplinary courses in Physics, Chemistry, and Biology at IMSA since the fall of 1993. This course, Integrated Science, adapts most of the major concepts encountered in the disciplinary courses but presents them in a novel, interconnected way. The newly created instructional units accentuate the interconnections between important, foundational concepts in the disciplines.

Throughout the process of writing this curriculum, the national science standards, primarily the *Benchmarks for Scientific Literacy* (1993) and the National Research Council *National Science Education Standards* (1996) served as guideposts.

The Integrated Science curriculum aligns particularly well with the *Illinois Science Content Standards* (1996) which drew heavily upon these national recommendations. In the past, Illinois state science standards have consisted mainly of goal statements and objectives presented in a rigid, prescriptive curriculum. Subject matter from one discipline was disconnected from that of others. In contrast, the new state goals feature unifying concepts and practices which recognize the interdependence in the natural world explored by science. These goals not only address some of the concepts students ought to understand, but also the science skills they should be able to practice at various points in their education.

What stands out as the major difference between Integrated Science and the disciplinary core at IMSA is primarily a pedagogical choice. Integrated Science utilizes "learning in context" to engage students and support their learning (Eggebrecht, et al., 1996). Realistic problems, such as a study of life

in a rain retention pond or the design of a self-sufficient Mars base, are used as rich platforms to engage students, organize content, and guide its sequence. In this approach, students encounter science content as if they were scientists and engineers; they recognize a need to learn in order to address a problem set before them. Problem platforms differ from a thematic approach in that students are actively involved in defining questions and finding solutions and not simply encountering a syllabus of material addressing an interdisciplinary theme. As a result of the problem platform approach of Integrated Science, students experience more self-guidance in their education.

This self-guidance is realized in two ways in Integrated Science. First, the course is firmly based in guided discovery. Students are required to experiment and think about the laboratory activities. Post-laboratory sessions typically employ discussions in which students cooperatively synthesize the fundamental concepts from data. Second, the course is guided, in part, by what students wish to learn. Early in each semester, students articulate questions which they believe they need to answer to satisfactorily address the problem platform..

We believe the use of problem platforms in Integrated Science align exceptionally well with national and Illinois state standards which call for students to learn "science through inquiry". In our curriculum students formulate questions, conduct experimentation and literature research, and evaluate evidence pertaining to the problem platform. In addition to providing an interesting context for learning, the problem platforms partially define the content about which students inquire.

We contend that integration supports student learning of "science through inquiry" effectively in that student questions are not restricted by disciplinary boundaries. The absence of discipline identification not only encourages scientific inquiry, but also the unification of factual knowledge into richer concepts, and an understanding of the interaction of science, technology, and society. These are all essential knowledge and skill areas of the Illinois standards for science. In addition, an integrated science program addresses the science section on the Prairie State Excellency exam scheduled for the 1999 school year and, if the Benchmark exams become a reality, could provide a means for science requirements to be met by the early high school testing.

Logistically, Integrated Science students meet for a double period block every academic day. The course is offered to incoming Sophomores and continues through the first semester of the Junior year. Integrated Science as we practice it constitutes the equivalent of a three-year program. We realize two advantages in scheduling for a double period daily: a teacher's student contact load is reduced to half and the teacher and student remain together for a longer period of time during the day. Both advantages, measured as more time and less fragmentation, allow more substantive teacher-student interactions. Periodic interviews with students result in meaningful narrative progress reports to parents. Ultimately, through these interviews our expectations for a student's academic achievement and personal growth are communicated more clearly than was possible in more traditional approaches to science learning.

Integration within Units

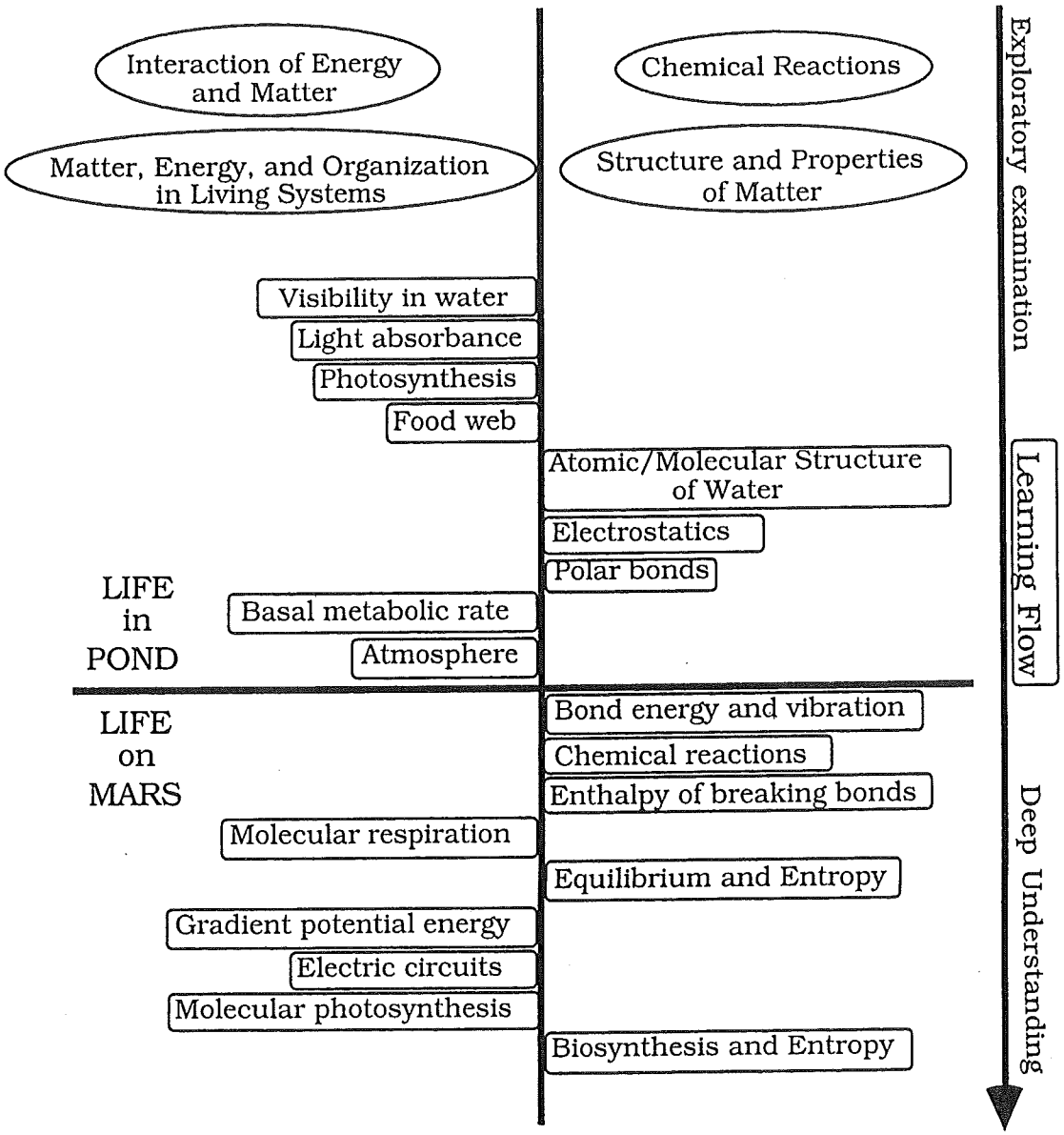
The initial problem platform encountered by students in the first semester of Integrated Science focuses on the ecosystem of a water retention pond, a tangible system that can be physically studied. At the beginning of the second semester, a more abstract problem platform is introduced which asks for a design of a self-sufficient Mars base. By following the pond problem platform, the Martian base becomes a vehicle to explore technological applications of some of the environmental concepts we examined in the pond. Some student questions, as anticipated, concentrated primarily on life support mechanisms of a base design. In particular, students were interested in the environmental conditions on Mars and how conditions suitable to maintain human life could be established. These student inquiries lead us to present a prepared instructional unit emphasizing the Earth's atmosphere.

In the design of this unit we balanced the interests from three separate but sometimes overlapping foci. The first focus was the students themselves who expressed a need to gather information on life support in order to design a Martian base. The second focus was the National Research Council's *National Science Education Standards.* We wanted to ensure alignment of what our students encountered in class and these standards. As the Illinois state goals and standards became available, we incorporated them into our curriculum. The third focus was the Integrated Science teachers, who wanted to select concepts and instruction relevant to the platform but not necessarily articulated in the standards.

Figure 1 depicts some of the concepts and instructional pieces that resulted from the synthesis of these three foci. The instructional pieces balance the two forces of student articulated interest and need and state standards. Writing curriculum which is true to state goals but responds to student inquiry is a challenge. Students must master factual and conceptual goals and standards, yet their inquiry may or may not be directed toward these goals. Our experience suggests that students often ask general questions when the concepts we want them to encounter are specific. For instance, a student will ask a general question about a Martian base design life support system, one with no established, correct answer. What we as teachers want students to understand is Earth life support systems and not Martian base ecology. When students ask about Martian base atmosphere, they speak from fantasy that excites and engages them. In response, we provide instruction in the Earth's atmospheric composition and important chemical processes.

We acknowledge that not all questions can be as easily molded to align with state goals as the example given here. But, if the problem platform is constructed carefully and engages students sufficiently, then students will ask many questions. The teacher can choose which questions are more appropriate for class time and which are more appropriate for student independent study.

Figure 2. Factual and conceptual outcomes are displayed in the chronological order (top to bottom) in which students encounter them in the course, beginning with a pond problem platform and leading into a Mars problem platform. The outcomes chosen highlight the interweaving of four of the NRC's National Science Education Standards outlined in ovals across the top.



Integration over Time

Part of the educational philosophy of Integrated Science is to present science concepts and facts to students in a way that practicing scientists might encounter them, through the use of realistic problems. However, scientists seek connections or explanations by progressively adding to what they already know in order to understand a system or issue deeply. In our program, students are exposed to major concepts several times as well as in multiple contexts.

Figure 2 shows the multiple contextual encounters students have with some of the NRC standards as they progress through both the pond and Mars problem platforms. The standards chosen to demonstrate this idea are: 1) interaction of energy and matter; 2) matter, energy, and organization in living systems; 3) chemical reactions; and 4) structure and properties of matter.

The facts and concepts identified in Figure 2 illustrate the recursive nature of the curriculum, and not its comprehensiveness. Examining a concept repeatedly and from

more than one perspective or in more than one context adds to the richness of encounters necessary to develop a sense of the concept's importance. We emphasize the ability to apply knowledge gained in any arena to the solution of novel problems. Again, this is what we consider to be the practice of science or engineering. The reiterative examination of concepts in varied contexts introduces students to this way of thinking and fosters the application of knowledge.

Re-examining concepts from different perspectives or in different contexts after the passage of time requires retention of knowledge. We do not expect students to master a concept at first exposure. Eventual mastery is reinforced through repetition such as using a concept in another context or addressing another question. As an example of how repetition leads to depth of understanding, consider the number of times photosynthesis is encountered by students (Fig. 2). Before students encounter the process of photosynthesis, they examine photosynthetic organisms which block or absorb light passage through the pond water. Later, they look at photosynthesis in a general way as important in maintaining the food web in the pond. Again, photosynthesis is considered, but in the context of atmospheric gases. Finally, photosynthesis is examined at the molecular level. Each encounter with the concept of photosynthesis is driven by the students as they ask questions pertinent to a particular problem.

Each successive encounter with photosynthesis is also supported by students' growing knowledge base. The right side of Figure 2 depicts a deepening, recursive treatment of the concept of the chemical bond. This starts with atomic and molecular structures in water and continues through the nature of bonds, bond energy and enthalpy of bond breaking, through entropy, to biosynthesis of bond, which is contemporary with molecular photosynthesis. The weaving of these four concepts demonstrates a significant advantage to integration of the scientific disciplines: there is no separation in time when students encounter important concepts from the life, physical, and Earth and space sciences.

Conclusion

We contend that the inquiry-based education in Integrated Science enhances students' belief in personal control, builds from students' personal values and interests, and increases motivation to learn. According to the American Psychological Association Principles (1992), these conditions promote both breadth and depth of knowledge gained and the duration with which it is retained. We expect Integrated Science students to retain knowledge long-term (due to repeated exposures in multiple context) and develop advanced thinking skills early in their education (due to the inquiry-based nature of the curriculum). As a result, we expect Integrated Science students to demonstrate a strong interest in pursuing science further and an ability to meet high academic goals in science related work.

We also believe that Integrated Science has the flexibility to meet the needs of a variety of students and programs. It could serve as a general science course, an alternative to a discipline-based program (as it is here at IMSA), a replacement of a more traditional approach to science, or a small piece of another total program.

Finally, and most important to us, Integrated Science supports and enhances student learning unlike any other courses in our experiences. The Integrated Science curriculum takes advantage of the problem-based approach: it provides students with a context for learning and supports their inquiry. It also is designed in such a way so that the national and state goals and standards are met. The most important of these for us is teaching "science through inquiry". Our students have responded positively; two wrote at the end of their sophomore year:

> This was the first true science course that I have ever taken. Every other one was merely a plug and chug course in memorization of scientific trivia. Understanding what governs the systems we studied wasn't important. All that counted was how well you could remember the vocabulary from that section. Integrated Science has been very different in that respect. We have actually gone in-depth enough to begin to comprehend the laws which govern the universe.

> The reason for learning in regular science classes is to pass tests it seems. With Integrated Science, the reason you learn is because you feel you want to.

Grammar aside, these students' attitudes are the very things we try to promote. A teacher's best effort in teaching is wasted if students do not want to learn. Integrated Science offers students a chance to learn what they want to learn in the context of a realistic problem platform. As students accept the responsibility of learning what for them is important, we guide them toward alignment with state and national standards.

Learners, such as those in Integrated Science, who achieve a deep and extensive understanding of the facts, unifying concepts, principles, procedures, and tools of science will develop an expanded scientific capacity. Being able to draw upon this scientific capacity will serve them well as they encounter diverse situations and challenging problems in their future.

References

American Association for the Advancement of Science. (1993). *Benchmarks for Scientific Literacy.* Oxford University Press, New York.

Eggebrecht, John, Raymond Dagenais, Don Dosch, Norman J. Merozak, Margaret N. Park, Susan C. Styer, and David Workman. (1996). Reconnecting the Sciences. *Educational Leadership,* 53(8):48.

Illinois State Board of Education. (1996). *Illinois Academic Content Standards* (Review and Comment Version). Springfield, Illinois.

McCombs, B.L. (1992). Learner-Centered Psychological Principle: Guidelines for School Redesign and Reform. American Psychological Association, Washington, D.C.

National Research Council. (1996). *National Science Education Standards.* National Academy Press, Washington.

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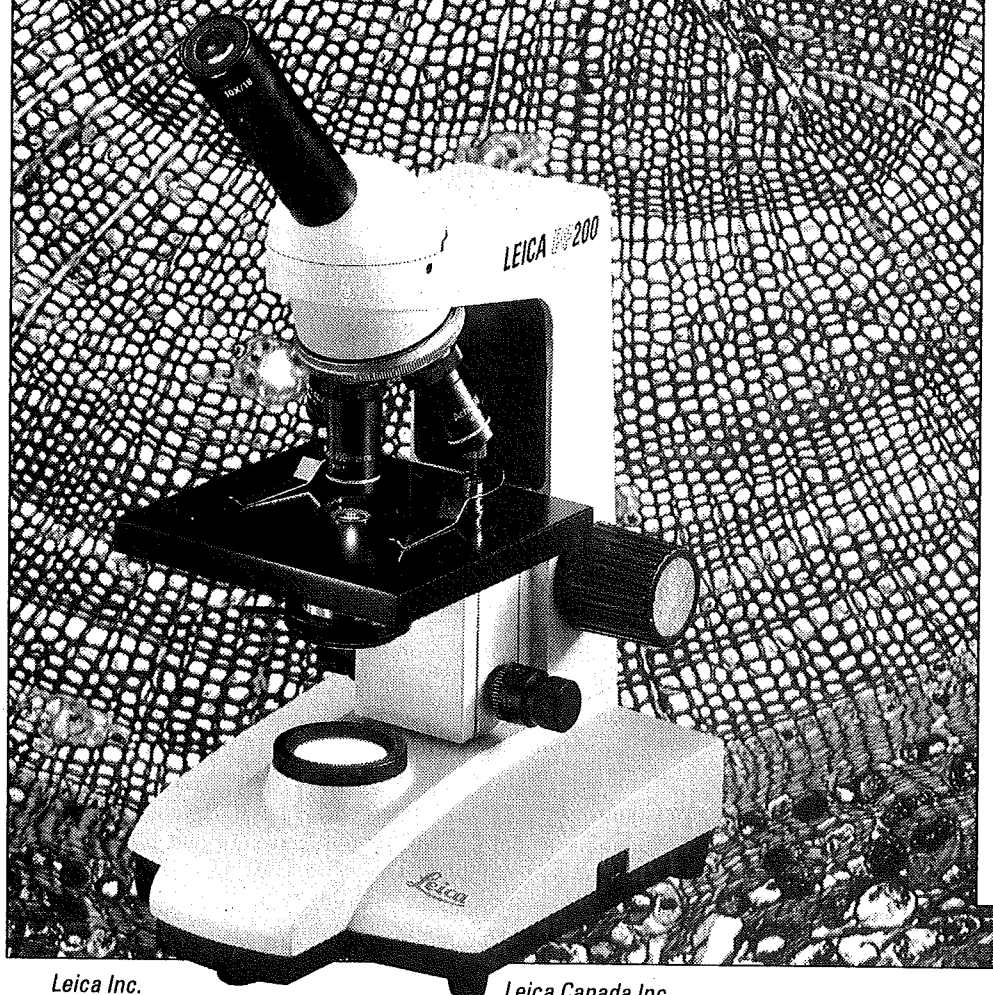

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Newton's Apple	http:///ericir.syr.edu/Newton/welcome.html
JPL Main Home Page	http:///www.jpl.nasa.gov/
Galioleo Mission to Jupiter	http:///www.jplnasa.gov/galileo
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ATLAS Experiment	http:///remus.jpl.nasa.gov/
GPS Networks	http:///milhouse.jpl.nasa.gov/
AVIRIS instrument	ftp://opelia.jpl.nasa.gov/README.htm
TOPEX/Poseidon Mission	http:///topex-www.jpl.nasa.gov/
ASTER Instrument	http:///haleakala.jpl.nasa.gov/asterhome.html
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University of Kansas	http:///kuhttp.cc.ukans.edu/swis/UDK/KUhome/KUHome.html
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Carbon Dioxide Data	http:///gemd.gsfc.nasa.gov/CO2/co2a.html
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Internet Connections List	http:///info.cern.ch/hypertext/DataSources/Yanoff.html
CUSI Search Engine	http:///web.nexor.co.uk/public/cusi/cusi.html
WebCrawler Search Engine	http:///www.biotech.washington.edu/WebCrawler/WebQuery.html
Xerox PARC Map Viewer	http:///pubweb.parc.xerox.com/map
Exploratorium Science Museum	http:///www.exploratorium.edu/
NASA Spacelink	http:///spacelink.msfc.nasa.gov
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Guide to NASA Resources	http:///naic.nasa.gov/naic/guide
Smithsonian Museum of Natural History	http:///mnmhwww.si.edu/nmnhweb.html
Smithsonian Air and Space Museum	http:///cdps.nasm.edu:2020/homepage.html
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CNN Special Report—Mars: Life Signs?	http://cnn.com/TECH/9608/mars.life.special/index.html
Astronomy	http://web.mit.edu/asante/www/siteday.html
	http://www.sol.com.sg/cgi-Bin/mathquote.cgi
Children	http://openweb.vassar.edu/library/kathy/children.html
	http://www.cochran.com/com/theosite/Ksites.html
Program (mathematics) for Gifted Youth	http://kanpai.stanford.edu/epgy/pamph.html
ERIC: Disabilities and Gifted Education	gopher://ericir.syr.edu:70/11/Clearinghouses/16houses/ERIC_EC
The Council for Exceptional Children	http://www.cec.sped.org/home.htm

SPECIAL INTERESTS

Sheila Ashbrook
MAST
Department of Materials Science and Engineering
1304 W. Green Street
Urbana, IL 61801

MATERIALS SCIENCE AND TECHNOLOGY: DISCOVERING THE WORLD AROUND US

Having completed the refrigeration and heating experiments on his polymer sample, the high school junior decided to run his own quick experiment before heading to school. He popped the sample in the freezer, grabbed a quick breakfast, retrieved the sample, and tried to bounce it as before. To his surprise and dismay, the sample shattered, destroying the product of the previous days' labors. Thinking quickly, the astute student decided to present this as a discovery rather than a disaster, and happily headed for school.

"Concrete canoes?" "No way!!" The physics teacher smiled to herself, she gets the same response every year when she introduces the module on concrete. As the students perform the labs in the module, she knows that many of their perceptions about the widely used material will be modified, and that they will gain a new appreciation for that "uninteresting" cement they see all around them.

"Corrosion, corrosion, we have to stop the enemy!!" The students in the metals lab joke about defending the universe from oxidation, but learning takes place as well as they explore ways to protect their company's metal products (and perhaps destroy those of the competition!)

Science teachers know that to teach effectively, they must first attract their students' attention, and then engage them in relevant and high-interest learning activities. Although currently much improved, science textbooks seldom excite students, and many texts and labs still seem divorced from things that happen in the real world. The Materials Science and Technology (MAST) curriculum, on the other hand, brings real life materials into the classroom, and encourages student discovery and investigation of the "stuff" of the world around them. They can investigate the workings and nature of the homes they live in; the clothes they wear; the computers, stereos, and telephones they use every day; the roads they drive on; and many other common objects and materials. Meanwhile, they can develop an understanding of the basic science principles which underlie their personal use of materials, and which also impact on major changes and advancements in our society.

The specific content of the MAST curriculum can be considered important and relevant for secondary level students for two additional reasons. First, the field of materials science and engineering is an interdisciplinary one, which can enable students to conceptualize the connections between physics, chemistry, mathematics, and other fields. Although curriculum integration is currently encouraged to promote better understanding of science concepts, many educators have difficulties finding ways to achieve this in a non-artificial manner. The MAST curriculum enhances integration through the incorporation of special topics into conventional physics, chemistry, and other science courses, or through use of the modules as a specialized course or unit.

Second, there is an almost total lack of awareness of the field of materials science, even though it enables many technologies encountered daily by students: information systems, aerospace, automotive, biotechnology, electronics, and others. Understandings of this content area can be of benefit to students in their everyday lives, as well as introduce the consideration of a career in a field where there is a great need for more well-trained scientists.

In developing the MAST curriculum, we realized that most teachers would be unfamiliar with the content area, and that teacher input into the development of the modules would be important in determining what information and activities should be included. We therefore held a series of summer workshops for teachers at which the teachers were first trained in materials technology and then worked with us to develop the curriculum modules. The modules were tested by the teachers in their classrooms during the following year, revised the following summer, tested again, and revised again prior to publication in Fall 1996. Although we would like to continue revision of some aspects of the modules, we believe that the present curriculum represents a well-tested set of information and activities which should be accessible to most high school science teachers.

The MAST modules on seven different topics represent complete curriculum supplements, ranging from 60-100 pages, and includes: background information on scientific principles for teachers and students, demonstrations, laboratory activities, and suggestions for discussion and review/assessment strategies. The laboratory activities vary in complexity and in the types of materials required, so teachers can select activities appropriate for their own specific teaching context.

MAST Overview: Descriptions of the Major Classes of Materials and their Applications

Semiconductors/Building Blocks for Microelectronics: Semiconductors are responsible for the advances in electronics which have had a major impact on our lives during the past 50 years. Students explore the physical properties and applications of semiconductors in labs related to electrical conductivity and resistance, photoconductivity, LED's, and more.

Metals/They're Everywhere!: Metals are a widely used material because of their special properties: strength, ductility, high melting point, thermal and electrical conductivity, and toughness. Students learn about crystal structure, processing, mechanical properties, heat treatment, corrosion, and recycling in hands-on labs.

Concrete/A Material for the New Stone Age: Concrete is by far the most widely used engineering material by volume. Students construct a concrete boat, and investigate cement hydration, material properties, and making concrete.

Polymers/The Material of Choice: Polymers are substances continuing a large number of structural units joined by the same type of linkage. Man-made or natural, polymers already have a range of applications which exceeds that of any other class of material available to man. Students discover the properties of plastics, synthetic nylon, and silly putty, and consider the implications of recycling.

Ceramics/Windows to the Future: Ceramics are everywhere and play an important role in many new technologies. Students find out about fiber optics, glass blowing, relection/refraction, and mechanical properties of ceramics.

Composites/The Designer Materials: Composites are physical mixtures of two or more different materials. Advanced composites include fiberglass and graphite. Students learn how mixtures of materials can result in improved properties; investigate fibers, matrices, and laminates.

Energy/Nature's Magic: Energy is required for materials processing and is a foundation topic for science inquiry. This module covers fossil fuels, renewable sources, and nuclear energy.

The modules can be used in whole or in part to supplement many traditional science courses or programs, such as chemistry, physics, earth science, tech-prep, and general science. Individual modules could also be used as integrated science units or the entire curriculum could be used as an integrated secondary science course. We encourage teachers to use these materials in their classrooms and to contact us with any assessments, comments, or suggestions they may have. The MAST modules can be downloaded free from WWW at http://matsel.mse.uiuc.edu/~tw. They can also be purchased for $40 for the 8 modules by writing to the above address. MAST is a National Science Foundation project.

1997 CLEAN WATER CELEBRATION SOARING TO NEW HEIGHTS

The 1997 Clean Water Celebration 1997 is a unique event for middle school students in grades five through nine. Students will be offered numerous educational experiences to increase knowledge about the importance of water conservation. Held at the Peoria Civic Center each spring, the Clean Water Celebration is slated for March 10. Something new this year are three multimedia presentations on global awareness, leadership, and experiences in space presented by former NASA Challenger astronaut Mike Mullane. Although entrance to the Clean Water Celebration is free, a surcharge of $1.50 per person is required to cover the astronaut's expenses.

1997 will be the CWC's fourth yuear. This event has grown each year to become an almost magical educational experience combining both the arts and science to education on such issues as aquatic life, riverbank erosion and water quality. Students will have chances to view water issues through the eyes of scientists, artists, wildlife managers, ecologists, industry leaders and educators. This is truly a unique experience for students. The CWC makes a very successful mesh of dedicated people from all over Central Illinois working toward the preservation of our Earth's most precious resource.

The Clean Water Celebration is free to all students and comprises three styles for learning experiences: exhibit booths, breakout presentations by high school students and professionals and special programs. Every student will have three study questions from each booth creating hands-on learning stations. There are many things to do so don't miss the 1997 Clean Water Celebration!

For More Information Contact:
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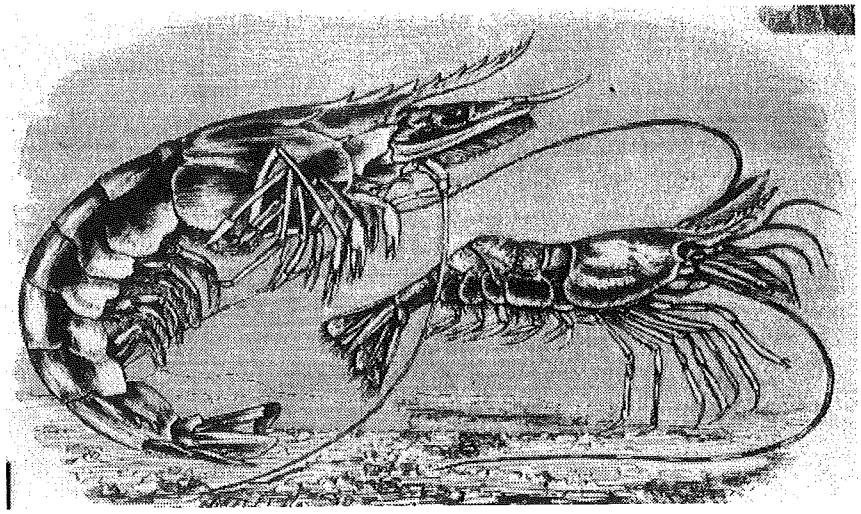


AMERICANS BOMB QUIZ ON BASIC SCIENCE

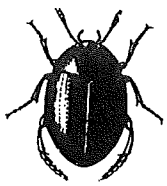
Fewer than half of American adults understand that the Earth orbits the sun yearly, according to a survey of basic scientific knowledge. Only about 25% of American adults got passing grades in a survey by the National Science Foundation of what people know about basic science. The worst showing came when those surveyed were asked to define scientific terms. Only about 9 percent knew what a molecule was, and only 21 percent could define DNA. But even more fundamental questions stumped many: Less than half knew that earth orbits the sun annually. In a test of environmental understanding, a third of Americans surveyed understood the effects of a thinning of the ozone layer, 14 percent could identify locations of ozone holes and only 5 percent could give a scientific explanation of acid rain. On a 10-part quiz testing scientific understanding, only 27 percent of the American adults surveyed could answer seven or more questions. The national survey of 2,006 adults found that 72 percent believe science research is worthwhile. Only 13 percent took the opposite view. The survey found many Americans afraid of some aspects of science. Support for nuclear power was about evenly split, with 43 percent saying its benefits were greater than its risks, and 42 percent taking an opposite view. Fourteen percent were uncertain.

O.K. SCIENCE TEACHERS, TEST YOURSELVES!

Answers are at the end, along with the percentage in the survey who answered correctly.

1. The center of the Earth is very hot. (True or False)
2. The oxygen we breathe comes from plants. (True or False)
3. Electrons are smaller than atoms. (True or False)
4. The continents on which we live have been moving their location for millions of years and will continue to move in the future. (True or False)
5. Human begins, as we know them today, developed from earlier species of animals. (True or False)
6. The earliest human beings lived at the same time as the dinosaurs. (True or False)
7. Which travels faster, light or sound?
8. How long does it take for the Earth to go around the sun: one day, one month, or one year?
9. Tell me, in your own words, what is DNA?
10. Tell me, in your own words, what is a molecule?

Answers, along with the percentage who had correct responses:
1. True. 78 percent, 2. True. 85 percent, 3. True. 44 percent, 4. True. 79 percent, 5. True. 44 percent, 6. False. 48 percent, 7. Light. 75 percent, 8. One year. 47 percent, 9. DNA, or deoxyribonucleic acid, is a large molecule in the chromosomes that contains the genetic information for each cell. 21 percent, 10. Molecule is the smallest unit of a chemical compound capable of existing independently while retaining properties of the original substance. 9 percent.


SPEAKING OF SAFETY

James A Kaufman
Laboratory Safety Workshop
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Natick, MA 01760
(508)647-1900 Fax: 508-647-0062.

THE IMPORTANCE OF PLANNING

Recently, in a Denver high school, a physics teacher was doing a demonstration for his students. He was burning magnesium. When the reaction was over, his students asked him to perform the thermite reaction. He had not planned to do this demonstration. And he forgot how hot burning magnesium can be. He poured the thermite mixture into the container which had held the burning magnesium. The still too hot dish ignited the thermite and he lost his hand in the explosion. Several students were also injured.

As I thought about this tragedy, I could recall two other accidents from the more than 3,000 I've collected over the years. One involved a science teacher in Vermont and the other occurred in Massachusetts.

In Fall River, Massachusetts, a science teacher was demonstrating the various colors produced when chemicals burn. He arranged five crucibles on the front demonstration desk. Four of the five ignited and burned. The third one did not ignite. The students asked to see it burn so he checked with his hand to be sure it was really out. Then, sensing no heat, he opened a bottle of alcohol and poured it into the crucible. The Alcohol vapors ignited immediately and burned back into the bottle causing it to act like a flame thrower. The bottle shot burning alcohol on the face, chest and shoulder of a student in the first row. The student needed to be flown by helicopter to the burn center in Boston. She was in the hospital for over one month and required plastic surgery.

The Vermont science teacher worked at a private school. She was demonstrating the evaporation of a liquid by heating alcohol in a beaker on a ring stand with a Bunsen Burner. When the demo was over, the students gathered around the front table and asked to see it again. The science teacher opened a bottle of alcohol and poured some into a clean, dry beaker. She set the still open bottle on the front table and then poured the alcohol into the original beaker which was still being heated over the Bunsen Burner. The alcohol ignited explosively and several students caught on fire. One student struck the open alcohol bottle with his arm knocking it onto the floor and adding fuel to the fire. Four students were badly burned. One was in the hospital for six months, and she required extensive plastic surgery. The school is now litigating a six million dollar law suit.

In each of these three examples, the teacher performed a demonstration in a way that he or she had not really planned. The interest and enthusiasm of the students propelled the teacher ahead beyond what was really thought out and prearranged. Also, in each of these cases, the teacher failed to use a portable shield between the demonstration and the students. The result...injured students!

This is not just a concern for teachers doing demonstrations. This is an issue for all of us in labs. First, it is not uncommon for industrial chemists to visit schools and in the presentation perform demonstrations. Second, lab workers often have experiments which may appear not to have proceeded as planned. Proceed with caution.

Here are six ideas that might be helpful in preventing a reoccurrence of these kinds of accidents.

1. Demonstrations need to be planned and tested in advance. Contac us for the Dow "safe operating package" and 3M Hazardous Reaction Review.
2. Portable shields should be used between the demonstration, the students and the teacher. Researchers need them too.
3. When something goes wrong, put it aside and start over with new, clean, dry chemicals and equipment.
4. Try to imagine the ways in which the demonstration or experiment could fail so that you can anticipate problems.
5. Do not add a flammable liquid or solid under conditions where an ignition source may be present (This is the lab equivalent of pouring lighter fluid on a hot barbecue grill!). You would not believe the number of accidents that occur when trying to refill a hot or still burning alcohol burner.
6. Make sure you are wearing the proper protective equipment to protect yourself and serve as a good example for the students.

Speaking of Safety is written and edited by Dr. James A. Kaufman. The newsletter is designed and produced by Nancy Irving. Annual subscriptions (three issues) are $12.50. Many safety related materials are available from us. Contact: Laboratory Safety Workshop, 192 Worcester Road, Natick, MA 01760 (508)647-1900 Fax: 508-647-0062.

EDUCATORS' OPEN HOUSE

The St. Louis Science Center would like to invite educators to an Open House in the new Exploradome on Wednesday, February 12, 1997 from 3 to 7 p.m. Educators will have free entry to the new special exhibition "Africa: One Continent, Many Worlds." Light refreshments will be served. Call Joan Esserman, Education Programs Liaison, at 314/533-8493 (or E-mail at jesserma@slsc.org) for more information. No reservations or RSVP necessary.

SEND YOUR STUDENTS TO MARS...AND BEYOND

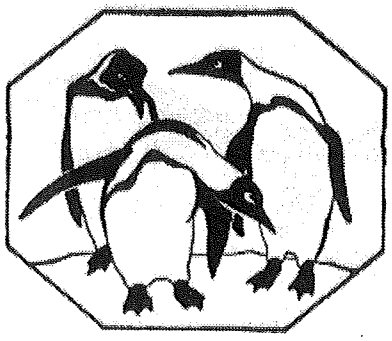
The NASA K-12 Passport to Knowledge (PTK) Initiative is a series of exciting electronic field trips. While targeted at the middle school level, these collaborative projects can be easily modified for both elementary and high school classes. PTK allows your students to experience real science, in real time, and with real scientists. Each module incorporates multiple modes of technology including live video, e-mail, a rich interactive web site, WebChat and CU-SeeMe sessions, classroom activities, and a detailed teacher's guide with resources.

Passport to Knowledge has two exciting projects planned for the 1996-97 school year. Half of the first project, titled Live from Mars, was aired on TUESDAY NOVEMBER 19, 1996. The second half will be broadcast THURSDAY APRIL 24, 1997, 13:00-14:00 ET. To find out more email <listmanager@quest.arc.nasa.gov> In the message body, write exactly these words: subscribe updates-lfm. Also, visit LFM's web site at http://quest.arc.nasa.gov/mars.

This spring, Live from Antarctica II will return to the icy continent, featured in the 1994-95 Passport to Knowledge module. This visit will focus on marine biology and the fascinating interaction of ocean, ice, seals, and penguins. The latest research on global climate change, ozone, UV radiation, and earth sciences will also be featured in new activities appropriate for elementary, middle, and high schools. Updated on-line resources and curriculum materials will be created to illuminate the new creatures and locations we will visit and the new researchers which we will encounter.

Live from Antarctica II will rely on collaboration between advanced NASA telecommunications and NSF's Office of Polar Programs, which funds and manages the United States Antarctic Program. Live telecast air dates are: THURSDAY JANUARY 23, 1997, 13:00-14:00 ET, THURSDAY JANUARY 30, 1997, 13:00-14:00 ET, AND THURSDAY FEBRUARY 6, 1997, 13:00-14:00 ET and can also be viewed on NASA Select-TV and many PBS stations.

For more information contact your closest PTK Teacher Advocates for Illinois: Charlotte Diller, John Hope Community Academy, 5515 S. Lowe, Chicago, IL 60621 (312) 535-3160. e-mail: cdiller@popmail.mcs.net OR Tim McCollum, Charleston Jr. High School, 920 Smith Dr., Charleston, IL 61920 (217) 345-2193. e-mail: cxtdm@eiu.edu.



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MICROSCALE CHEMISTRY

During July a unique pollution prevention workshop was held for Lake County High School teachers. The workshop was sponsored by Abbott Laboratories in partnership with the Illinois Environmental Protection Agency and Lake County Educational Services.

The first day of the workshop was held at Abbott Laboratories. Workshop activities included sessions on chemical waste disposal problems and issues, proper waste disposal procedures and pollution prevention techniques for high school labs. Participants listened to an intriguing presentation by Abbott scientist, Stefan Loren on combinatorial chemistry, and toured the labs at Abbott. Day two of the workshop was held at Stevenson High School.

On day two facilitators from Argonne National Laboratories provided the opportunity for participants to gain first-hand experience at using microscale equipment. Participants learned that the overal objective in using microscale techniques is the capability to generate a great deal less chemical waste in the high school lab. Abbott graciously donated a full classroom set of microscale equipment and several resource books on microscale chemistry to each participating teacher. Follow-up sessions are planned for the 96-97 school year. The group is hopeful that this pilot will serve as a model that can be used in other parts of the state. For more information on the microscale chemistry pilot project contact Anne at the above address.

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IJAS FUTURE STATE EXPOSITIONS
Champaign Illinois

May 9-10, 1997
May 8-9, 1998
May 7-8, 1999
For information on IJAS contact Kevin at the above address.

OPPORTUNITIES

ILLINOIS BIOLOGY TEACHERS PART OF NATIONAL BIOTECHNOLOGY PROJECT

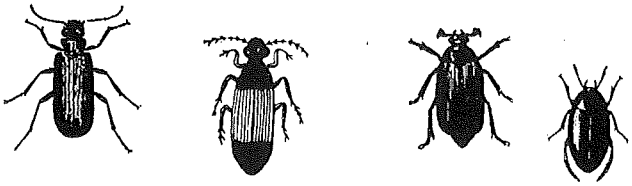
The NABT High Quality Biotechnology "On a Shoestring" project is progressing on schedule. Major funding has been provided by the National Science Foundation's Advanced Technological Education Program. In addition, Life Technologies Inc. (LTI), Genentech Inc.'s Access Excellence and Media-Seek Inc. also have contributed very generous support. The goal of the project isto provide all students with biotechnology education at the two-year college and second school biology levels.

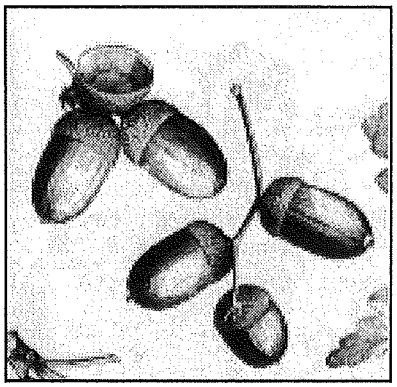
From July 14th to August 2nd, nine high school and nine community college teachers alpha tested the laboratory activities in Germantown, Maryland at the campus of Montgomery Community College and the LTI Training Center. Carl F. Koch of Riverside Brookfield High School attended the three week workshop as a high school teacher participitant. In addition to testing the activities, Carl had the opportunity to tour the National Institute of Health and the United States Department of Agriculture Research Station. Speakers at the workshop included Paula Gregory of the Human Genome Project, John Schollar of the University of Reading, Tracy Wilkins of Virginia Tech's Frolin Biotechnology Center, Melissa Smrz of the Federal Bureau of Investigation, Ed Dougherty and Gregg Silk of the United States Department of Agriculture.

To qualify for the workshop or to field-test the labs during the 1996/97 school year, each teacher had to seek a partner (community college or high school) and an industrial (research) partner. After a year of field testing, the activities will be ready for national distribution in 1998. The field testers from our state are:

Jack Gallagher W.R.Harper College	Patricia G. Tosto Lincoln Park HS	MAJECO Palatine
Elizabeth Gerity Elgin CC	Kenneth L. Johnson Connant HS	DeKalb Genetics Corp. Elgin
Sandra Schanzle Lincoln Land CC	Ed Anderson Tropia HS	Burris Seed Farms, Inc. Springfield
Dr. L.D. Spears J.A. Logan CC	Larry Gene Kepple Herrin HS	Marion Mem. Hospital Carterville
Daniel Ward Waubonsee CC	Kevin Gannon Geneva HS	Cargill Hybrid Seeds Sugar Grove
Alan Wade Triton College	Carl F. Koch Riverside Brookfield HS	Brookfield Zoo Brookfield

As Regional III Coordinator for the NABT, Carl Koch can supply information regarding NABT and would welcome any suggestion regarding the organization and biology education. His e-mail is AECKoch@aol.com





ENVIRONMENTAL EDUCATION STANDARDS PROJECT

What does it mean to be an environmentally literate citizen? The National Environmental Education Standards Project, initiated by the North American Association for Environmental Education (NAAEE), is attempting to answer this question. Environmental education is a process that aims to develop an environmentally literate citizenry that has the skills to make well-informed choices.

Through a process of critique and consensus, a set of national environmental education standards is being developed. These standards will be modeled after those produced by the various discipline-based groups, such as the National Council for the Social Studies. The standards will provide teachers with guidelines that will support the development of comprehensive environmental education programs that meet the high standards already set by the core disciplines.

The National Environmental Education Standards Project, funded through the Environmental Education and Training Partnership and the U.S. Environmental Protection Agency, is interested in gaining input from classroom teachers, program developers, and curriculum specialists. If you're interested in reviewing standards documents as they are developed, or have questions concerning the process, contact Bora Simmons at Northern Illinois University, Lorado Taft Field Campus, Box 299, Oregon, IL 61061; (815)753-0205; FAX (815)732-4242.

Ken King <kking1@niu.edu>
Betsy Rothery
http://coe.cedu.niu.edu/scied/homepage.htm

OPERATION PRIMARY PHYSICAL SCIENCE: AN OVERVIEW AND AN OPPORTUNITY

Operation Primary Physical Science (OPPS) is a national teacher inservice program in selected physical science topics for teachers of students in grades K through 3. OPPS is based at Louisiana State University and funded by the National Science Foundation. Its purpose is to provide opportunities for teachers of young children to enhance their physical science knowledge and teaching methods. This past July, 36 teams from across the nation were trained to provide workshops for primary level teachers. Each team has three members, one of whom has primary level teaching experience. Illinois is fortunate enough to have two teams selected to be trained. One team is based at Southern Illinois University--Edwardsville and the other is from Northern Illinois University.

Current OPPS workshops consist of the following topics: Solids and Liquids, Sound, Air, Magnets, Light and Shadows, Magnets, Light and Mirrors, Changes in Matter, Moving Objects, Sinking and Floating, and Lenses. These workshops are based on AAAS Benchmarks for Science Literacy, National Science Education Standards, and various sate curriculum frameworks. OPPS workshops have a strong content emphasis, are research-based, stress the nature of science, are transferable into the classroom and are designed for the K-3 teacher. Each workshop is structured so that teachers must construct their knowledge from "ground zero."

A typical OPPS workshop includes a variety of components. each workshop is divided into two sections. The first focuses on developing teachers' own understandings of physical science concepts. The second part shifts the focus to teaches finding ways of enhancing their students' understandings of the physical science concepts. Teachers work in groups to design, test, and present instructional activities, related to their own district's objectives. The activities developed are designed to be suitable for infusion into their own district's science curriculum; teachers depart the workshops prepared to teach the concepts. Workshops may also include a chance to earn graduate credit and an opportunity to receive a stipend. The concepts stressed in OPPS are standards based on and related to the Illinois State Goals. The key concepts utilized in the OPPS workshops apply to Illinois State Goals I and II and the very nature of OPPS provides the foundation to meet Illinois State Goals III and IV. If more information is desired about OPPS, the following people can be contacted:

For Northern Illinois
Tom Thompson
Northern Illinois University
Department of Curriculum and Instruction
DeKalb, IL 60115
(815) 753-9027

For Southern Illinois
Virginia Bryan
Southern Illinois University--Edwardsville
Office of Science and Math Education
Room 1339 Science Building
Edwardsville, IL 62026-2224
(618) 697-629-3557

4TH, 5TH AND 6TH GRADERS INVENT A TOOL

Sears Craftsman and the NSTA are encouraging students in grades 4 - 6 to use their imagination and creativity to invent a tool. The program offers students a chance to win $10,000 for their design of a new or improved tool. NSTA President JoAnne Vasques adds, "We think that this unique new competition will encourage students to think creatively...and ultimately get excited about science in the process."

Contact Craftsman/NSTA Young Inventors Awards, c/o NSTA, 1840 Wilson Blvd., Arlington, VA 22201-3000 or call toll free. 1-888-494-4994

Ronnee Yashon
Wright Center for Science Education
Tufts University
4 Colby St.
Medford, MA 02144
617-628-5000 x5394
fax: 617-627-3995
Email: ryashon@pearl.tufts.edu

SCIENCE EDUCATOR FELLOWSHIP

The Wright Center is inviting applications for its year long fellowship in residency for secondary teachers of science. This fellowship offers teachers time to pursue projects related to their fields while in residence at Tufts University. A $35,000 salary plus benefits and a moving stipend are part of the package.

The dates for the fellowship are September 1, 1997-June 30, 1998.

For applications contact Ronnee Yashon at the above address.

Deadline for Application: February 1, 1997

WORKSHOPS

MaTR INSTITUTE SUMMER WORKSHOP FOR SCIENCE TEACHERS —GRADES K-6

University of Wisconsin-Stevens Point
Sponsored by
the National Science Foundation

WHAT IS IT?
The MaTR Institute* ("matter") is a special collaboration between teachers, the National Science Foundation, the Intersociety Polymer Education Council, and the University of Wisconsin-Stevens Point. The purpose of the Institute is to assist teachers in linking classroom science with the "real" world by helping them become more familiar with polymer (macromolecule) topics.

WHO IS IT FOR AND WHEN ARE THE WORKSHOPS?
The Institute is for elementary (K-6) teachers. The 1997 summer training workshop will be held July 13 to August 1, 1997 with a weekend follow-up session in the Spring of 1998.

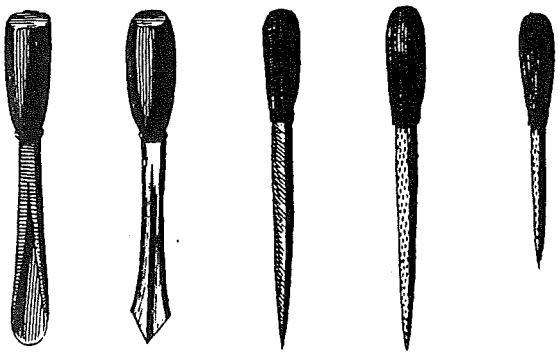
CAN I RECEIVE GRADUATE CREDIT?
Participants in the workshops will receive three graduate credits from UWSP.

WHAT DOES IT COST?
Workshop participants will be expected to pay part of their travel costs and any personal expenses. The Institute's sponsors will pay fees, room and board, will provide participants with a daily stipend, and will assist with travel expenses. Participants also will receive materials for use in their classrooms and a special budget for classroom supplies and in-service offerings.

WHO WILL LEAD THE WORKSHOPS?
Teams of grade-level teachers and faculty from UWSP's chemistry department will lead the workshops. The workshops will feature Polymer Ambassadors and other national award-winning teachers recognized for their use of polymer topics in the classroom. Industry representatives also will share their expertise with the participants.

POLYMER EDUCATION AT UWSP
UWSP has a long tradition of polymer education and is a leader in the development of polymer-related curricular materials. The POLYED National Information Center for Polymer Education, which opened in 1989 at UWSP, has processed nearly two thousand inquiries from teachers at all grade levels, K through post-graduate.

HOW CAN I GET MORE INFORMATION?
MaTR Institute (**Ma**cromolecular **T**eacher **R**esource **I**nstitute)
c/o POLYED National Information Center for Polymer Education
Department of Chemistry
University of Wisconsin-Stevens Point
Stevens Point, WI 54481
(715) 346-3703



"EXPLORING ARCHAEOLOGY" WORKSHOP FOR TEACHERS

On Saturday, April 5, from 9:00 A.M. to 1:00 P.M., Belleville Area College will be offering a workshop for teachers of grades 4 through high school who are interested in archaeology. The workshop, featuring a field and classroom activity called "Exploring Archaeology: Simulation I, The Controlled Surface Collection," combines math, science, social studies, and language arts to teach the basic methods and objectives of archaeology. Participants will perform the simulation and receive all materials and instructions needed to conduct the activities with their classes.

A "controlled surface collection" is the first procedure performed on nearly every archaeological site. In this realistic simulation, students will use mathematical techniques to set up a grid for collecting simulated surface artifacts or to record their coordinates. Scientific and geographical skills will be used to collect, label, and sort the artifacts, then map and analyze their spatial distribution. After reassembling the artifact fragments into whole objects, students will use the scientific method to hypothesize a practical use for the artifacts, group the artifacts into similar activity classes, and locate areas on their maps where hypothesized activities may have taken place. This simulation is an excellent preparation for teachers planning a field trip to the Cahokia Mounds World Heritage Site or other archaeological sites.

The fee is $14 plus $25 for materials. For additional information, contact the Belleville Area College Office of Non-Traditional programs at (618) 235-2700 Ext. 540 or the instructor, Suzanne Lowry, at (618) 234-6498. To register, call 1-800-BAC-5131 Ext. 455 or 393. If you are unable to attend the workshop but would be interested in obtaining the simulation kit and a videotape, contact Suzanne Lowry at 18 Hunters Point, Swansea, IL 62226 or at the number above. Availability of these materials should also be listed in The Archaeological Institute of America's "Archaeology in the Classroom" sourcebook in the fall of 1997.

1997 High School Essay Contest

"Advantages and Disadvantages of Building in a Floodplain"

The Illinois Association for Floodplain and Stormwater Management (IAFSM) is a nonprofit association of professionals concerned with protecting people from the dangers and damage of flooding. To encourage high school teachers and students to learn more about floodplain development, the Association is conducting an essay contest.

Topic: "Advantages and Disadvantages of Building in a Floodplain"

Prizes:

1st place:	$200
2nd place:	$100
3rd place:	$50

The first prize essay will be published in the Association's quarterly newsletter, *IAFSM News*.

Essay requirements:

1. The contest is open to any Illinois high school student.

2. The essay must be 500 to 1,000 words, double spaced, typewritten.

3. The essay must use a minimum of two references. Possible references include local building regulations, newspaper articles, and state and federal publications on floodplain or stormwater management.

4. The essay must reference a minimum of two interviews. These can be with local building officials, engineers, developers, naturalists, floodplain residents or other people with knowledge or experience with the topic.

5. All references and interviews should be included in a bibliography.

6. A maximum of three essays from each high school will be accepted.

7. Submit the essay so it is postmarked no later than February 14, 1997. Multiple submittals from the same school can be included in the same mailing. Each submittal must include:

   -- the author's name, address and phone number;
   -- the name, address, and phone number of the high school; and
   -- the name of the teacher.

Mail to: IAFSM Essay Contest, 153 Nanti, Park Forest, IL 60466

Questions? Call Brad Brink, Chair, IAFSM Education Committee, 708/210-5672

AWARDS AND RECOGNITION

JOHN VOSSEN MEMORIAL AWARD FOR MIDDLE AND HIGH SCHOOL SCIENCE TEACHERS

The American Vacuum Society (AVS) wishes to recognize and reward active and creative middle and high school teachers in the United States, Canada or Mexico. The purpose is to encourage the development of science demonstration experiments involving reduced pressures (vacuum) or controlled gaseous environments at atmospheric pressure. Experiments above atmospheric pressure will be considered only if adequate safety measures are included.

The John Vossen Memorial Award consists of an equipment grant to implement the experiment, a cash a prize and reimbursement of travel expenses to attend to the AVS 1997 National Symposium in San José, CA. There, the selected teacher will receive the award and will demonstrate the award-winning experiment during the AVS Science Educators' Workshop. this two day workshop will be held during the Symposium on October 20-21, 1997. Attendance to the workshop will include approximately 25 high school science teachers from locations throughout the United States. Teachers will receive continuing education credit through the State of Ohio Department of Education.

Proposals will be judged by the Education Committee of our Society based on novelty, suitability as a demonstration experiment (transportable), clarity of the physical concepts and of the proposal, and the extent to which the concepts involved relate to the interests of the American Vacuum Society.

The American Vacuum Society is a member society of the American Institute of Physics. members of the American Vacuum Society come from industry, universities, and national laboratories. The areas of interest of the AVS are diverse, multidisciplinary and touch on all aspects of modern technology. As part of its commitment to foster science education at all levels, the Society conducts an annual program for high school science teachers.

Interested teachers should send:

- An abstract (200-300 words),
- a proposal (two pages maximum, including figures) with a write-up of the experiment detailed enough for others to duplicate thwe experiment.
- a letter of support from the school principal or director, and
- a budget for equipment needed to implement the experiment. This should include an equipment list with vendors and current prices.

The complete submission package should be mailed to:
Ms. Angela Mulligan
American Vacuum Society
120 Wall Street, 32nd Floor
New York, NY 10005
Deadline for submission: January 31.

SPRINGFIELD MAN WORKED ON NOBEL PROJECT

Mention the Nobel Prize in chemistry and some people might envision scientists spending their lives in laboratories performing years of tedious research that ultimately leads to a hard-won breakthrough.

For a former Springfield resident who played a major role in a project that actually won a Nobel Prize, the reality was much different. Sean O'Brien says it took just two weeks in 1985 for the team he was a part of to discover a new form of carbon that has led to an entirely new field of chemistry research. O'Brien, 34, was part of a research team at Rice University in Houston that discovered fullerenes, oddly shaped carbon molecules whose even odder properties are being explored by labs all over the world. Fullerenes are perhaps better known as buckyballs, with both names coming from architect Buckminster Fuller, because of their resemblance to his geodesic domes.

Recently, the three leaders of that team—Harold Kroto of Sussex University in England, and Robert Curl Jr. and Richard Smalley, both of Rice—were awarded the Nobel Prize in chemistry. O'Brien was Smalley's graduate assistant and one of two graduate assistants working on the project. At the time, the team members from Rice were using unusual and very powerful vacuum chambers and lasers to study semiconductors. Then Kroto — a "wild-eyed scientist from England" — asked if he could use their equipment and their expertise to look at how carbon might behave under highly unusual circumstances. The team wasn't all that interested in the idea, O'Brien said, but Kroto persisted and they finally relented. Just two weeks after they began, they discovered the unusual new form of carbon. It did take longer, approximately a year, for the team to analyze its discovery and work out some of its major ramifications. O'Brien continued working in the field throughout the remainder of his four years at rice, and many other scientists around the world are current studying fullerenes.

Some practical uses for fullerenes have yet to be discovered, but scientists think they may be useful in such varied applications as conducting electricity without resistance and delivering medicine into the human body. O'Brien said he and the other graduate assistant did almost all of the lab work for the project, and he was there when the group realized they had discovered something new, but he said it doesn't bother him that he was not included in the award. "It's very rare for graduate students to get any notice or awards," he said. "There's a lot more to big science than running the experiments. there is no way we could have done the research without the professors, but they could have muddled through without us."

A 1980 graduate of Lanphier High School, O'Brien spent 17 years in Springfield, attending Little Flower, Wilcox and Edison schools. He graduated from the University of Illinois in 1984 and went straight to Rice for his Ph.D. For the past six years he has been a member of the technical staff with Texas Instruments in Plano, Texas, where he specializes in research and development in contamination removal and surface preparation for semiconductors. O'Brien said he owes much of his success to his chemistry teacher at Lanphier, ISTA member Ray Bruzan. "He taught me everything I know about chemistry," O' Brien said. "he really encouraged me to go into chemistry."

O'Brien said being a part of a Nobel Prize-winning team has put him in the spotlight. He has been getting requests for interviews from the news media, as well as a lot of attention from his fellow workers at TI. He also plans to attend the Nobel awards ceremonies in Stockholm. This has been one of the most amazing periods of time in my life," he said.

1997 POLYMER TEACHING AWARD ANNOUNCED

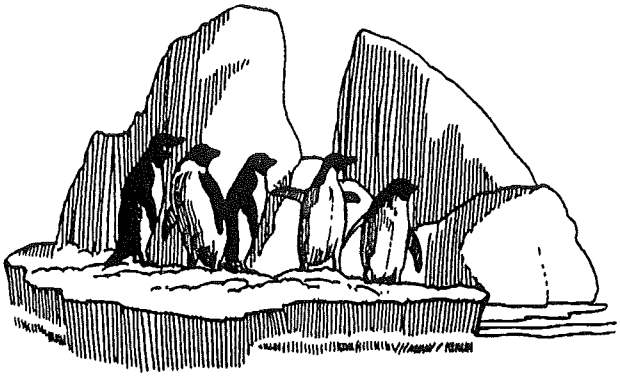
The Polymer Education Committee (POLYED) of the American Chemical Society (a joint committee of the Polymer Chemistry Division, Inc., and the Division of Polymeric Materials: Science and Engineering) has announced details of the 1997 Award for Excellence in Polymer Education by a High School or Junior High School Teacher. The award, sponsored by the Dow Chemical Company Foundation, recognizes the efforts of high school and junior high school teachers who help students meet the challenges the responsibilities of living in a technological age and who encourage students to consider careers in science and engineering. Awards are based on the applicants' innovative use of classroom and laboratory activities to promote understanding of polymer chemistry and its role in the everyday lives of students, and the applicants' outreach activities to encourage other teachers to explore polymers with their students.

POLYED will recognize the national award winner at an American Chemical Society national conference. Award winners receive a travel grant to attend national chemistry and teacher conferences, a plaque, a cash prize, and a set teaching materials for use in the classroom. Applicants for the 1997 award are available from Professor David M. Collard, School of Chemistry and Biochemistry, Georgia Institute of Technology, Atlanta, Georgia j20332-0400, phone, (404) 894-4026.

Deadline April 1, 1997.

1997 CONSERVATION EDUCATION AWARDS PROGRAM

Nominations are being accepted for the Conservation Education Teacher of the Year Awards Program. The recognition program is open to all full-time educators at the kindergarten through high school levels who have implemented innovative soil and water conservation activities for reaching students and other audiences. There are two divisions, elementary (grades K-6) and secondary (grades 7-12). The first place national recipient in both categories receives $1,000 cash and an expense-paid trip to Nashville, Tennessee for the National Association of Conservation Districts annual meeting. if you are interested, contact Brenda Weiser at (800) 825-5547, extension 27.



EDUCATIONAL MATERIALS

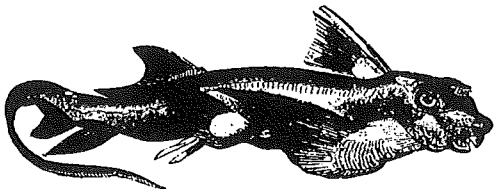
Classroom News
Susan Ernst
American Society of Agronomy
677 S. Segoe Road
Madison, WI 53711
(608) 273-8080, fax (273-2021)
sernst@agronomy.org.

Educational Posters for Grade and Middle Schools

Three posters are available from the American Water Resources Association. The titles of the posters are: Water: The Resources That Gets Used & Used & Used For Everything!; How Do We Treat Our Wastewater?; and Wetlands: Water, Wildlife, Plants & People. Each poster (3 by 2 feet) has a worksheet on the back that is applicable to either grade school or middle school students. The posters are easy to understand and come in either full color or black-and-white to color your own. Cost of each poster is $2.00, including shipping and handling (quantity priced upon request). To order or for more information, please contact: AWRA, 950 Herndon Parkway, Suite 300, Herndon, VA 22070-5531; fax (703) 904-1228.

"Project Seasons" Offers a Year of Activities

It's the first snowfall of the year and students are more interested in studying snowflakes than in learning how to divide fractions. How can a teacher harness students' interest in the natural world and use it to teach academic subjects? "Project Seasons" integrates science, agriculture, and environmental themes into the elementary school curriculum and shows students and teachers how all things are interconnected. Each season contains thematic groups of activities that reflect changes on the farm and in the natural world. Each of the activities included is designed to stand alone, but together all work to help students cultivate an awareness and appreciation of agriculture and natural resources. Most can be tailored for more than one season or for different geographic locations. A bibliography at the end of "Project Seasons" offers a selection of story books, children's information and activity books, and teacher resource or activity books on all the themes introduced in the book. Single copies are available for $24.95 plus $3.50 shipping and handling, from The Stewardship Institute, Shelburne Farms, Shelburne, VT 05482. Call (802) 985-8686 for information on reduced prices for multiple copies.



Gardening Literature for Youth

Eight pieces of literature are now available in a series of gardening publications from the University of Tennessee Agricultural Extension Service. They cover gardening skills and information for youth from the 5th through 12th grades. Youngsters in grade 5 start with the basics of growing plants. This unit introduces them to the seed and the requirements for germination and growth. In the 6th grade unit, youth grow their first six warm-season vegetables, and the grade 7 unit provides ideas on growing a complete vegetable garden. The unit for grade 8 deals with improving techniques for vegetable production, and the unit for grade 9 focuses on special techniques for vegetable production, such as multiple-row or bed gardening, composting, mulching, and irrigation. Unit 10 teaches about plant-growing structures. Youths actually construct a small structure and have an opportunity to visit some local growers who use some of the structures. The unit for grade 11 encourages them to try other practices, such as organic fertilization, planting dates and depth, the effects of light and other environmental conditions. The senior unit deals with career opportunities. For more information, contact Dr. Alvin D. Rutledge, Plant and Soil Science, Agricultural Extension Service, University of Tennessee, Knoxville, TN 37901; phone (423) 974-7208.

Fish Banks, Ltd. Game

Fish Banks, Ltd. is a group role-playing simulation, assisted by one micro-computer, that teaches principles of sustainable management of natural resources. Proven effective with middle school, high school, and college students, as well as adults in the business world, Fish Banks, Ltd. creates profound insights into the interaction of ecological, economic, and psychological forces that impact our use of renewable resources. In addition to conveying factual knowledge, participants practice communication, group problem solving, and reasoning skills. Fish Banks is certified as an exemplary educational program by the U.S. Department of Education. It is presently used by 800 high school and college teachers in the United States. For more information or to order, contact Luisa Gina Fowler, Institute for Policy and Social Science Research, Hood House, 89 Main Street, Durham, NH 03824-3577, phone (603) 862-2186, ext. 7, or fax (603) 862-1488.

Explore Agriculture in the Classroom

The following units were developed by the California Foundation for Agriculture in the Classroom. The five teaching ideas combine agriscience into lessons appropriate for grades 2 to 9.

Where Does It Come From? (grades 2-3). Students research food and fiber products by tracing back to their raw sources on the farm and exploring their food packaging and storage techniques. Hands-on activities and experiments. Unit no. SACP 113, $8.

Edible Numbers (grades 2-4, 5-6, 7-8). Lessons relate grocery store experiences to classroom math and nutrition education. Unit #SACP 114; designate grade level; $8/unit.

From Genes to Jeans—An Activity Based Unit on Genetic Engineering and Agriculture (grades 7-9). Students use basic scientific principles and tools associated with genetics to think critically, creatively, and freely about the viability and ethics associated with genetic engineering in agriculture. Unit no. CU 407, $8.

Where'd You Get Those Genes? (grades 4-6). Five-unit lesson allows students to learn basic genetic concepts using ag commodities, then apply them to current trends in genetics and genetic engineering. Each lesson stands alone. Unit no. CU 408, $8.

Edible Plant Parts (grades 2-3). Students think about the fruits and veggies they eat, and categorize them into edible roots, stems, leaves, flowers, fruits, and seeds. Incorporates ag topics into several curricular areas, including literature, art, science, and math. Unit no. SACP 103, $8. For more information or to order, contact CFAITC, 1601 Exposition Blvd., Sacramento, CA 95815; phone (916) 924-4380.

For multiple copies of "Classroom News" or to subscribe to the *Journal of Natural Resources and Life Sciences Education*, call (608) 273-8080 or fax (608) 273-2021 for more information.

FREEBIES REPRINTED FROM NSTA REPORTS!

Medicines: The Inside Story CD-ROM, which explores the past, present, and future of medicines. Suitable for the high school level, the curriculum unit featured on the CD-ROM was developed in coordination with NSTA's Teacher Center and is designed to support the Standards. The CD-ROM also is part of a traveling exhibition that will run for the next two years. Send your name, address, phone number, FAX number, school name, and list of subjects you teach to Michael R. Harris, Project Director, Medicines: The Inside Story, 1500 K St. NW, Suite 650, Washington, DC 20005; e-mail mrharris@erols.com. Please specify Mac or PC version.

Educational resource lists (elementary, middle, and high school levels) and high school levels) and resources brochure from The Antarctica Project, which works with educators, scientists, members of Congress, and the Administration to promote environmental awareness about Antarctica. Contact The Antarctica Project, PO Box 76920, Washington, DC 20013; (202) 544-0236; FAX (202) 544-8483; e-mail antarctica@igc.org.

Three-card sample of F.I.N.Z., Inc.'s series of "fish card collectibles" featuring photographs of tropical fish commonly found in aquariums. The cards can be used as learning tools in biology and the natural sciences. The backs of the cards can increase student interest in geography, while the color photos can inspire young artists. Contact Barry Milks, F.I.N.Z., Inc., 5757 Lorraine Rd., Bradenton, FL 34202; phone/FAX (941) 747-3532.

The video *Planet Insect* and its accompanying teachers guide, *Insect Zookeeping*—both part of an education program designed to introduce students to insects. The 10-minute video depicts bug collecting and identification and encourages students to start insect zoos of their own. Also featured are scenes from the Smithsonian Institution's O. Orkin Insect Zoo. Call Orkin Pest Control at 800-563-4687.

Materials from the Entomological Society of America (ESA)—

• *Bug Briefs*, ESA's seasonal lesson plans and activity guides for teachers. They contain handouts and follow-up ideas for free or inexpensive activities and may be copied for classroom use.
• information sheets on various entomology-related topics, such as raising butterflies or butterfly gardening
• up to 25 copies of the pamphlet "Discover Entomology," designed to introduce high schoolers to entomology careers
• resource lists for entomology-related suppliers and organizations that provide information for teachers.

Contact ESA, 9301 Annapolis Rd., Lanham, MD 20706; (301) 731-4535; FAX (301) 731-4538.

Free Catalogues

• Science for Kids© CD-ROM catalog and preview disc (version 2.0), which operates on Windows and Macintosh computers and describes and previews the company's K-8 Science Curriculum and Science Adventures product lines. The preview disc also contains product demos from other publishers showing language arts, skills assessment, keyboarding, portfolio assessment, and screen saver software. contact Science for Kids, Box 519, Lewisville, NC 27023; (910) 945-9000; FAX (910) 945-2500.

• Catalog of posters, curriculum units, biographies, games, videos, and CD-ROMs from the National Women's History Project. Call (707) 838-6000; e-mail nwhp@aol.com.

• Exploration edition of the Pitsco catalog, which features products related to such topics as engineering, transportation, and invention. Call 800-835-0686.

• Spring/Summer 1996 edition of the Consumer Information Catalog, which contains free and low-cost publications, some of which may be useful to teachers. Contact Consumer Information Catalog, Pueblo, CO 81009; (719) 948-4000.

Information on environmental health effects from ENVIRO-HEALTH, a National Institute of Environmental Health Sciences (NIEHS) clearinghouse. At no change, a technical information specialist will conduct an online computer search and answer your questions over the telephone, mail NIEHS publications to you, conduct research on an inquiry and call you back, or refer you to another organization that may be helpful. Contact ENVIRO-HEALTH Clearinghouse, 100 Capitola Dr., Suite 108, Durham, NC 27713; 800-643-4794 (9 AM to 8 PM Eastern Time weekdays); FAX (919) 361-9408.

***Earth 2U, Exploring Geography* curriculum guide for teachers of grades 4-6**, which is connected with the Earth 2U traveling exhibition (see the article in the September 1996 issue of *NSTA Reports!*, page 36). The guide contains eight lesson plans with handouts and activities for each. Copies will be available at the museums and science centers hosting the exhibition; call (202) 357-2700 or see the web site http://www.si.edu/organiza/offices/sites for a list of these locations. Guides also will be distributed through the Geographic Alliance, a geography education network. To find out your state's Geographic Alliance coordinator, call the National Geographic Society at (202) 775-6701 or see the web site http://www.nationalgeographic.com.

"Highlights of Research Achievements, Weizmann Institute of Science," 16-page pamphlet describing efforts in such areas as physics, energy and environment, chemistry, medicine, drugs, agriculture, and computers. Request a single copy from American Committee for the Weizmann Institute of Science, 51 Madison Ave., New York, NY 10010; (212) 779-2500;FAX(212) 779-3209
e-mail INFO@ACWIS.ORG.

Video and booklet detailing how several schools are using technology to improve learning. Request the "Connected Learning Community" resources by calling Microsoft at 800-426-9400.

***Viking* 20th Anniversary CD-ROM**, available to K-12 teachers who request it from the web site http://eggfoo.arc.nasa.gov/signup/signup.html. (The site also features programs and resources about the *Viking* mission.)

Solar system poster that features planets, the Moon, asteroids, and comets, shown in color and to scale. The back of the poster contains information about the solar system. Write on school letterhead to Education Office, Code FEO, NASA Headquarters, Washington, DC 20546.

***Planet Patrol*, a solid waste education unit** for grades 4-6. Write to Educational Services, PO Box 14009, Cincinnati, OH 45250.

Video on oil spills and six pamphlets for teachers, available from Exxon. Call (713) 656-8758.

Solar fact sheet (for solar energy resource). Write to Energy Inquiry and Referral Service, PO Box 8900, Silver Spring, MD 20850.

Information on free or low-priced trees. Write to The National Arbor Day Association, 100 Arbor Ave., Nebraska City, NE 68410.

"How To Make Paper," pamphlet that describes how handmade recycled paper can be created in school classrooms. Send SASE to "How To Make Paper," American Forest and Paper Association, 1111 19th St. NW, Washington, DC 20036; (202) 463-2700.

Web page authoring software, available from Microsoft's web site (http://www.microsoft.com/). Select "Free Downloads"; on the next page, scroll down to "Authoring Tools" and "Word Internet Assistant." Then choose the appropriate software and follow the instructions.

America Goes Back to School: Get Involved! Partners' Activity Kit, 1996-1997. The kit offers dozens of suggestions for creating community-based partnerships and includes resources, a sample proclamation and local school board resolution, activities from last year's back-to-school initiative, and more. Call 800-USA-LEARN or see the web site http://www.ed.gov/Family/agbts/.

Booklet from Ed-Net and the Global SchoolNet Foundation that introduces schools to e-mail collaborative learning projects. Send e-mail to info@ednet.com or see the web site http://199.106.67.200:80/gsn/ednet/alt/mailto.htm.

Single copies of "Principles for Professional Development," pamphlet from the American Federation of Teachers, 555 New Jersey Ave., NW, Washington, DC 20001; (202) 879-4400. Request item no. 176.

Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge, report from the Clinton Administration released this past summer. Call 800-USA-LEARN or access the full report from the U.S. Department of Education's web site: http://www.ed.gov/technology/.

Give Water a Hand Action Guide and Leader Guidebook, second edition. Both publications are connected with a national youth program for local environmental action. The 72-page action guide provides students in grades 4-8 with step-by-step instructions for investigating local watershed issues and planning and carrying out a service project to address an environmental problem. The 40-page leader guidebook helps teachers work with students on these projects. Both publications may be downloaded and printed from the web page http://www.uwex.edu/erc. Teachers without web access should call 800-WATER20 for prices on print versions. These publications may be duplicated at no charge for educational purposes.

INTERNET CONNECTION

The Classroom Connect Mailing List is now archived and online. The daily digest of about 10 posts points subscribers to online educational sites, projects, and more. To visit the archive site, go to http://www.classroom.net/classroom/maillist.html. To subscribe to the mailing list, send e-mail to crc-request@classroom.net, leave the subject line blank, and type "set digest" in the body.

The **Eisenhower National Clearinghouse** offers teachers The Digital Dozen, a listing of 12 new resources for science and math, updated monthly. Activities. Listings from previous months are archived. http://www.enc.org/ddnow.htm

Planning to develop your own education web site? Then visit the **Busy Teacher's Web Kit** for suggestions on planning your site, background choices, and links to shareware for organizing HTML and graphics files.
http://rampages.onramp.net/'dkerns/lily/

Have your students board **World Flight 1997** to recreate (and then complete) Amelia Earhart's 1937 ill-fated flight around the equator. The journey begins on March 17, 1997, when World Flight 1997 will take off on Earhart's route and visit 30 cities in 20 countries, including eight U.S. cities. The flight's "partners in education" can communicate with the plane's pilot and navigator, see digital postcards from global touchdown spots, follow the plane's progress in real time, exchange e-mail with other classrooms along the route, and access weather forecasts for the flight. A teachers package that includes science and math topics such as weather, flight, navigation, and time zones will be available. Contact Beth Fisher at (303) 786-9222; e-mail bfisher@interramp.com.

Internet Curriculum Integration is the latest Internet training video from *Classroom Connect*. The three-tape series guides teachers through the myriad of Internet learning resources and explains how to best incorporate these resources into lesson plans and project-based learning activities. The tapes feature dozens of interviews with teachers, students, and media specialists in the field who are successfully incorporating Internet-based learning in the classroom. The video series costs $149 and includes a resource guide. Individual tapes are available for $50 each. For more information, contact *Classroom Connect*, 1866 Colonial Village Ln., Lancaster, PA 17605; 800-638-1639; FAX (717) 393-5752; e-mail connect@classroom.et; http://www.classroom.net.

For a look at some sites used by other teachers, visit the homepage that compiles the results of an **Eisenhower-sponsored inservice workshop** on the Internet, held last summer. As part of the workshop, a number of participants supplied their top 10 Internet sites in both science and math. The URL for the homepage is http://www.ncmc.cc.mo.us/Eisen/Index.htm (click on Participants and scroll down).

The Mid-Atlantic Eisenhower Consortium for Mathematics and Science Education homepage offers content organized around six themes critical to improving math and science learning for all students: equity issues; informal education; professional development; technology and telecommunications; public outreach; and curriculum, standards, and assessment. http://www.rbs.org/eisenhower/index.html

The **Global SchoolNet K-12 Opportunities** web site is a searchable archive with announcements about free software, contests, conferences, training opportunities, and educational web sites. http://archives.gsn.org/k12opps/

On **PedagoNet**, teachers can exchange learning materials and resources, such as curricula, courses of study, integrated units, and documents. To find out more, send e-mail to educ@pedagonet.com or visit the web site. http://www.pedagonet.com

Connections+ consists of Internet resources—lesson plans, activities, curriculum resources—linked with the corresponding subject-area content standards. Also included are links to assist teachers who use the Internet in the classroom, such as a direct link to the Lycos search engine. Among the featured subject areas are economics with an article entitled "Supply and Demand"; geography with "What Do Maps Show?"; and science with "Primates" and "Project Athena: Space and Astronomy." http://www.mcrel.org/connect/plus/

The **Grant Writers Assistant** offers free aid to schools and colleges seeking funding, grants and scholarships, and links to other funding sources. Call 800-447-2680 or visit the web site. http://fallingrock.com

The **American Chemical Society** announces CHEMCENTER, the electronic bookmark for chemistry. At this "one-stop shopping" site for chemistry-related information, ACS plans to offer educational materials, including continuing education courses and a variety of online chemistry publications, scientific and technical databases, and interactive forums for members. http://www.ChemCenter.org/

For quick and concise information on what the corporate world offers for educators, visit **The Chalkboard—A Classroom Corporate Connection**. At the site, which is free to educators and funded by corporate sponsors, teachers can access timely information on corporate services for teachers, including plant tours, mentorship programs, free materials, workshops, grants, and other programs. http://thechalkboard.com

Attention, newbies! To learn how to find the information you need on the Internet, sign up for **Making the Connection**, an online tutorial that will save you time when searching for lesson plans, classroom projects, and educational resources. For more information, visit this web site: http://www.icon.data.com/stores/marketing/main.htm.

The **TalkCity EduCenter** provides educators, parents, and students with information about using the Internet and ways to communicate with other classes online live and via e-mail. The Edu-Center sponsors more than 50 live chat events each month, and volunteer educators are on hand to answer your Internet questions. http://www.talkcity.com/educenter

Thinking of joining **Prodigy**, the online subscription service? Its Education Area includes features such as Homework Helper; The Study Web; Learning Adventures and Classroom Prodigy; a weekly online column called "EdFocus"; and interest groups. According to Prodigy, members can also download lesson plans and activities and participate in chat areas and weekly polls. For more information, visit the web site http://www.prodigy.com.

You'll find lesson plans, graphs, maps, and dates on environmental topics such as biological diversity, climate change, and deforestation at the web site maintained by the **World Resources Institute**. http://www.wri.org/wri.enved

Point your students to **B.J. Pinchbeck's Homework Helper**, which offers more than 240 links to sites around the world (including many science/math links), a comprehensive search engine, and a reference section. Created and maintained by nine-year-old Pinchbeck (and his dad), this site has received 10 awards since April 1995. http://tristate.pgh.net/~pinch13

Ye Olde Professor's Chemistry Student's Helper provides links to chemistry study aids, chemistry resource pages, and suggested bookmark sites. http://www.gemlink.com/rstein/chemhelp.htm

For a comprehensive listing of distance education programs and courses, visit the **Globewide Network Academy**. The site also offers a Teachers Lougne where teachers can post messages, links to resources, and job listings. http://uu-gna.mit.edu:8001/uu-gna

A Teacher's Guide to Super-conductivity for High School Students by the Oak Ridge National Laboratory reviews current and future uses of superconductors and how they work. It also discusses the history, physics, chemistry, and applications of superconductors and includes demonstrations, student problems, and classroom experiments. http://www.orni.gov/HTSC/htsc.html

Check out the entries sent to **The CyberFair '96**, a worldwide competition last spring in which 360 schools in 30 countries submitted Internet-based curricular activities involving their local businesses and communities. http://www.gsn.org/gsn/cb

Elementary students will love a visit to another "yucky" site (see the February/March 1996 issue of *Reports!*, page 38), this time dedicated to **worms**. Join reporter Wendell Worm as he interviews a few of his friends: an earthworm, a leech, a planarian, a tapeworm, and a bearded worm. Get up close and personal with the worm in the "Body Parts" section, and learn more about how worms are used as recyclers. http://www.nj.com/yucky/worm

Middle level educators may be interested in **MiddleWeb**, a web site dedicated to urban middle school reform that has been developed and maintained by The Focused Reporting Project. The site promises updated information on the reform efforts, links to standards and assessments at the middle level, and more. http://www.middleweb.com

The **CyberSpace Middle School**, for students and teachers, includes links to a number of science projects and programs. http://www.scri.fsu.edu/~dennis]/MCS.html

The **Education Media Library** in Nova Scotia, Canada, offers a web page with many online curriculum units and educational web links, including a large list of science links. http://rs6000.nshpl.library.ns.ca/~nmacdona/medlib/scilink.html

For late-breaking scientific news, turn to **Science in the Headlines**, a web site provided by the National Research Council and the Institute of Medicine. Written by volunteer committees of experts, each report gives information about the science behind the issues, written in nontechnical language; relevant press releases from other agencies are often included. Current items featured on the site include the juvenile crime rate, life on mars, the Food Safety Act, protecting buildings from bomb damage, airport security, whooping cough vaccine, safety information for 1997 model cars, and a back-to-school look at science education. http://www2.nas.edu/new/newshead.html

For profiles of more 300+ individual **U.S. National Park Service** (NPS) museum collections,containing more than 28 million objects and specimens and 14,000 linear feet of archives, connect to the NPS Museum Collections site. The site describes each collection, including the numbers and types of objects, specimens, and archives; gives information for each museum collection; includes a selected list of nationally significant objects and specimens with images of selected objects; contains glossaries, curricula, and educational tools; and lists tours and classroom use of objects/specimens. http://www.cr.nps.gov/csd/collections/parkprof.html

The Gulf of Mexico Program Information Network relates how a partnership of various state and federal agencies in the Gulf of Mexico region are working to protect, restore, and enhance the Gulf ecowystem. http://pelican.gmpo.gov/

The **National Marine Fisheries Service** (NMFS) provides links to its and NMFS-related sites in addition to the books *Our Living Oceans Annual Report 1993* and *Index for Fisheries of the U.S. 1992*. http://kingfish.ssp.nmfs.gov/

The **Brookhaven National Laboratory** web site contains information about basic and applied research in the physical, biomedical, and environmental sciences and on selected energy technologies that the lab performs.
http://suntid.bnl.gov:8080/bnl.html

Particle Data Group Databases, an international collaboration centered at Lawrence Berkeley Laboratory, reviews the field of particle physics and compiles and analyzes data on particle properties. It also publishes and distributes the *Review of particle Properties*. http://pdg.lbl.gov?

A concise listing of information on the **Atomic Age**, including biographies of those involved, historical texts, glossary, test sites, time line, photos, and more can be found at the Atomic Archive site.
http://sd.znet.com/~ajsftwre/AtomicAge.html

This site at Rice University introduces fractals to students with an **Elementary and Middle School Fractals Lesson**. Students will make a fractal, explore fractals on the web, and investigate what's so cool about fractals. Included are teachers notes and assessment materials.
http://cml.rice.edu/~lanius/frac

The **National Biological Survey** serves as an information clearing-

NATIONAL SCIENCE STANDARDS

Wee Three, Inc. has announced the availability of review and assessment materials for use in middle and high schools. The materials address the topics presented in the National Science Education Standards and they lend themselves to classroom use in a variety of game formats. topics covered include Physical Science, Earth and Space Science, Life Science, Science and Technology, and Science as Inquiry. The materials have been developed by three professors of Natural Science who collectively have nearly eighty years of experience in secondary and higher education. A deck of cards, consisting of approximately 300 questions and instructions for use is available at a cost of $15.95 plus shipping for each topic and educational level. Additional information can be obtained from Wee Three, Inc., PO Box 21092, Wichita, KS 67208-7092 or by e-mail at Wee3Inc@aol.com.

CUTE, CUDDLY, AND FASCINATING

Most students can identify with mammals, but can they identify the local mammal species? Do they know what makes an animal a mammal? The American Society of Mammalogists shares with fellow scientists in other disciplines a concern for the science literacy of our country's youth, and would like to help. We can provide assistance in

- Locating a local mammalogist to
  Speak to your class
  Acquire live mammals from local habitats
  Construct mammal "units" to meet you specific needs
  Consult for science fair projects dealing with mammals
  Learn about possible summer opportunities to participate in mammal research (students or teachers)
- Acquiring slides of mammals from around the world
- Awards to science fair projects on mammals
- Career opportunities in mammalogy

For assistance, contact the ASM Public Education Committee, c/o Tom Tomasi, Dept. of Biology, Southwest Missouri State University, Springfield, MO 65804
Email: TET962F@VMA.SMSU.EDU

Our goal is to establish a clearing house for mammal-related activities which will educate/entertain your students. To this end, descriptions and comments on activities that you have already tried will be gratefully accepted.

National Women's History Project
7738 Bell Road, Windsor, CA 95492
707-838-6000 Fax: 707-838-0478

MATERIALS FEATURING WOMEN IN MATH AND SCIENCE

You can easily introduce K-12 students to women's achievements in science and math with the posters, curriculum materials, biographies, video, and CD-ROM available from the National Women's History Project.

Computer programmer Admiral Grace Hopper and biologist Ida Hyde are among 68 women profiled in *Women in Science*, an inexpensive, 16-page gazette interlaced with science-based puzzles, quizzes, and games. In the "You Can Be a Scientist, Too!" video, young students will see that their "why" and "what if" questions related to women's work in fascinating science careers. "Inventive Women," a full-color poster set, introduces eleven accomplished women and their diverse patented inventions.

These are just three of twenty-one excellent, multicultural items featuring women in math and science available from the National Women's History Project. Ask for their free catalog! National Women's History Project, 7738 Bell Road, Dept. P, Windsor, CA 95492-8518, or (707)838-6000.

American Forest Foundation
Project Learning Tree
1111 Nineteenth Street, NW, Suite 780
Washington, DC 20036

RESOURCES FROM PROJECT LEARNING TREE

CHILDREN'S ENVIRONMENTAL INDEX

The Index contains activities that localize environmental and population issues and emphasize the importance of sustainable communities. The activities help develop students' ideas about community well-being and promote citizen participation. Thirty copies of the Index, a teaching unit called "Living a Quality Future," and a teacher guide are available at $10 per set from: Zero Population Growth, Inc. Publications, 1400 16th Street, NW, Suite 320, Washington, DC 20036; (202) 332-2200.

BACKYARD STEWARDSHIP

New educational materials are being offered by the National Association of Conservation Districts (NACD) in conjunction with the National Soil and Water Stewardship Observance. Backyard Stewardship focuses on the importance of individual action in our own backyards to be better stewards of the environment. A sample education kit is available for $4.50 which includes a 16-page educator's guide, an 8-page pre K through grade 3 activity guide, an 8-page activity guide for grades 4 through 6, a poster, book mark, and a place mat. For more information, contact your local conservation district or NACD at (800) 825-5547.

BIRD BASICS AND BACKYARD BUTTERFLIES

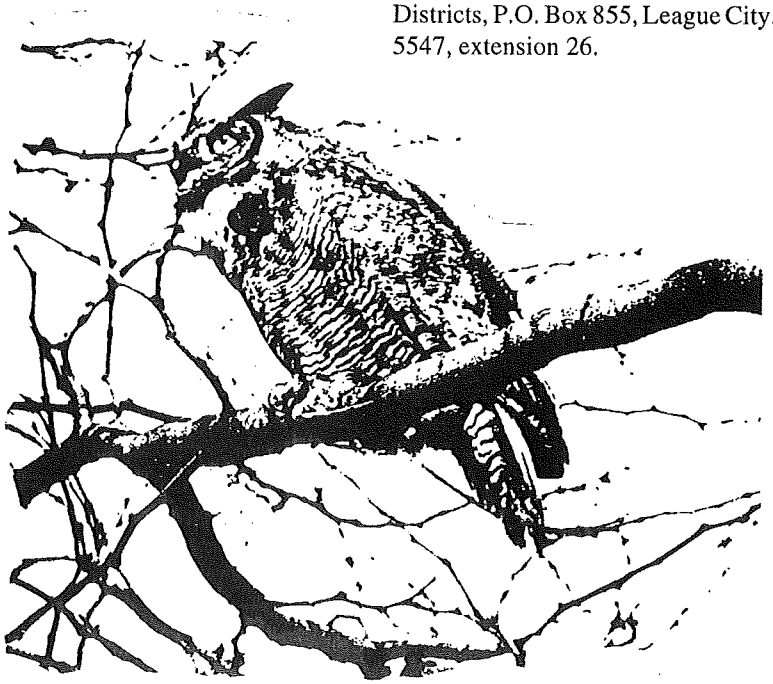
NACD has also developed two new comic books to reach the importance of birds and butterflies. The comic books are designed for grades 4 through 6 but all ages can enjoy the text and appreciate the information. Both books show students how to observe and to identify basic life cycles and outline the elements needed to create habitats for butterflies and birds. For ordering information, contact Maine Mathis at (800) 825-45547, extension 32.

JUST UNDERSTANDING GROUND WATER (THE JUG)

The JUG is a self-contained, portable flow-model kit that comes with everything needed to construct a ground water flow model. The 81/4" durable plastic JUG comes with all the accessories, instructions, and activities needed to understand aquifer geology, water movement and pumping, and contamination and clean-up. For ordering information, contact the Ground water Foundation, P.O. Box 22558. Lincoln, NE 68542-2558; (800-858-4844.

FOR STUDENTS, MONEY CAN GROW ON TREES

Students in schools throughout the country are having bake sales and selling candy bars to raise money for projects and school trips. With the "Get Growin" program, students can raise money and promote tree planting at the same time. "Get Growin" offers trees, shrubs, and other living products for every planting zone in the U.S. In addition, "Get Growin" offers an unconditional guarantee on all its products and includes a survival pack for planting. Student groups keep 40% of all the proceeds of the "Get Growin" products that are sold. For full-color ordering information and customer service, contact the National Association of Conservation Districts, P.O. Box 855, League City, TX 77574; (800) 825-5547, extension 26.



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___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.

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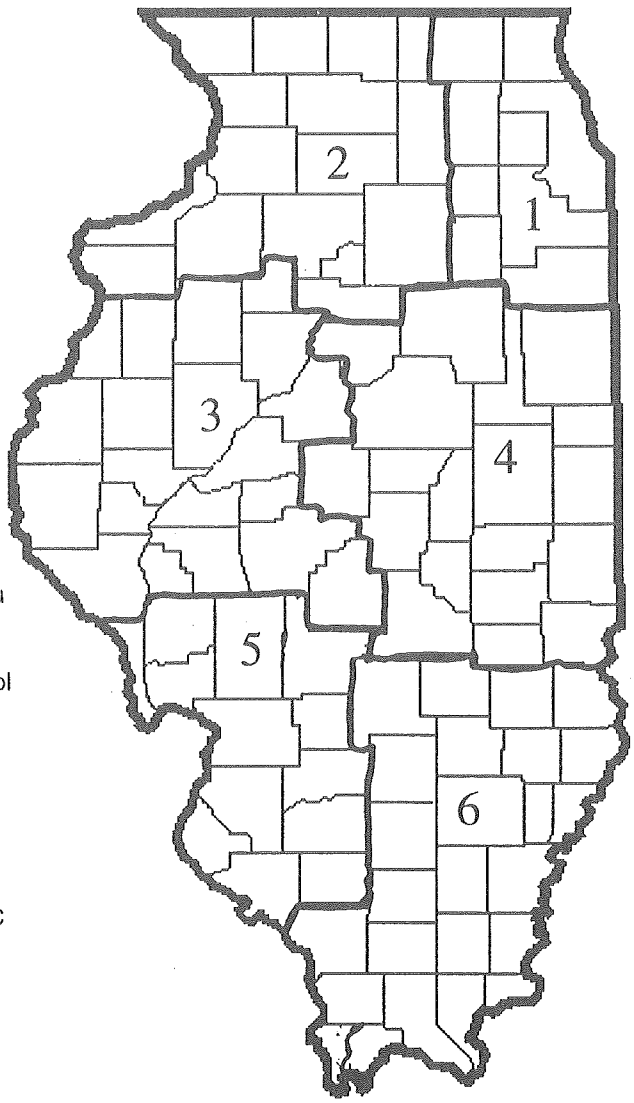

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Listing of Counties Comprising Each ISTA Region

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

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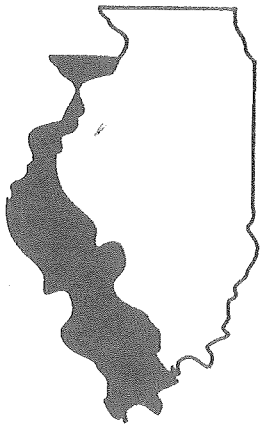

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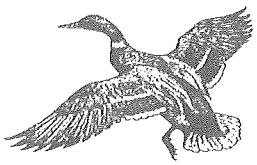

WINTER 1996