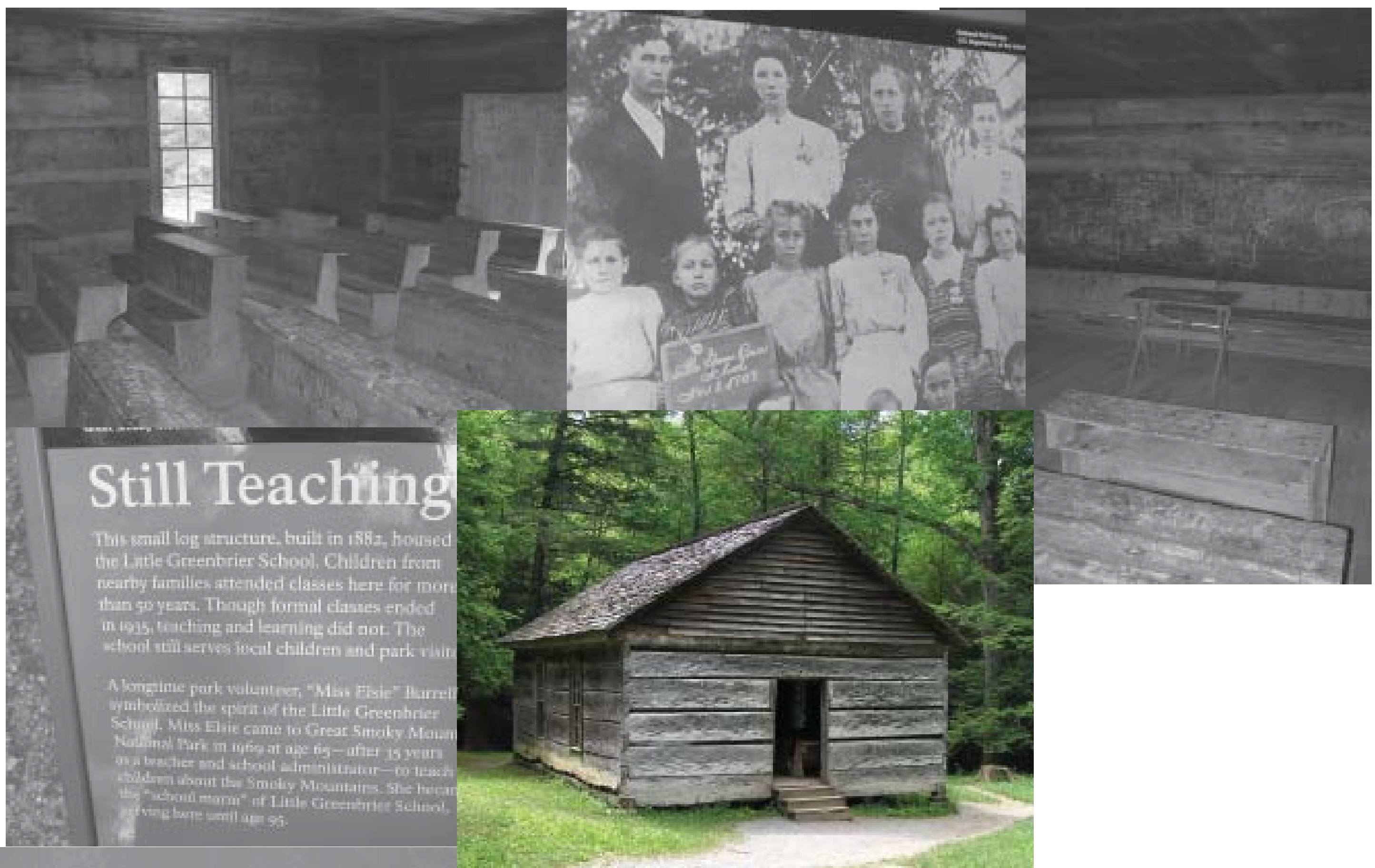
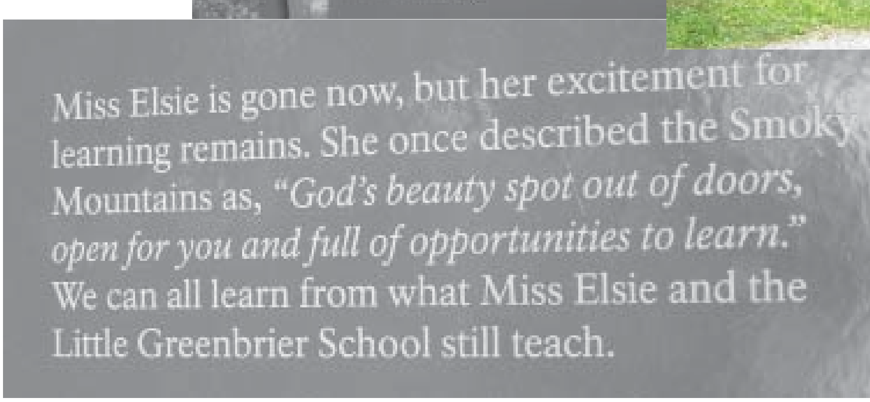
SPECTRUM

Spring 2006, Vol. 32, No. 1

The Journal of the Illinois Science Teachers Association

In this Issue:
National Science Board Hearing on K-16 STEM Education





Plan Ahead:
EEAI Conference - May 4-6, 2006
ISTA Conference - November 2-4, 2006

Spectrum

The Journal of the Illinois Science Teachers Association
Volume 32, Number 1

Spectrum is published three times per year, in spring, fall, and winter, by the Illinois Science Teachers Association, Illinois Mathematics and Science Academy, 1500 W. Sullivan Rd., Aurora, IL 60506. Subscription rates are found with the membership information. *Subscription inquiries should be directed to Sherry Duncan (email: sjduncan@uiuc.edu).*

Send submissions and inquiries to the editor. Articles should be directed to individual area focus editors (see next page and *write for the SPECTRUM information).*

Judith A. Scheppler, Ph.D.
Coordinator of Student Inquiry
Director of the Grainger Center for Imagination and Inquiry
Illinois Mathematics and Science Academy
1500 West Sullivan Road
Aurora, IL 60506
quella@imsa.edu

On the cover: Scenes of a backwoods American schoolhouse and its people circa 1910. Photographs courtesy of Raymond J. Dagenais, Ed.D. See article inside “We’ve come a long way, but ...”

SPECTRUM

The Journal of the Illinois Science Teachers Association

Spring 2006

Volume 32, Number 1

Table of Contents

Articles

ISTA News

President's Corner

Raymond J. Dagenais, Ed.D.

Illinois Mathematics and Science Academy

Springtime is upon us in all its guises. The weather can be unpredictable but, generally speaking, we will see warmer days and nights as the school year progresses. This time of year also brings necessary assessment activities, both local and statewide, as well as celebratory events such as awards ceremonies and graduations. It is a time of year for wrapping up our efforts and for planning for the future.

There are some things of importance to consider as we do our planning. In a recent *Time* magazine article (Feb. 13, 2006), "Are We Losing Our Edge?" the following statements are made, "The U.S. still leads the world in scientific innovation. But years of declining investment and fresh competition from abroad threaten to end our supremacy."

This is the concern that provided the impetus for the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine to prepare the report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.* One of its recommendations is to "Increase America's talent pool by vastly increasing K-12 science and mathematics education."

It is a challenging time for science education, but challenges bring opportunities. If greater resources are devoted to achieving the recommendation in the previous paragraph, will we as a scientific education community be ready? Preparation includes "doing something." Below is a check list of some worthwhile things that ISTA members can do.

Request and present an ISTA Exemplary High School Student Medallion and Certificate to a deserving student (Check out the ISTA web page, http://www.ista-il.org).
Plan to make a presentation at the 2006 ISTA Science Education Conference in Peoria, IL by completing and submitting the Call for Presentations in this issue of the *Spectrum*.
Register for the 2006 ISTA Science Education Conference in Peoria, IL.
Write and submit material for the next issue of the Spectrum.
Take responsibility for helping one other person become a member of ISTA.

These are suggestions for taking action. Achieving the science education goals identified by the national academies and institutes will require not only significant resources but also the commitment of a prepared community of science educators. Will we be ready?

Yours truly,
Ray Dagenais

2005-07 ISTA Executive Committee

Vice President
Denny Moore
John Deere Middle School
jogger25@aol.com

Secretary
Kendra Carroll
Shiloh CUSD #1
carrollk@shiloh.k12.il.us





President-Elect
Jill Carter
Pekin Community
High School
jcarter@pekinhigh.net

Treasurer
Carl Koch
aecKoch@aol.com

Past President
Marylin Lisowski
Eastern Illinois
University
mlisowski@eiu.edu

Welcome New ISTA Board Members for 2006-08!

Susan Dahl	Region 1
Don Terasaki	Region 2
Randall Musch	Region 3
Linda Shadwick	Region 4
Tom Foster	Region 5
John Giffin	Region 6
J. Brent Hanchey	Region 7

The entire ISTA Board looks forward to working with you.

2005-07 ISTA Committee Chairs

Archives	Maurice Kellogg
Awards	Eeva Burns
Convention	Executive Director
Finance	Vice President
Membership	Donna Engel
Nominations and Elections	Past President – Marylin Lisowski
Public Relations	Tom Kearney
Professional Development/Building a Presence	Mary Lou Lipscomb
Publications Committee	Judith A. Scheppler

Regional Directors

Region 1 Director 06-08
Susan Dahl
Fermilab
Lederman Science Center
sdahl@fnal.gov

Region 1 Director 05-07
Tom Kearney
Andrew High School
TKearney@d230.org

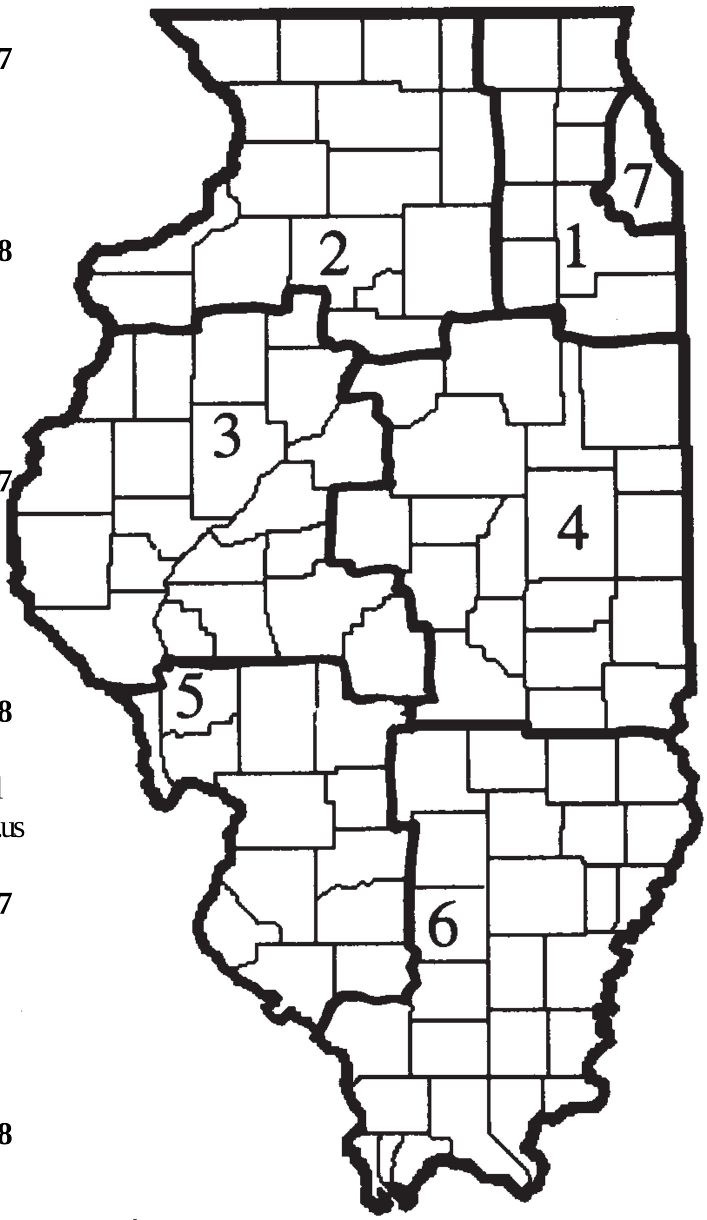
Region 2 Director 06-08
Donald Terasaki
Rockford Boylan High School
dsaki@hotmail.com

Region 2 Director 05-07
Larry McPheron
Rockford Boylan High School
lamcp@hotmail.com

Region 3 Director 06-08
Randal Musch
Jacksonville High School
rmusch@jac117.morgan.k12.il.us

Region 3 Director 05-07
Coleen Martin
Wilder-Waite Grade School
cmartin@dunlapcusd.net

Region 4 Director 06-08
Linda Shadwick
Villa Grove High School
l.shadwick@mchsi.com



Region 4 Director 05-07
Susan E. Golden
Professional Development Institute
sgolden@dps61.org

Region 5 Director 06-08
Tom Foster
Southern Illinois University
tfoster@siue.edu

Region 5 Director 05-07
Kathy Costello
MillstadtSchool
kjcostel@stclair.k12.il.us

Region 6 Director 06-08
John Giffen
Vienna High School
jgiffin74@hotmail.com

Region 6 Director 05-07
Vicki L. Tripp
Buncombe Grade School
ctripp@bgs.johnsn.k12.il.us

Region 7 Director 06-08
J. Brent Hanchey
Nancy B. Jefferson High School
jbhanchey@cps.k12.il.us

Region 7 Director 05-07
Denise Edelson
Hannah G. Solomon School
dnedelson@cps.k12.il.us

http://www.ista-il.org/

ISTA Plans 2006 Conference

Call for Presentations

A Vision of Excellence: Building the Future through Science Education

Illinois Science Teachers Association 2006 Conference on Science Education
Peoria Civic Center & the Hotel Pere Marquette
Friday & Saturday, November 3 & 4, 2006

Deadline for Submission: ***Extended until May 1, 2006!***

Principal Presenter: (Only principal presenters will be notified of presentation acceptance and scheduling.)

Name: ________________________ Day phone ________________________
Affiliation/School ________________________ Evening phone ________________________
Mailing Address ________________________ Email ________________________
City, State, Zip ________________________

Additional Presenter(s): Please attach additional sheet.

Title of Presentation: ____

Program Description (exactly how you want it to appear in the program) – 25 word limit**:**

____
____
____
____

Detailed Description of Presentation (for committee review purposes only) – 200 word limit)**:**
Please attach additional sheet. This description will only be used by the program committee for presentation selection purposes.

***Preferred presentation date:** ☐ Friday (50 minutes only)
☐ Saturday – Select one: __ 50 minutes**;** __ 1 hour, 50 minutes**;**
__ 2 hours, 50 minutes

********The Program Committee will attempt to honor the preferred presentation date, but due to scheduling issues this may not always be possible. All presentations longer than 50 minutes will be on Saturday only.*

Check the intended audience: ☐ K-3; ☐ 4-6; ☐ 7-8; ☐ 9-12; ☐ K-12; ☐ preservice;
☐ college/university; ☐administration

Subject: ☐ biology; ☐ chemistry; ☐ earth science; ☐ environmental; ☐ general/integrated; ☐ physics;
☐ technology; ☐ other (specify) ________________________

Room Set-up: All rooms will be set up with tables unless requested otherwise: ____________________

Safety: All ISTA presentations must conform to NSTA minimum safety guidelines for presenters. Check the ISTA website for those guidelines: http://www.ista-il.org.

Will you be using chemicals or hazardous materials? ☐ yes; ☐ no; If so, please describe:

____

Agreement: I have read and understand the NSTA minimum safety guidelines for presenters. I agree to conform to these guidelines while giving my presentation at the 2006 ISTA Annual Conference. I understand that I will be notified via **email** by May 15, 2006 as to whether my presentation proposal has been accepted or not. If I must withdraw my presentation request, I agree to notify ISTA *no later than* September 5, 2006, so that another presenter can be found in order to fill my slot.

Signature: ___________________________________ Date: __________________________

Note: ISTA requires that all presenters register for the conference.

Return to: Jill F. Carter, President-Elect ISTA
Pekin Community High School
1903 Court St.
Pekin, IL 61554
jcarter@pekinhigh.net

Pere Marquette Hotel

The 2006 ISTA conference hotel is the Pere Marquette Hotel in Peoria. The Thursday (November 2, 2006) pre-conference session will be held at the Pere Marquette, along with several conference breakout sessions on Friday and Saturday. Expect to meet friends and colleagues at one of the many social gathering spots on the premises. The Pere Marquette Hotel is a short walk to the Peoria Civic Center where the exhibitors will have all the newest supplies, equipment, and science education resources on display.

The Illinois Science Teachers Association has reserved a limited block of rooms at the Pere Marquette for conference attendees. Be sure to mention that you are registered for the Illinois Science Teachers Association conference in order to reserve at room at the special conference price:

Single $82.00 Double $82.00 Triple/Quad $108.00

To reserve a room at the conference rate you must contact the Pere Marquette Hotel:
Reservations only: 1-800-447-1676 Information: 1-309-637-6555

Room rates are per night and are subject to taxes and applicable charges
Parking is free for registered guests.

Illinois Science Teachers Association
2006 Conference on Science Education
Peoria Civic Center & the Hotel Pere Marquette
November 2 – 4, 2006
Pre-Registration Form

Deadline for Early Bird Pre-Registration: Postmarked by October 2, 2006

Deadline for Advance Registration: Postmarked between October 3, 2006 and October 23, 2006

Registration on or after October 24, 2006: On-site only

Fill out form completely. Print clearly. Information will be used for our records.

Name: ______________________________________ Spouse/Guest Name (if attending) ______________

Home Address _________________________________ Home phone (_____) ______________________

City/State/Zip _________________________________ County where you work ____________________

Affiliation/School ____

Business Address: ___________________________________ Business phone (_____) ______________

City/State/Zip _________________________________ Email ____________________________________

☐ Check here if you need special assistance due to handicap (describe on extra sheet).

☐ Check here if you would like to be a presider for a session.

☐ Check here if you have been teaching 3 years or less.

Pre-Conference Registration (Thursday only)
(Includes Exhibit Preview and Exhibit Hall Preview Reception)

☐ Registration $75 __________

Conference Registration (Friday and Saturday)
(Includes Thursday Exhibit Preview and Exhibit Hall Preview Reception)

Please circle correct amount.

Registration Fees	**Earlybird** 10/02/06	**Advance** 10/23/06	**Full Rate** After 10/23
☐ Current ISTA member	$100	$115	$125
☐ Nonmember (includes one-year membership)	$135	$150	$160
☐ Institutional members (up to 3 individuals) *	$95/person	$110/person	$120/person
☐ Full-time student	$15	$15	$15
☐ Saturday only (Exhibit Hall not open)	$65	$70	$75
☐ Non-teaching spouse/guest	$15	$15	$15

Enter Registration fee _______

Social Events

Thursday Reception in Exhibit Hall (4:00 to 6:00 pm) No charge, but please register $00.00 _______

Friday Luncheon – Hotel Pere Marquette – All are encouraged to attend $15.00 _______

Friday Night Gala (dinner/dance) & Awards Reception at Lakeview Museum – open to anyone attending Thursday, Friday, and/or Saturday $10.00 _______

Total Due: ________

* Please send all registrations in the same envelope.

Make checks payable to: Illinois Science Teachers Association. Send to Sherry Duncan, ISTA Registration, College of Education, University of Illinois, CRC #61, 51 Gerty Drive, Champaign, IL 61820. No one will be admitted to any part of the convention without registering. If your registration form is received by October 25th you will receive a confirmation in the mail. If it is received after that date, you may pick up your information at the registration area in the Peoria Civic Center.

A Vision of Excellence: Building the Future through Science Education

Come to Peoria November 2nd, 3rd, and 4th for our 2006 Conference on Science Education! We are planning for a number of great sessions and other events. Our theme is focused on the need for a high quality science education in order to ensure a scientifically literate citizenry. Here's a sneak peak at some of the things we have in store for you:

- Details about our pre-conference on November 2nd can be obtained on our website at http://www.ista-il.org/.
- Thursday evening we'll have the exhibit hall open. You won't want to miss this event! Talk to vendors, pick up freebies, network with fellow teachers and win prizes!
- On Friday and Saturday we will have a number of sessions of interest to teachers from pre-K all the way through college.
- We'll have sessions of special interest to pre-service teachers and for those with less than five years of experience.
- On Friday evening we are hosting a gala at Lakeview Museum in Peoria. You'll definitely want to be at this fabulous event! The museum galleries will be open. Browse through the gift shop. See a planetarium show. Catch up on news and make new friends. Have dinner and dance away the evening with a live band!
- On Saturday you'll have a choice of attending 50 minute sessions or workshops lasting two or three hours.

What can you do?

- Be a presenter! The form is available on our website at http://www.ista-il.org. Just as in past years we're looking for sessions on classroom activities, investigations, assessments, and more. Consider offering a short session or a longer workshop on Saturday morning. Do you have suggestions for new teachers, ways they could incorporate inquiry into their classrooms, or classroom management techniques for them to try? Present! We need you!
- If you would like to be a presider, or a committee member, please contact Jill Carter at 309-347-4101 ext. 6267 or jcarter@pekinhigh.net.

Do *You* Know an Exemplary Science Student?

Remember, ISTA members in good standing, who would like to honor one high school science student each year, may request an **ISTA medallion and certificate** by contacting sjduncan@uiuc.edu.

This award program is supported by contributions from the Illinois Petroleum Resources Board.

Illinois Science Teachers Association

2006 Membership Application

Please print or type and fill-out complete form

Name	Day Phone
Affiliation (School or Organization)	Home Phone
Address of Above Organization	Home Address
City, State, Zip Code	City, State, Zip Code
Email and/or Fax	County in Illinois/ ISTA Region (see map)

CHECK APPLICABLE CATEGORIES IN EACH COLUMN

O Elementary Level
O Middle Level
O Secondary Level
O Community College
O College/University
O Industry/Business/ Government
O Other___________

O Elementary Sciences
O Life Science/Biology
O Physical Sciences
O Environmental Science
O Earth Science/Geology
O Chemistry
O Physics
O General Science
O Integrated Science
O Other_____________

O Teacher
O Administrator
O Coordinator
O Librarian
O Student
O Retired

Send form and check or money order, made payable to Illinois Science Teachers Association, to: Sherry Duncan (email: sjduncan@uiuc.edu), ISTA Membership, College of Education, 51 Gerty Drive, Champaign, IL 61820.

MEMBERSHIP OPTION (see below)_______ AMOUNT ENCLOSED __________

ISTA Membership Categories

Option 1: Full membership dues - $35.00. Full membership entitles individuals to the following benefits: a one year subscription to the *SPECTRUM*; inclusion in the members-only ISTA-TALK listserv; notification of regional conferences and meetings; voting privileges; and the opportunity to hold an ISTA officer position.

Option 2: Two-year full membership dues - $60.00. Two-year full membership entitles member to full membership benefits for two years.

Option 3: Five-year full membership dues - $125.00. Five-year full membership entitles member to full member benefits for five years.

Option 4: Associate membership dues - $15.00. For full-time students and individuals who are on retirement status. Entitles member to full menbership benefits, with the exception of the opportunity to run for office.

Opiton 5: Institutional membership - $75.00. Institutional membership entitles the member institution, for a period of one year, to two subscriptions to the *Spectrum*; notification of regional conferences and meetings, and a reduced registration fee for the annual ISTA conference for a maximum of three members of the institution.

ISTA/ExxonMobil Outstanding Teacher of Science Awards Program 2005-2006

The Illinois Science Teachers Association, with the generous support of ExxonMobil, announces the 2005 -06 ISTA / ExxonMobil Outstanding Teacher of Science Awards. Applications were accepted from K–8 teachers of science who have demonstrated “extraordinary accomplishment” in the field of science teaching.

The 2005-06 program consisted of seven one thousand dollar prizes. One $1000 award was intended to be presented to one K–8 teacher of science from each of the seven ISTA regions in the state of Illinois.

The awards are intended to recognize “extraordinary accomplishment” in the field of science teaching. Winners provided evidence that demonstrated accomplishments beyond normal classroom teaching including:

1. Current ISTA membership.
2. Full time teaching assignment.
3. Teaching assignment in the ISTA Region for which application was submitted.
4. Written narrative (maximum of 500 words) that described the teacher’s “extraordinary accomplishments” in the field of science teaching.
5. Evidence that supported the teacher’s description of “extraordinary accomplishments” in the field of science teaching.
6. Two letters of support from individuals that attested to the impact of the “extraordinary accomplishments” in the field of science teaching.

Eeva Burns
ISTA Awards Chair
Email: eevaburns@comcast.net

And the Winners Are .....

Region 1 Kathleen M. Schmidt

Kathleen teaches grades 6-8 science and social studies in a gifted program at Jay Stream Middle School in Carol Stream. She has been a teacher for six years. During this time, Kathleen has developed an integrated science curriculum based on the “Physics First” philosophy of science instruction, implemented the “Hands-on Solar System” curriculum, and also started a science fair program. She has been a Fulbright Memorial participant, traveling to Japan in June, 2004. She has presented at the Illinois ASCD Conference, is a key leader in science, and a school board member. Her work with the Astronomy Resources Connecting Schools program at the Yerkes Observatory has resulted in connections with scientists for her students. Her philosophy of teaching was stated very eloquently, “It is my hope that through the program I have designed, the opportunities I provide for my students, and the knowledge and life experience I bring to the classroom, that I am doing just that—enabling my students to be creative and independent thinkers who see science as a process, and not just as an accumulation of facts to be learned.”

Region 2 Dennis Moore

Dennis teaches seventh grade science at John Deere Middle School in Moline. He has been a teacher there for thirty-six years. He has written and received twenty-five grants, including a GTE GIFT grant for $15,000 to do research on the effect of the Quad Cities on the Mississippi River, and $10,000 from the Toyota Tapestry Grant to have students discover a material that zebra mussels won't attach to. He has also been an instructor for the River's Project and taught a course at Western Illinois University. Dennis brings his students on numerous field trips to Black Hawk State Park, a local hospital, and a farm. He has also organized telescope nights for families to view the stars. He currently is the vice-president of ISTA. Dennis stated in his application, "Because of the grants and workshops I have attended, my students get to do many activities most middle school students do not get to do. They use Vernier probes to analyze Mississippi River water. They play as though they were research scientists and grow bacteria cultures."

Region 3 Coleen Martin

Coleen teaches fifth grade at Wilder-Waite Grade School in Peoria. She has been teaching fifth grade there since 1974. She has attended many science classes and workshops to enhance her curriculum. She has designed a science kit for "Toys in Space" and sessions at the U.S. Space Foundation at the Air Force Academy in Colorado and also the NASA Educational Workshop at John Glenn Research Center in Ohio. Coleen was awarded the 2001 Presidential Award for Excellence in Math and Science Teaching. Her students participate in a rocketry project in her classroom and then she takes a group of fifth graders to Space Camp in Huntsville, Alabama. She is involved with the World in Motion program which incorporates engineering projects in the classroom with visiting engineers who meet and work with her students. She has also been instrumental in the building of a three-quarters scale model of the Spirit of St. Louis and currently is working on building a full size model of Gus Grissom's Mercury space capsule, the Liberty Bell 7. One of the things she does with her students outside of class is run with them. She has started an after school running club for students with the ultimate goal of running in the Steamboat Classic, a four mile race. One student is quoted as saying, "Running with your teacher was really weird at first, but it turned out to be a lot of fun. We talk about a lot of stuff while we run." Coleen says, "I have found that running and accomplishing a goal like running Steamboat makes the kids feel better about themselves…as a result of improved self-esteem, the kids work harder in other areas."

Region 4 Ann Trent

Ann teaches seventh grade life science at Iroquois West Middle School in Onarga. She has been a teacher since 1986. She was selected to attend a one week Food Safety workshop in Washington D.C. and returned to incorporate the new curriculum into her unit on bacteria. As a result of her training, she presented workshops to area science and home economics instructors. She received a Toyota Tapestry large grant to develop a cross-curricular unit with the seventh grade team. Ann also has had an article titled "Hamburger Science" published in the *Science Teacher* magazine in October, 2004. Ann has presented many workshops both locally and nationally. She has organized and directed a drama elective class, adopted a home for handicapped adults, and serves as a resource to her colleagues. A co-worker and parent of one of Ann's former student's shares this insight, "I remember my daughter coming home with a website for a virtual frog dissection. She was thrilled and spent over an hour at the site. It was these activities, the ones that went above and beyond the required classroom learning, that drew my daughter towards the field of science."

Region 5 Susan Kautzer

Susan teaches seventh grade science at Dupo Junior High School in Dupo. She has taught there for the past five years. Susan writes many grants and has received money to provide Earth Day celebrations, hands-on workshops presented by the seventh grade students, family science nights, and also innovative materials for the classroom. As a result of grant funding, she and her students have developed a courtyard garden area at the school. She has presented at several state workshops and also a national science workshop. She coaches the science Olympiad team at her school. Susan has received the Emerson Excellence in Teaching Award. She is also working with the Southern Illinois University Department of Engineering to collaborate on several projects. Her principal writes, "Her classroom and her students reflect her absolute dedication to investigating the way the natural world works. They speculate, investigate, explore, hypothesize, measure, reflect, and report."

Region 6 No entries

Region 7 Joy Reeves

Joy teaches K-8 science at Claremont Academy in Chicago. She has taught since 1987, with two years being spent as an Educator on Loan at the Museum of Science and Industry in Chicago. She has given presentations at the state and national level, taught classes for the Museum Partners Program, she is a teacher liaison to the Space Foundation and has been named a Teacher Academy project trainer for the National Space Biomedical Research Institute. She has been writing modules for the Chicago Web Docent which is an on-line set of lessons for students. Joy has organized a family science night lock-in and also a family night featuring forensics experiments. Joy has received numerous grants to provide materials and opportunities for her classroom. Sarah Rossi, Director of Programs and Development for the Chicago Foundation for Education stated, "As a person, Joy is dependable, optimistic, and passionate. What I find most incredible about Joy is that she is involved in nearly every professional development opportunity in her field, yet she still seeks ways to hone her practice and never says "no" given an opportunity to share her knowledge with others!"

The award from Region 6 was given to the highest point holder from the remaining applicants
Region 4 Tim McCollum

Tim teaches eighth grade science at Charleston Middle School in Charleston. He has been teaching since 1973. Tim is an educational reviewer for Argonne National Laboratory, faculty and site coordinator for the Illinois Mathematics and Science Academy Summer AD'Ventures Programs at Eastern Illinois University, a NASA/JPL Solar System educator, a Toyota Tapestry ambassador, and received the 2003/04 Presidential Award for Mathematics and Science Teaching. Tim recently testified before the National Science Board in Boulder, Colorado. He has also received multiple awards from other prestigious organizations. Tim has written numerous grants to provide materials for his classroom. His students are currently partnering with Arizona State University to conduct scientific research using photos of Mars. They have also conducted snowflake research and in-depth weather studies. His principal, Sandra Wilson, states, "Students receive instruction each day from a dedicated, hard-working, caring teacher that finds interesting ways to connect scientific principles to real-world application. More importantly, Tim allows opportunities that engage and hook students into in-depth concepts by the use of hands-on activities incorporating technology for every lesson. His student-centered, interactive approach inspires students to further educate themselves giving them motivation to learn independently beyond the classroom walls."

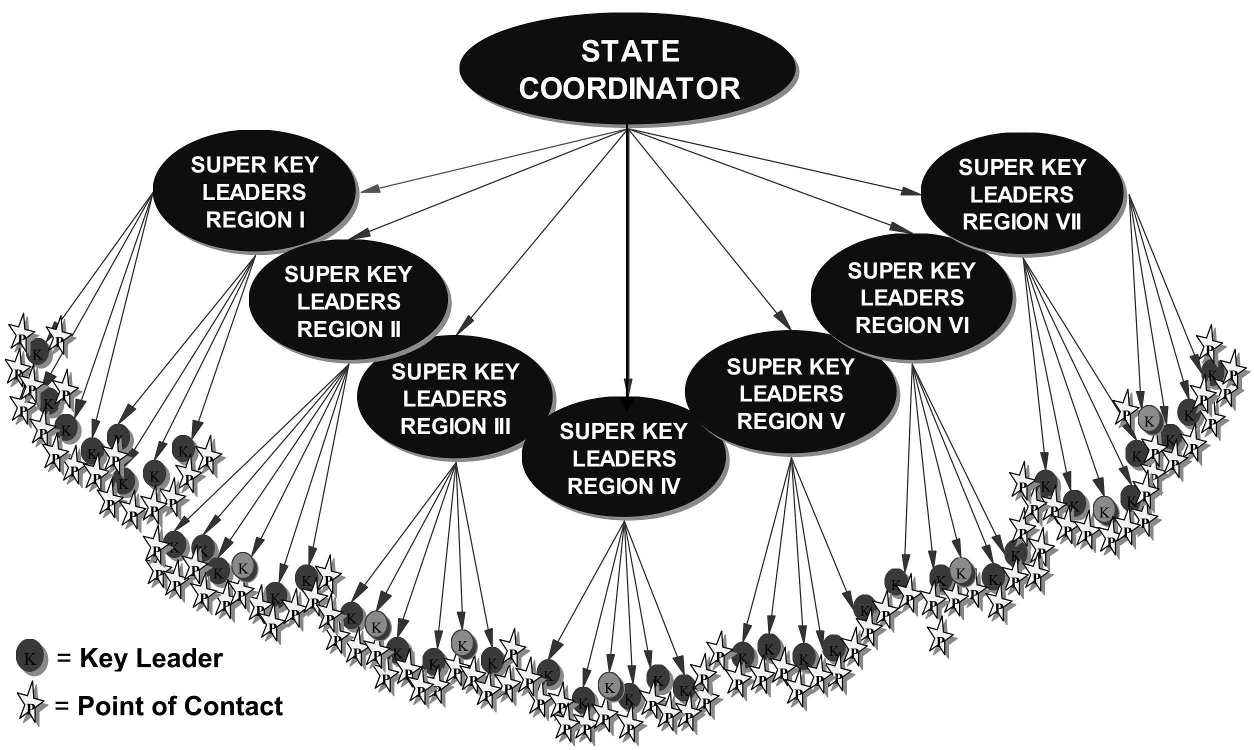
Building a Presence for Science

Mary Lou Lipscomb
BaP State Coordinator, Illinois

Building a Presence for Science (BaP) is an electronic network initiated by the National Science Teachers Association to foster communication, collaboration, and leadership among science educators. Through the network teachers are provided with information about professional development opportunities and science teaching resources. Network participants also have the ability to share ideas and information with each other using the BaP web site (http://www.nsta.org/bap), by sending email, or by posting ideas or questions on the Illinois message board.

In Illinois, ISTA implements the BaP program and during the last several months changes have been made in the way BaP-Illinois is organized. In this new model, rather than having many small regions as was previously the case, BaP will now have seven regions corresponding to the current ISTA regional structure. Each of the seven regions will have two or more super key leaders who will work with the Illinois state coordinator and the key leaders in their region to provide regional opportunities for their key leaders and points of contact (PoC). Key leaders who have been planning professional development opportunities for their points of contact are encouraged to continue to do so. Currently ISTA regional directors have been designated as the super key leaders in their regions, and in some of the regions with larger populations, additional super key leaders have been or will be added. The graphic below shows the new organizational structure.

BUILDING A PRESENCE FOR SCIENCE-ILLINOIS



BaP website: http://nsta.org.bap

If you are currently a key leader or point of contact, you are encouraged to go to the BaP web site, http://www.nsta.org/bap, to update your contact information. If you don't know your password, click the "Lost your password?" link. If your email address has changed since you became a member of the network you will need to contact me at lipscomb@imsa.edu. Include your full name and that you need your password in the body of the email message.

The BaP network is growing in Illinois and you are encouraged to participate. Our ultimate goal is to have a point of contact in every school in Illinois. As a participant you will be seen as a communicator, leader, and advocate for standards-based science education. You will have access to a variety of information to share with colleagues, as well as opportunities to learn and grow both professionally and personally. As each school joins the network with a point of contact, BaP become a more powerful means of communication.

Does your school have a point of contact? If not, ISTA invites you to consider volunteering to serve as a point of contact for your school. You and your colleagues will become less isolated and benefit from the information shared within the network. A point of contact may be a classroom teacher or an administrator who is an advocate for science education and is willing to serve as a contact in his or her school building.

To volunteer to become a point of contact go to the Building a Presence web site at http://www.nsta.org/bap.

- Find the box that states "Become a Point of Contact" on the right side of the page.
- Select "Illinois" from the pull-down menu and then click "Submit."
- Enter your school's city and/or zip code and click "Submit."
- Click on your school's name from the list.
- Fill in all required information and click "Submit." If your school already has a PoC, his or her name will be listed as well as his or her key leader.

Are you interested in taking more of a leadership role in your school district, county or area of Illinois? If you are currently a point of contact and would like to become more actively involved in the Building a Presence for Science Program, consider stepping-up to key leader. To do so please contact me at lipscomb@imsa.edu and include the following information:

Your first and last name.
Your e-mail address.
The name and address of your school.
The county in which your school (district) is located.
Your current teaching assignment.
A short paragraph indicating why you would like to become a key leader.

All members of the BaP-Illinois network will soon be invited to attend an awareness session in their area. These sessions will provide more information about the new model and opportunity to network, face-to-face, with other members of the BaP electronic network. Hope to see you there!

Contact Mary Lou Lipscomb
email: lipscomb@imsa.edu
phone: 630-907-5892
mail: Illinois Mathematics and Science Academy
1500 W. Sullivan Road, Aurora, IL 60506

We've Come a Long Way, But ...

Raymond J. Dagenais, Ed.D.

Illinois Mathematics and Science Academy

The photographs on the cover of this issue of the *Spectrum* give a visual example of an American schoolhouse and the people who used it in the Smoky Mountains region of Tennessee around 1910. The wooden walls and roof of the structure provided some protection from the elements, offering the possibility of schooling through the winter months. This is an important consideration as many of the learners probably spent the warmer months tending to agriculturally related tasks.

The austere atmosphere of the building reflects the attitudes of funding toward education in that place and time. By one account, "The curtailment in school expenditures, along with the general impoverishment of the people, led to drastic cuts in the length of the elementary school term (Rippa, 1984)." This comment refers to the system of public schooling in the south during this time period. Schools such as the one in the photo probably operated through the generosity of the local families who sent their children to these schools.

The education that children received in such schools was probably comprised mainly of reading, writing, and arithmetic, along with some geography and religious studies. What must it have been like learning science in this place and time? What science was included in the curriculum? Was science included in the lessons of the day? It is likely that much of the science that was learned was learned outside of school. John and Margaret Jane [King] raised eleven children in the area of the Little Greenbrier School and this feat is credited to Margaret's skill as an "herb doctor" (*Hiking Trails of the Smokies*, 1999). Where did Margaret learn the science of these medicinal approaches? Might we speculate that these understandings were passed on to sons and daughters?

Little Greenbrier School in the Great Smokey Mountains, Tennessee. The school house was built in 1882.

This "science" along with the science of agriculture, animal husbandry, and machinery, among others, was probably learned through hands-on experiences and the coaching of elders. Even though some teachers had an understanding of the science of the day, scientific knowledge and the processes of science were largely relegated to newly and sparsely established secondary institutions. Science laboratories were the fields, barns, and shops of rural America and, perhaps, a corner of schools or schoolrooms where such facilities could be built.

Fast forward to the present. Students enrolled in secondary schools across the country are expected to study and learn science. For the most part, they have access to curricula and laboratory facilities, to varying degrees, that are supported through a variety of funding sources. Expectations for the learning of and doing of science have been formally extended to elementary and middle school levels (National Research Council, 1996). Opportunities for current day American students to study and learn about the natural and manmade world can be considered to be vastly greater than those available to students in the place and time of the Little Greenbrier School. Students of that earlier era found ways to learn science. Some of our most well funded schools have outstanding science laboratory facilities. In some places separate laboratories exist for physics, chemistry, biology, and perhaps, even Earth science. Equipment to extend the study of space science from naked eye observations to technology enhanced information gathering is even available to some learners.

Interior view of the Little Greenbrier School.

The internet has opened up avenues of knowledge, inquiry, and investigation not available to previous generations. It is true that we “know” more about our world today and therefore there is much more to be studied in today’s schools. With such support and resources available to today’s schools, the natural question is,

Are we using our resources to their best advantage?

If not, what are the obstacles standing in the way of making use of these resources to provide the highest quality science education in the world?

We’ve come a long way, but . . .

References

Rippa, S.A. (1984). *Education in a Free Society: An American History*. Longman, Inc. White Plains, NY, pg 146.

Hiking Trails of the Smokies. (1999). Great Smoky Mountains Natural History Association. Gatlinburg, TN, pg 349

National Research Council. (1996). *National Science Education Standards,* Washington, D.C: National Academies Press.

Author information

Dr. Raymond J. Dagenais is a professional development specialist in science and mathematics for the Excellence 2000+ program at the Illinois Mathematics and Science Academy in Aurora, Illinois.

Testimony to the National Science Board Hearing on K-16 STEM Education

February 10, 2006 - Boulder, Colorado

Tim McCollum

Charleston Middle School, Charleston, IL

Background Information

The National Science Board (NSB) was established with the National Science Foundation (NSF) in 1950 and assigned two broad areas of responsibility: 1) establishing the policies for and guiding the Foundation, and 2) serving as an advisor to the President and Congress on issues in science and engineering research and education. In 1982, the board established the Commission on Precollege Education in Mathematics, Science, and Technology that provided a “plan of action...directed toward the Nation’s achieving world educational leadership in mathematics, science, and technology in elementary and secondary schools by the year 1995.” This report was coordinated with the 1983 report, *A Nation at Risk*. Despite these and many other reports prepared by eminent bodies over the last two decades, sounding the alarm and recommending solutions to well-recognized weaknesses in STEM education, the U.S. continues to slip further behind in international assessments in these fields. During recent congressional hearings, the board was asked to reconstitute its commission. In response, the board is holding a series of three public hearings and roundtable discussions across the country to consider the charge for the reconstituted NSB Commission. The first hearing was held in Washington D.C. in December, 2005. The second hearing was held at the University of Colorado in Boulder on February 10, 2006. This was the hearing that I was invited to provide testimony for. The final hearing will be held in San Diego, California. Note: the January 2006 *NSTA Reports* included a cover story which focused on these hearings.

My Reflections

The event was held in the University Memorial Center at the University of Colorado. Approximately twenty members of the board sat around a large “U” shaped table arrangement, each with his/her own table microphone. A separate table and five chairs and table microphones closed the top of the “U,” and this is where members of each of the five panels provided their testimonies. A gallery of approximately thirty to forty people sat behind the panel table. Two video cameras were capturing the hearing for webcast. Following opening remarks by President Hank Brown (of Colorado University) and Congressman Mark Udall (of the subcommittee on Space and Aeronautics), Dr. Steven Beering (president emeritus of Purdue University) instructed the panel members in the logistics of the hearing and restated the need to limit each testimony to five minutes.

The first panel consisted of legislators; the second (mine) of people involved in K-12 education; the third was composed of higher education members; the next was composed of scientists, including Dr. Leon Lederman, along with representatives of the American Association for the Advancement of Science (AAAS), TERC, and Education Development Center (EDC); and the last panel was composed of corporate representatives including a vice president of IBM. I was actually the only classroom teacher providing testimony, as the other two on my panel were the superintendent of the Jefferson County Public Schools and the director of K-12 science for the Charlotte-Meecklenburg Schools. Each panel testimony was followed with 10-15 minutes of discussion and question and answer with the NSB members.

Testimony

Mr. Chairman, members of the board, fellow panelists, distinguished guests - I am deeply humbled to be invited to contribute to such a significant event as this hearing on improving both the quality of teaching and the performance of our nation's students in the areas of science, technology, engineering, and mathematics. Seldom does a classroom teacher have the opportunity to participate in an initiative of this magnitude. I would remind the board, however, that my role as a teacher may be the most important role represented here today. After all, I am probably the only person in this room who needed to arrange for a substitute in order to attend.

As a veteran teacher of thirty-three years, and having nurtured a passion for science since my youth, I am happy to respond to the stated goals of the Commission and the related questions I received in advance of this hearing.

1. Through my involvement with the Illinois Science Teachers Association, the National Science Teachers Association, and the network of Presidential Awardees in Science Teaching, I have come to appreciate that our nation's schools are blessed with an abundance of outstanding teachers and exemplary programs. Unfortunately, these success stories are seldom made known to the public. In addition, many master teachers are retiring, and the need for attracting the "best and the brightest" into science and math education has never been greater. This is particularly true for males. Male teachers are becoming an endangered species, especially in elementary schools and middle schools. Until recently, I was the only male among eight science and math teachers in my school. Now there are two. In order to meet this need, salaries for science and math teachers must begin to rival those available in the private sector or in school administration - another career option which often draws our most capable teachers out of the classrooms. Establishing differential pay scales for math and science teachers would be a positive step toward attracting our most capable candidates into STEM education.

2. The inquiry model for science education is a prominent component of the National Science Education standards. Teacher education programs must model this approach within their own curricula if it is to be effectively integrated into K-12 education. Future teachers must understand the importance of *doing science* rather than simply learning about science. With access to more and more quality resources on the web, effective teachers are moving away from textbook-centered curricula. Online resources and collections like the National Science Digital Library (NSDL) and the Digital Library for Earth Systems Education (DLESE) provide students and teachers access to data that was once only within the domain of research scientists. Fostering the movement away from content-heavy instruction and toward inquiry and application will surely lead to a more productive citizenry that is better prepared to solve the problems of this century and beyond.

3. While I applaud the goal of *No Child Left Behind* to raise the performance level of all students, the resulting emphasis on high stakes testing has often led to the unintended de-emphasis of science instruction and performance in favor of an expanded emphasis on reading and mathematics. At a time when the quality of science education will directly impact our future standard of living and even our national security, science has unfortunately taken a back seat to reading and mathematics in many of our public schools. More and more science teachers are being assigned to teach subjects outside of their trained discipline. This growing practice often results in larger science class sizes, less time for science preparation, less funding for science supplies and professional development, and sadly, a diluted passion for teaching. One would consider it absurd for a reading teacher or language arts teacher to be assigned to teach a chemistry or physics class, yet science teachers are often expected to teach other disciplines. This is increasingly common as more departmentalized junior high schools are transformed into middle schools. Science as a discipline must be elevated to a position of high priority in our schools. Failure to do so will surely lead to a continuation of the unacceptable condition of K-12 STEM education in this country.

4. The loss of federal funds for science education, such as the Eisenhower program, has severely curtailed opportunities for professional development. Meeting with ambitious and motivated members of the profession and gaining fresh ideas from workshops and conferences have a very positive effect on one's teaching performance. Many teachers seeking such opportunities are now faced with paying their own expenses and even paying for their own substitutes. Like slide rules and 16 mm projectors, professional travel funding for science has become a thing of the past in many schools. Fortunately, exemplary programs like the Presidential Award for Mathematics and Science Teaching, Toyota Tapestry, and Exxon-Mobil Building a Presence for Science provide special teacher recognition and funds to support innovative programs. A renewed effort to establish funds for professional development and professional travel would go a long way toward improving the quality, resourcefulness, and enthusiasm of science educators.

In summary, and in the opinion of this classroom teacher, the charge to the Commission should include strategies for 1) establishing differential pay scales for math and science teachers, 2) fostering the movement away from content-heavy instruction and toward inquiry and application, 3) re-establishing science as a priority discipline in relation to reading and mathematics during this era of high stakes testing, and 4) renewing federal funding sources to support professional development in STEM education. Borrowing from the words in Chairman Washington's invitation to this hearing, these strategies are essential to future U.S. eminence in discovery and innovation.

General Comments on Which All Panels Agreed

1. The need to stress inquiry, application, and critical thinking versus content alone, although teachers need a solid foundation in content knowledge
2. The stress of high stakes testing and how many administrators have pushed reading and math to the highest priority and science instruction has been demoted....and in some cases, nearly eliminated. Some sad stories and examples were shared here.
3. The need to attract the best and brightest into science and math education, especially secondary physical science.
4. The need for more funding to provide world class science instruction, business partnerships, and paid summer internships for teachers in research and industry
5. The need for salaries of teachers to be raised to attract and retain the best and the brightest. To think "outside the box" of ways to attract the best students into teacher education.

Where we Differed

The main and most interesting topic of debate was the idea of differential salary structure for science and math teachers. Ironically, this was actually a suggestion in the 1983 report and in several more recent commissions. Many in attendance argued that all teacher salaries must be increased, not just those in math and science, and some even cited that salary was seldom a stated reason for those leaving the profession. The corporate leaders, however, were united in support of differential salary scales - not just to retain science and mathematics teachers, but mainly to attract the best and the brightest. One mentioned that she had originally planned to be a math teacher, but the higher earning potential in the private sector led her away from that goal. She is now the president and CEO of Analytic Services, Inc. During the reception following the hearing, one higher education member reminded me that differential salary scales already exist at the university level. Why not in K-12?

Surprisingly, assessment was hardly discussed during the hearing.

Highlights for Me

1. Spending one-on-one time on the shuttle bus, and later over breakfast, with Dr. Arden Bement, director of NSF. He proposed establishing an alliance of presidential awardees to play a very active role in improving the quality of K-12 science and math education.
2. Visiting with Dr. Lederman and benefiting from his wisdom, his wit, and hearing about his passion for working with IMSA students and staff.

Over all, the atmosphere of the hearing suggested Sputnik revisited; an awareness that we still lead the world in science and technology, but China and India have made huge gains, and we will lose our position unless we make major improvements quickly. Government leaders, business, education, and science all have recognized the growing threat and the need to act now.

On a timely note (pardon the pun) be sure to read the February 13, 2006 issue of *Time* magazine with its cover story, "Is America Flunking Science?" Terrific article! As science educators, we'll surely be at the heart of the endeavor.

Exciting times ahead!

Author information
I have taught science for thirtythree years at Charleston Middle School in Charleston, Illinois. I received the Presidential Award for Excellence in Mathematics and Science Teaching for Illinois during the 2003-04 school year, and last summer I served on the PAEMST National Selection Committee in Washington D.C.

Write for the *Spectrum!*

The *Spectrum* is actively seeking articles, tips, announcements, and ideas that can be shared with other science teachers. Articles should be sent to the appropriate area focus editor, listed below. Other submissions and inquiries should be addressed to the editor, Judy Scheppler, at quella@imsa.edu. Please send all submissions electronically. Further information about writing for the *Spectrum* can be found at: www.ista-il.org/spectrum.htm

Elementary School Education:
Jean Mendoza (jmendoza@millikin.edu)
Millikin University

Middle School Education:
Richard NeSmith (bioscience_ed@yahoo.com)
Eastern Illinois University

Secondary School Education:
Gary Ketterling (gketterling@ben.edu)
Benedictine University

Higher Education:
Maria Varelas (mvarelas@mailserv.uic.edu)
University of Illinois at Chicago

Building a Presence for Science Program:
Mary Lou Lipscomb (lipscomb@imsa.edu)
Illinois Mathematics and Science Academy

Editor:
Judith A. Scheppler (quella@imsa.edu)
Illinois Mathematics and Science Academy

Teacher - to - Teacher

Educators Share Information, Lessons, and Tips

Mary Lou Lipscomb, Editor

Illinois Mathematics and Science Academy

Teachers have a “bag of tricks” that they use on a regular basis or from time to time to spark or maintain interest, keep things moving, and/or help students understand a concept in a way that is unique or different. Sharing these activities or ideas with colleagues provides a professional development opportunity for everyone involved in the sharing.

In this issue three teachers have submitted an activity, lesson, or an entire unit that they have used successfully with their students. One is a great interactive demo that can be used to start a unit on electricity, the second encourages the students not to jump to conclusions, and the third is an entire unit that uses a variety of learning modalities to produce enduring understandings of cell structure and function. The teachers have indicated the level at which they use the material, but I think each could be adapted for use at other grade levels. Perhaps you will be able to incorporate all or part of these into your repertoire. A sincere “Thank You” to those who submitted their ideas and information for this issue.

+++++

Can You Light This Bulb?

Kevin Wilmot, a sixth grade science teacher and BaP point of contact at William Harris Elementary School in Decatur, recommends this activity as a good attention getter for an electricity or electrical circuits unit.

Hold up a wire, a battery (D cell), and a bulb, (flashlight size) and ask if anyone can demonstrate how to make the bulb light. Most students will think they can. Ask them if they would like to demonstrate how to do so for the entire class and have one student at a time try.

Some will try to connect one end of the wire to the battery and the other end to the bulb, which will not make a complete circuit and will not light the bulb. If no students are able to light the bulb, show them that it can be done by holding the bulb on either end of the battery so that the contact point of the bulb is touching the battery and at the same time connect one end of the wire to the side of the bulb base with the opposite end of the battery. This should make a complete circuit which will light the bulb. Make certain that students understand that in order for the electricity to flow though a circuit, it must have a path to return to the battery.

Don't Jump to Conclusions…

Peggy Deichstetter, a BaP key leader and biology teacher at St. Edward High School in Elgin, writes, "This is a wonderful and fun activity to help students understand why every step in the problem solving process is important."

The problem that the students investigate is, "Which grasshopper will win the race?"

Organize the class into teams of four students each. Each team is given the "Don't Jump to Conclusions" worksheet (Figure 1) with a graph grid printed on the reverse and a set of four slips of paper, each with different information/observations printed on it (Figure 2). As the student groups work through the worksheet, they are directed to silently read the information on their slip of paper and to not let the others in their group see what is written. They then share the information in their own words. The purpose of *not* reading the observations directly off of the slips of paper is to challenge students to communicate in their own words, as scientists would.

Group Names____*Answer_Key*____________________________

Don't Jump to Conclusions

The following exercise involves the scientific method process. Each member of your group will be given a piece of paper to read. Do NOT let anyone else in your group read your paper. In your own words share the information with the other members of your group. Fill in the information for each step of the scientific method.

State the **PROBLEM:**__*Which Grasshopper will win the race ?.*____

List the Important (data that will help solve the problem) **OBSERVATIONS:** _*The Race Track was 5. 0 meters long. It was a straight track. The race was to be up and back. The green grasshopper jumped 20cm every 2 seconds and the brown grasshopper jumped 40 cm every four seconds.*______________

State the **HYPOTHESIS: IF**__*each grasshopper jumps 40 cm every 4 seconds*_______, **THEN**_____*the_race will be a tie*_________

EXPERIMENTATION: (Use the graph on the back of this sheet for a diagram of: the racetrack, the hops using green and brown colored pencils, and any necessary calculations, etc. to prove or disprove your hypothesis.)

CONCLUSIONS:_____*The green grasshopper won the race because the brown grasshopper over jumped the midpoint.*________

Figure 1. Don't Jump to Conclusions. Worksheet with answer key.

As they work to complete the worksheet, students may be frustrated at first because they are not sure what the problem is that they are trying to solve. In the section that asks them to write down their observations, the students should only include observations that will help determine the winner of the race. A good scientist must decide what information is pertinent to the problem.

If the students try to figure out the problem mathematically, they will state the race is a tie. Do not tell them it isn't. *Insist* they prove it by drawing the racetrack (to scale) and draw the grasshopper jumps in brown and green. If they draw a round track suggest that they check their observations.

Because the race is up and back, the brown grasshopper, because of his longer jumps, will over-jump the midline. This will put him behind in the race, so the green grasshopper will win. Some students will attempt to have the brown grasshopper do a 180 degree turn in mid-air and break all laws of physics to have the race end in a tie!

Contact Peggy at pdeichstett@yahoo.com if you would like a copy of the activity.

Communicate your observations accurately to your group members in your own words.

1) The racetrack was 5.0 meters long.

2) The green grasshopper jumped a distance of 20 cm. every hop!

3) The brown grasshopper's jump took 4 seconds each.

Communicate your observations accurately to your group members in your own words.

1) The race was to be down and back beginning and ending at the start marked with a chalk line.

2) The brown grasshopper's jumps were 20 cm. high!

3) The green grasshopper's jumps took 2 seconds each.

Communicate your observations accurately to your group members in your own words.

1) The weather conditions were sunshine, blue skies, and no wind.

2) The green grasshopper made two jumps in the time that the brown grasshopper made only one jump.

3) The 5 meter distance was marked with a chalk line.

Communicate your observations accurately to your group members in your own words.

1) Two grasshoppers decided to have a race!

2) The big brown grasshopper jumped a distance of 40 cm every hop!

3) The green grasshopper's jumps were 10 cm. high!

Figure 2. Don't Jump to Conclulsions. Information and observations.

+++++

Enter…the Cell

Robert Burtch, a seventh-grade teacher at Rotolo Middle School in Batavia and a BaP key leader, engages his students in the study of cells using lessons that incorporate various learning modalities. He writes, "Mitochondria, lysosomes, endoplasmic reticulum, vacuoles – my students and I are about to embark on one of our important units of study – the cell."

Explaining how cells function and describing their requirements is a benchmark in the *Illinois Learning Standards* for middle school. Getting middle school students involved with the concept of cell theory and related terminology, rather than having it to be a stumbling block, was my challenge.

Inspiration Strikes

To me, cell theory is about the most important topic to teach in life science, but I always found it difficult to make interesting for students. When I went to science conventions I would always talk with the exhibit vendors and ask them what they have for teaching cell theory. I would find a weak response at best. There were no engaging experiential units out there. This prompted me to develop my own. What I am sharing in this article are activities and strategies that I have used and that have been successful with my students.

The Work

A major component of the unit is the transformation of my classroom into a "cell." So before the unit begins, I gather a variety of familiar materials such as foam balls, cellophane, fishing line, zipper-type plastic bags, spray paint, bread sticks, pipe cleaners, colored balloons, candy bars, antacid tablets, foam weather stripping, peanuts, colorful bows, paper lunch bags, Christmas tree icicles, plastic fruits and vegetables, and clear plastic sheeting, among other things, that will become the various structures of my classroom-sized cell model. If you would like specific directions about making the cell model, or further information about any of the following activities, please contact me at robertburtch@earthlink.net.

I begin to hang cell parts around the room as the students begin a short preliminary unit on microscopes. As I teach the labs in microscope skills, I add new cell parts each day after school until we have completed the introductory lessons for the cell unit. Students are very curious as our classroom takes on a whole different aura. They throw out endless suggestions and questions regarding the changes and of course I play "ignorant" about the whole process. This keeps them guessing, and frustrated as they are used to immediate gratification.

The first lesson of the unit is an easy to read, straightforward one-page historical article on cells and the scientists who led the way to our current understanding of them. I have students answer simple questions about the reading and then label basic structures and color code a diagram of a plant cell and one of an animal cell. The understandings I expect the students to come away with are: all living things are made of cells; cells are the basic unit of structure and function in living things; and living cells only come from other living cells.

One of my goals is to teach students how to read science content, so next, I work with the students to understand a more technical reading on the cell. This article contains information on each cell part name, its structure, and its function. I ask the students to be prepared to use three different colored pencils to highlight important information and make a bar graph of the content of the article. I begin to read the article aloud with the students and I model how to make the graph. As we read together, the important information is highlighted and the students develop their graphs. In the end, they are able to see the content of the article in graphic display.

After school on the day of the second reading, I hang a large piece of transparent/translucent plastic sheeting over the doorway to my room on which I have drawn black pores with magic marker – the last piece of the classroom cell model is now in place.

The next day I stand in the hallway and allow only those students who have come prepared with the previously assigned 4" by 6" cards through the "cell membrane" (the plastic over the doorway into the classroom). The other students are left in the hallway. As is true with most middle schoolers - half of them have forgotten their cards, have the wrong size, lost them, or whatever and think they are in big trouble.

After the students with cards are seated in the classroom I allow the others in the classroom. This is when I first divulge that they are sitting in a cell and I ask the question, "Why were some of you allowed in today and some not?" After the obvious response "because we did not have our cards," they do a bit of thinking and usually can answer that the plastic with the pores represents the cell membrane and it is semi-permeable, allowing only certain things through.

I give out extra 4" by 6" note cards to those students without them. I now begin what I call the *Cell Flash Card* assignment. The students use the cell article they have read and color coded and make one card for each of the cell parts in the article. Each card has the name of the cell part on the unlined side, and on the lined side is function, structure, a precisely labeled drawing, and whether it is found in a plant and/or animal cell.

The next day I add another component of the unit by giving them a rubric for identifying the cell parts hanging in our science classroom cell model. For example, I have several power bars hanging from the ceiling to represent mitochondria. I love hearing student banter about what the objects hanging from the ceiling represent.

Final Product

The introduction to the unit engaged the students in reading a short article and answering simple questions related to it and labeling basic structures on a diagram of the cell. Next, bar graphs were created as a visual representation of the categories of content covered in another article that they read; then lab investigations on plant cells (onion) and animal cells (cheek) were performed. The *Science Classroom Cell* checklist assignment and the Cell Flash Cards have brought the students a long way toward understanding cell structure and function. They are now ready for the final activity: making their cell projects.

They may choose either a plant or animal cell and I have differentiated instructions for ways that students may make their cells depending on their ability level. They are given rubrics for the project to clarify the way it will be assessed.

For me, this is the highlight of the unit. One student made a clever model from items found under his bed; another did a broken skateboard model; another, a clever three-dimensional diorama; others created a cell analogy on a t-shirt; and many, many more. Student creativity amazes me when they are given a chance. I call it guided discovery.

What are you waiting for? Dive in and enjoy a Cell-abration!

+++++

If you have lab or classroom management hints, great websites you have used, science activities, lessons, or demonstrations that you have found to be effective with your students, please send them to me electronically at lipscomb@imsa.edu, fax them to 630-907-5893, or mail them to me at 1500 West Sullivan Road, Aurora, IL 60506-1000.

Articles

Brain-based Strategies are Needed to Improve Student Science Achievement, Not Clichés

Dr. Richard A. NeSmith
Eastern Illinois University

Beginning in 2007, No Child Left Behind mandates the inclusion of high-stakes testing results as a means of accountability for science.

As science teachers across our nation are aware, beginning in 2007, *No Child Left Behind* mandates the inclusion of high-stakes testing results as a means of accountability for science. The Bush Administration has called for NCLB science assessments to become a component of each State's AYP; adequate yearly progress (NSTA Legislative Update, 2006). The United States Department of Education adheres that such measures will increase science and mathematics achievement (Proven Methods, 2004). The U.S. Department of Education asserts that eighty-two percent of our nation's twelfth graders performed below the proficient level on the 2000 National Assessment of Educational Progress (NAEP) science tests (Proven Methods, 2004). The current Administration seriously believes, and has declared, that the U.S. has solved our problems in teaching students to read, therefore, we can solve our problems in science. It appears that national reading data from the first phase of NCLB, however, are at best unimpressive and insignificant. Turnbull et al., noted the following regarding the 2003 highlights from the reading data resulting from NCLB: "No significant increase was found in fourth-grade reading scores during 2003 as compared to previous years beginning in 1992" (Turnbull, Turnbull, Erwin, et al., 2006, p. 133). The U.S. Department of Education makes the following statement on the federal government website:

"Over the last decade, researchers have scientifically proven [sic] the best ways to teach reading. We must do the same in science. America's teachers must use only research-based teaching methods and the schools must reject unproven fads." (Proven Methods, 2004).

With this in mind, I was eager to view the reading results posted that brought such optimism and inspiration. These results, which are clearly noted as *estimates*, are available from the National Center for Education Statistics (2004, n.p.). The NCES reported the following regarding reading results:

"On a 0 to 500 point scale, fourth-graders' average score was 1 point higher and eighth-graders' average score was 1 point lower in 2005 than in 2003. Average scores in 2005 were 2 points higher than in the first assessment year, 1992, at both grades 4 and 8.

Between 1992 and 2005, there was no significant change [sic] in the percentage of fourth-graders performing at or above Basic, but the percentage performing at or above Proficient increased during this time. The percentage of eighth-graders performing at or above Basic was higher in 2005 (73 percent) than in 1992 (69 percent), but there was no significant change in the percentage *scoring at or above Proficient between these same years." (Reading results, 2005, n.p.).*

Thinking that I may have misunderstood, or simply failed to notice the grounds for such optimism due directly from the NCLB "proven methods," I sought to determine just how successful our "proven methods" of teaching reading might be, since this is being proposed as a scientific accomplishment put forth by the federal government and the forte for resolving the ailments of U.S. student's unacceptable science scores on standardized tests. I conjectured that maybe the *great* improvement in reading possibly occurred in aggregated scores among the lower socioeconomic status students since the data in *Reading results* were, collectively at least, of little or "no significance." This, in any case, would have explained the optimism, since researchers have documented and reported extensively on the ever-widening of differences in academic performance among ethnic and racial groups, particularly those considered at-risk (Haycock, 2001, Poliakoff, 2006, Ramirez & Carpenter, 2005). Seeking answers, I again searched the NCES government website and noted the following:

The average score for students who were not eligible for free or reduced-price lunch decreased by 1 point between 2003 and 2005. The longer trend between 1998 and 2005 showed no statistically significant changes regardless of free-lunch eligibility (Reading results, 2005, n.p.).

It would appear that during the last decade researchers have scientifically *sought* the best ways to teach reading. It does not, however, deem that we have *scientifically proven* the best way to teach reading for it appears, according to qualitative data, that nothing of *significance* has been discovered or accomplished, yet. There are grave differences in political ideology and science, and to blur the lines of demarcation with clichés only confuses the issues, at best, or acts as a smokescreen, at worse (Gonyea, 2006). The fact is that the use of the words *proven* and *scientific* must be questioned, for such combination of words does not elicit a great deal of confidence or encouragement in those trained in, and teaching, science. Many of us carefully warn our science students about using the words proven and science in the same breath. Science can only provide data to support or deny the hypothesis. The fact is we do not have a fail-proof method for teaching reading…or science or mathematics. More precisely, we do not, at the present, have many methods identified, to be considered *statistically significant*, much less proven. If we are going to improve student achievement in science we need to concentrate on how best to *teach* students, how students best *learn*, and how to best *challenge* students, and not simply the production of shallow and naive clichés which will only lead to further educational disappointments, greater educational disparities, and put even more students at risk.

Schools during the 2007-08 academic year will be required, by NCLB, to test students in science once a year in each of three grade levels: 3–5, 6–9, and 10–12. Some science educators are apprehensive that this high-stakes thrust might force teachers to lessen their hands-on activities in science classes and resort to more rote memorization, direct instructional methods, and teaching to the tests (Cavanagh, 2004). Since the 2001 reauthorization of the Elementary and Secondary School Act, along with the significant expansion of federal control over public education, reading and mathematics has been the main center of attention in most schools (Yell & Drasgow, 2005). Most of the other disciplines have been neglected, ignored, or placed on "hold" as a result of the resounding need to meet NCLB AYP in reading and mathematics; namely, achievement scores (Varlas, 2003). Such a feeding frenzy has, and will continue to have, an effect on the quality, and the quantity, of core and non-core disciplines (Graham, 2006). Some disciplines, for example, such as social studies have been almost totally lost in the program maze due to the lack of a NCLB mandate, emphases, or funding. It was not that many years ago that the general public became horrified at the inability of students to place simple common geographic locations on a map.

We must begin preparing for the upcoming changes which include our own discipline. As a profession, if we do not "police" ourselves the government will do it for us. Some school districts are already beginning to cringe at the thought of yet another obligation. As we approach the commencing

If we are going to improve student achievement in science we need to concentrate on how best to teach students ...

of the 2007 academic year a great deal has already been said about reform measures for middle level education (Big Ideas, 2005; *Breaking Ranks*, 2006; The Daring Dozen, 2006; Erickson, 2006; Juvanen, Kilgore, 2005; Kosar, 2005; Le, Kaganoff, et al., 2004; NeSmith, in press; Rushton & Larkin, 2001; Yecke, 2005). Yecke (2005) sounded a serious alarm that the middle school has failed. Kosar (2005) has suggested more *good government* [*sic*]; that is, more federal control of education is desirable (p. 2). A recent Congressional report, entitled, "Rising above the gathering storm," along with the Protect America's Competitive Edge (PACE) Education Act, proposes measures to advance U.S. students into regaining and maintaining an international competitive edge in science and mathematics. Congress' primary concern is economics. Our primary concern should be students and learning.

Paradigm shifts requiring change are mounting pressure and many schools have, or are presently considering, consolidating and redefining grade-level and school configurations, which would return the middle level to the K-8 elementary building model. These decisions, also, seem to be based primarily on economical concerns rather than on educational research. It seems that once again we are on the verge of another "turning point." Nevertheless, with an emphasis on brain-based research and practical applications to accommodate students, we should be able to provide a variety of strategies or methods to facilitate and significantly improve student learning and academic achievement in science.

The purpose of this article is to place emphasis on the concept of brain-based educational strategies for the classroom teacher and to create some dialogue among science teachers. In further issues, we will seek to establish the relationship between the brain and learning based on what cognitive scientists and educational researchers have conceptualized during the last few years. We also intend to point out potential methods and strategies, as offspring of cognitive science, which could be utilized in the middle school science classroom. This author recommends a need for an "awakening" which concentrates on *learning* rather than testing; a focus on comprehension as opposed to teaching to a standardized test. Learning should be the main goal. Assessment and accountability should be learning-centered, not standards-centered. As learning-centered schools form they would adjust and adapt to the ever-changing standards. Placing the emphases where it needs to be permits us to utilize the research we presently have and to make reflective changes. Once we realize this we will see far greater progress. Financially penalizing schools because they failed to meet AYP does not make much sense. Those schools and districts failing need the *most* help and the *most* funding! How does reducing a school's funding help them to reach their next AYP? It is time that we define learning; make it the centerpiece, and determine how it should be properly assessed. Brain-based research can be one important aspect in the scope of things to assist in reaching this goal for it provides the educator with tools, strategies, and methods to address student needs holistically: mind, body and soul. This may require that we have greater diversity in the types of schools available to students. It might require that we consider thinking outside of the traditional box of the traditional and unchallenged system of American education. In any profession, the professionals have tools of the trade. Standards should be a tool for academic success, not an end in itself. As standards become the end result, instead of the means to an end, then education becomes a matter of the lowest common denominator. The floor becomes the ceiling.

Many important lessons have been learned from the enactment of NCLB. What we have not learned is how to accurately assess learning. Nor have we come to realize when calculating AYP that the first 20 to 40 percent increase in achievement will prove to be *less* difficult than the latter 20 to 40 percent, culminating to a desired 100% by 2012 (Yell & Drasgow, 2005). As when I diet, the first ten pounds is not "extremely" impossible, but the last ten pounds…well, never mind! Nonetheless, if we can focus, and refocus, on student achievement and seek to help our students become scientifically literate we will have provided them with the skills, knowledge, and tools to become critical thinkers, life-long learners, and to be educated constituents in their respective communities. Even the advertising media has sought to benefit from brain-based learning principles and appear to have a solid grasp on the concept. For example, a consulting firm called Funderstanding, assists marketing clients in securing their share of the youth market, utilizing brain-base concepts, noting that, "This learning theory is based on the structure and function of the brain. As long as the brain is not prohibited from fulfilling its normal processes, learning will occur" (Brain-based Learning, 2001, n.p.). Brain-based research has become so important in the marketing industry that these consultants seek ways to make applications (for profitable purposes) and even provide their clients with twelve brain-based core principles. The following are listed from the Funderstanding Internet website (Brain-based learning, 2001):

1. The brain is a parallel processor, meaning it can perform several activities at once, like tasting and smelling.
2. Learning engages the whole physiology.
3. The search for meaning is innate.
4. The search for meaning comes through patterning.
5. Emotions are critical to patterning.
6. The brain processes wholes and parts simultaneously.
7. Learning involves both focused attention and peripheral perception.
8. Learning involves both conscious and unconscious processes.
9. We have two types of memory: spatial and rote.
10. We understand best when facts are embedded in natural, spatial memory.
11. Learning is enhanced by challenge and inhibited by threat.
12. Each brain is unique.

Brain-based research provides the educator with tools, strategies, and methods to address student needs holistically.

Such principles provide educators with multiple opportunities to develop practical applications for the classroom to improve the learning environment and, potentially, student achievement. In order to set the stage for the sharing of brain-based educational strategies, it seems appropriate here to begin by providing a summative basis for brain-based research in relation to education and learning. Cognitive science is an interdisciplinary field of researchers encompassing neuroscience, psychology, linguistics, philosophy, computer science and anthropology, all seeking to understand the mind (Willingham, 2003).

The fields of neuroscience, cognitive psychology, and educational research have provided educators with numerous explanations of what is involved in learning. Though practical applications have been slow in forming, these disciplines have provided conceptual explanations to assist educators in understanding the processes of learning as well as implications for how to create more effective learning environments, namely, the classroom (Juvanen, Le, Kaganoff, et al., 2004; NeSmith, *in press*; Rushton & Larkin, 2001; Yecke, 2005). As technology continues to advance so does our understanding of how the brain works and learns, but in this transition many scientific premises are presently being challenged. Because of past limitations involving the inability to actually observe the internal brain at work, researchers tended to monitor and measure, instead, the behaviors which resulted from brain activity. The results were the rapid growth and dominance of behavioral

As a profession, if we do not police ourselves, the government will do it for us.

psychology. New technologies have advanced the concept of learning by enabling scientists to monitor the internal brain activity revealing that the human brain is far more dynamic than ever considered. For example, Sylwester (1993) reported over a decade ago that, contrary to conventional wisdom, the brain was not like a computer but more like a *jungle ecosystem* with neuronal groups and connections (synapses) running in all directions and susceptible to rather rapid change, and operating much like an orchestra, in that separate brain areas all assess and conceptualize in order to provide a richer and more accurate image of the external world in which the individual exists (pp. 46-51).

This innovative concept of the brain results in the upgrading to a more precise biologically/chemically-based *cognitive science*, which seeks to provide a greater understanding of the anatomy and physiology of the human brain and its ability to learn as opposed to simply resulting behaviors. The modern concept involves the continuous connecting, reconnecting, rerouting, and pruning of neuronal connections, in response to both genetic factors *and* environmental stimulation (*Sylwester, 1993)*. Neurons, or nerve cells, are activated by a mental task or motor response thus eliciting an electrochemical firing, which is accompanied by energy consumption and an increased blood flow to the area of the brain. For example, when a person hears the spoken word, neurons in the auditory cortex and parts of the temporal lobe are activated (Kim, Myer, & Murphy, n.d.). The creation, or modification, of neurons and synapses is continual and vibrant. As connections are reinforced they become faster in response and eventually a plexus, similar to a spider's web, forms. Learning is the physiological and anatomical changes that occur in the brain. Using Sylwester's analogy of a jungle ecosystem, one can easily see how the entire forest is in constant change. In many ways this modern reconceptualization of the human brain has caused educators to take another look at *how* we teach and *how* students learn.

Many past scientific premises are being challenged. For example, it was once believed that humans are born with a specific number of brain cells called neurons. This may not be the case, after all, and research is now challenging this concept. It is estimated that humans have approximately 100 billion specialized and unique cells in the brain and spinal cord of the central nervous system. Neurons were recognized as unique, non-reproducing cells. This precept is also being challenged by more recent research (Gould, Reeves, Graziano, & Gross, 1999; Kempermann & Gage, 1999). As more is being learned about how heredity and environment enables the neurons to connect via dendrites and axons, we are encouraged that more connections provide greater recall abilities due to numerous data access points. As neurons "connect" by way of synapses, they communicate with one another by means of electrical and chemical signals, thus making them unique to other cells. In many cases, we are learning, retrospectively, why some methods and strategies have been working in the classroom and why others have not. As students encounter various educational experiences, are provided context, and have established connections between what they already know and what they are learning, these multiple neuronal connections provide them with a conceptional understanding (broad view) that not only includes facts (specifics) but how they relate (context). The lack of context and application causes students to sit in our classrooms and simply practice *surface learning* (Willingham, 2003). Surface learning may enable them to pass a unit test, but it does not provide them with long-term benefits, and often simply results in their moving into the next grade level and expressing to their new science teacher, "We *never* did this last year."

The more we know about the human brain and how it best learns, the better able we are to help our students become more successful in academic achievement and in life. The more we learn about how the brain learns the more responsible we will be as classroom teachers to try to help all students learn science and mathematics. The more we learn about how the brain learns the better our students will perform on properly-designed mandated standardized tests.

Brain-based principles should be considered by classroom teachers as possibly relevant to student learning, and might provide educators with variables which can be controlled. Teachers and administrators are truly limited in what variables can be controlled. We have, for example, little influence in changing students' home life, though some schools have made progress in this area. We have little influence in what students do after school hours (though this trend may also be changing in the near future). We can, however, account for what *we* do in the classroom. It is the leadership (administration and faculty) that determine how well a school operates and the degree of effectiveness in the school's programs and practices. These leaders are the most influential factors in sustaining academic success (Chrisman, 2005). A number of educators have established that *the most powerful influence* in educational reform is the classroom teacher (Barth, 1990; Blum, 2005; Darling-Hammond, 1997; Dozier, 1993; Mintrop, 2003). Though a vital component, until recently the classroom teacher has not been of major concern in most reform efforts. This is an important omission for, clearly, this is the heart of student achievement.

The State government may dictate specific standards, the district may dictate specific outcomes, and the building administration may even require specific procedures but as a professional, what I do in the classroom is a matter of *my* creativity, *my* philosophy, *my* training, *my* standards and *my* expectations. As a classroom teacher, you and I have "control" of what we do *in* the classroom. I have the *freedom* and *responsibility* to determine what *works* and what does not work. I must be attentive to the academic and developmental needs of my students, and it is up to me to provide the most effective strategies and methods available to motivate and encourage students to be all that they can be in life.

Such freedom and responsibilities require that classroom teachers stay abreast of educational research which might encourage some strategies and methods over others. Even the utilization of new methods, however, must be practiced and scrutinized by the classroom teacher *in the classroom*, for what *works* in one school may not work so well in another. The one-size-fits-all pedagogy is, or should be, extinct. Education, itself, is not outmoded but our traditional educational practices may well be. We no longer live in the era of the Industrial Revolution for which present educational practices and systems were designed to serve. Some trial and error may be appropriate at times, but not that of blatantly shooting in the dark. By continuously seeking research-based pedagogy, classroom teachers could consider *possible* strategies and methods that would improve student achievement, keeping in mind that one's own students and classes have specific needs, strengths, weaknesses, and various learning styles.

We are learning why some methods and strategies have been working in the classroom and why others have not.

As a professional, the classroom teacher is in the most strategic position to use their experience and knowledge to make important changes and as teachers, schools, or school districts examine their present practices and embrace *effective* changes, student achievement will rise (Chrisman, 2005). What is important to understand is that *context determines the application*. Teachers, as professionals, must monitor, reflect, and assess various strategies and methods in order to determine whether the results (i.e., levels of learning) are acceptable for their own population of students. By monitoring numerous assessment results the classroom teacher can fine-tune the most effective methods producing the most prepared students, realizing that *any method loses its effectiveness if overused*.

During the last ten years, research data has grown exponentially in the area of brain-based studies. The present strategy of this Administration is for the federal government to evaluate, approve, and provide an exclusive data base of *acceptable* strategies, known as *What Works Clearinghouse* (n.d.). At present, teaching methods are submitted to the data base for approval by the government, though not *yet* considered mandatory, this would seem to be the plan. In this data base, however, the use of ambiguous and elusive labels are used such as, "*Meets Evidence Standards*" and "*Meets Evidence Standards with Reservations*." Unfortunately, limiting, licensing, or mandating strategies or methods will only hinder the process of improving education.

The strategies and methods highlighted in upcoming issues will center on the classroom teacher and brain-based applications for improving student learning. Constantly adding to one's repertoire of successful strategies and methods is a sign of professional growth. In light of the upcoming 2007 NCLB science mandate, professional growth will prove to be vital. This article seeks to spur interests, elicit discussion, dialogue, suggestions, and to provide science teachers with promising and effective strategies and methods which facilitate student achievement. The research-based strategies and methods emphasized are not considered "silver bullets," nor will all applications bring about the same exact results for every teacher or every class. People are multi-dimensional and complex and therefore improving achievement will require craftiness, professional insight, and pedagogical wisdom in being selective while being creative. As individual teachers begin to tweak, modify, amend and adapt their teaching strategies, student achievement can be facilitated, monitored and assessed. The author would like to encourage science teachers to submit what they believe to be the most useful or helpful strategies and methods they have used to raise their students' achievement levels in science. These will be compiled and published in an upcoming issue of *Spectrum*. The key is to search for more effective means of facilitating learning, not just making rhetorical clichés that only ignore the real problems and seek to cause one's constituents to be appeased.

References

Barth, R. S. (1990). *Improving schools from within*. San Francisco: Jossey-Bass.

Big ideas for better schools. (2005). *Edutopia, (1)*6, n.p.

Blum, R. W. (2005). A case for school connectedness. *Educational Leadership, 62*(7), 16-20.

Brain-based learning. (2001). Funderstanding, Retrieved March 8, 2006 from: http://www.funderstanding.com/brain_based_learning.cfm

Breaking ranks in the middle: Strategies for leading middle level reform. (2006). Reston, VA: National Association of Secondary School Principals.

Chrisman, V. (2005). How schools sustain success. *Educational Leadership, 62*(5), 16-20.

Cavanagh, S. (*2004, November 10).* NCLB Could Alter Science Teaching. *Education Week*. Retrieved March 1, 2006 from: *http://www.aeoe.org/news/online/nclb-science-edweek111004.html*

Darling-Hammond, L. (1997). *The right to learn*. San Francisco: Jossey-Bass.

Dozier, T. K. (1993). Involved and empowered teachers are the keys to education reform. *On Common Ground, (1)*. New Haven, CT: Yale-New Haven Teachers Institute. Retrieved February 26, 2006 from: http://www.yale-university.com/ynhti/pubs/A14/dozier.html

Erickson, T. (2006, January 10). Minds on middle school: Davis District sets goals to keep adolescents academically engaged. *Deseretnews*. Retrieved January 11, 2006 from: http://deseretnews.com/dn/view/0,1249, 635175055,00.html

Gonyea, D. (2006, February 28). Bush science push fails to transform critics. Washington, DC: National Public Radio. Retrieved March 14, 2006 from: http://www.npr.org/templates/story/story.php?story ID=5232410&f t=1&f=1013, n.p.

Gould, E., Reeves, A., Graziano, M., & Gross, C. (1999). Neurogenesis in the neocoretex of adult primates. *Science*, *286*, 548–552.

Graham, K. A. (2006, March 12). Gimme a T, gimme an E ...Test prep reaches high-stakes frenzy. *The Philadelphia Inquirer.* Retrieved March 15, 2006 from: http://www.philly.com/mld/inquirer/ 14075904.htm

Harcombe, E. S. (2005). Science teachers, under construction. *Educational Leadership, 62(6)*, 50-54.

Haycock, K. (2001). Closing the achievement gap. *Educational Leadership, 58*(6), 6-11.

Juvanen, J., Le, V., Kaganoff, T., Augustine, C. & Constant, L. (2004). *Focus on the wonder years: Challenges facing the American middle school*. Santa Monica, CA: RAND Corporation.

Kempermann, G., & Gage, F. (1999, May). New nerve cells for the adult brain. *Scientific American, 280*(6), 48–53.

Kim K., Myer, C. F. & Murphy, M. H. (n.d.). *Brain Based Learning and the Implications for Teaching Social Science*. Retrieved March 8, 2006 from: http://www.nssa.us/27_1/27-1%2011%20KorcsmarosBrain-Based.htm

Kilgore, S. (2005). Comprehensive solutions for urban reform. *Educational Leadership, 62*(6), 44-47.

Kosar, K. R. (2005). *Failing grades: The federal politics of education standards*. Boulder, CO: Lynne Rienner Publishers.

Mintrop, H. (2003). The limits of sanctions in low-performing schools: A study of Maryland and Kentucky schools on probation. *Education Policy Analysis Archives, 11*(3), p. 32.

NeSmith, R. A. (in press). Middle school recommendations: Improving middle school student success is vital in 2006. *Eastern Illinois Education Journal, 34*(1).

NSTA Legislative Update. (2006, February 6). Science and Math Education Part of Major New Initiative Unveiled During the President's State of the Union Address to the Nation. Retrieved February 26, 2006 from: http://science.nsta.org/nstaexpress/nstaexpress_2006_02_06_legupdate.htm

Poliakoff, A. R. (2006, January). *Closing the gap: An overview. Baltimore: Association for Supervision and Curriculum, 44. Retrieved March 14, 2006* from: http://www.ascd.org/portal/site/ascd/menuitem.a2a89ee e8c7d0d0968e045b5d3108a0c/

Proven methods: The facts about…science achievement. (2004). Washington, DC: United States Department of Education. Retrieved March 6, 2006: http://www.ed.gov/nclb/methods/ science/science.html

Reading results: Executive summary for grades 4 and 8. (2005). Washington, DC: National Center for Educational Statistics. Retrieved March 6, 2006: http://nces.ed.gov/nationsreportcard/reading/

Ramirez, A. & Carpenter, D. (2005, April). Challenging assumptions about the achievement gap. *Phi Delta Kappan*, *86*(8), 599-603.

Rushton, S. & Larkin, E. (2001). Sharing the learning environment: Connecting developmentally appropriate practices to brain research. *Early Childhood Education Journal, (29)*1, 25-33.

Sarason, S. B. (2004). And what do you mean by learning? Portsmouth, NH: Heinemann.

Sylwester, R. (1993). What the biology of the brain tell us about learning. *Educational Leadership*, 51(4), 46-51

Turnbull, A., Turnbull, R., Erwin, L. J., & Soodak, L. C. (2006). Families, professionals and exceptionality: Positive outcomes through partnership and trust. (5th Ed.). Upper Saddle River, New Jersey: Pearson Prentice Hall.

The daring dozen. (2006). Edutopia, *2(2),* 33-45.

Varlas, L. *(2003).* Teaching Science: Fewer topics may lead to deeper learning. *Curriculum Technology Quarterly, 12*(4). Retrieved February 26, 2006 from: http://www.ascd.org/affiliates/articles/ctq2003summer_ varlas.html

What works clearinghouse: *A trusted source of scientific evidence of what works in education.* (n.d.). Washington, DC: U.S. Department of Education's Institute of Education Sciences. Retrieved March 8, 2006 from http://www.whatworks.ed.gov/Products/ rowseByLatestReportsResults.asp?EvidenceRptID= 03&Report Type=All

Willingham, D. T. (2003). Students remember…what they think about. *American Educator*. Retrieved March 13, 2006 from: http://www.aft.org/pubs-reports/american_educator/summer2003/cogsci.html

Yall, M. L., & Drasgow, E. (2005). *No child left behind: A guide for professionals*. Columbus, OH: Pearson Education.

Yecke, C. P. (2005). Mayhem in the middle: How middle schools have failed America—and how to make them work. Washington, DC: Thomas B. Fordham Institute.

Author Information

Richard NeSmith: BioScience_Ed@yahoo.com

Elementary Pre-service Teachers' Experiences With Science and Literacy Connection

Hanna Kim
DePaul University

Integrating science and literacy is an effective teaching strategy that will serve to fulfill both science and literacy teaching goals.

Introduction

When teachers speak of integrating the language arts, they can mean two distinct things: integrating the teaching of reading, writing, listening, speaking, and viewing, or integrating the teaching of these language arts into the study of content (Lesley, Michael, Jeffrey, & Michael, 1997). Theoretical and practical support for the integration of language arts into content-area instruction dates back to the progressive education movement, which is associated with the work of John Dewey (1966). In pursuing his concern with teaching children how to learn, Dewey hypothesized that interest drives thought. He suggested that learning experiences should include discovery and problem-solving in social settings. Current models for learning, such as the integrated language arts model, are similar to Dewey's theories in maintaining that knowledge is not merely conveyed to the learner, but learners construct their own understanding based upon what they already know (Vosniadou & Brewer, 1987). Some research has shown that integrating science and literacy is an effective teaching strategy that will serve to fulfill both science and literacy teaching goals. El-Hindi (2003) gave suggestions for combining literacy with science that supports both inquiry-based science instruction and a student-centered approach to literacy. She addressed the concept that students should have the opportunity to own the discourse in the classroom, pose questions, articulate their observations, and disseminate their findings. She also mentioned that science trade books may be introduced to students to read about a particular scientific topic.

Fleener and Bucher (2004) studied integrating reading children's literature and fiction throughout science units. They recommended that teachers use fiction books with a PAR (Preparation, Assistance, and Reflection) reading framework to help students make connections between the fiction tradebooks and the discipline of science, while simultaneously sharpening and enhancing their reading skills. They also recommended using a graphic organizer when pairing fiction with non-narrative, informational text (figure 1), as well as emphasizing that children could use trade books in science, since they can relate to them and thus have a better understanding emotionally, psychologically, and intellectually. Lundstrom (2005) also discussed a teacher who liked to connect science fact with science fiction. For instance, after a unit on genetics, this teacher would not just stop at the facts. He also had his students read a science fiction novel related to DNA, and at the end of the unit he had the students try their hand at writing science fiction.

Ebbers (2002) addressed the idea that not all science trade books limit themselves to divulging information about specific topics. Many writers give us tales of scientists engaged in all stages of inquiry, including the development of explanatory structures. For example, the stories of Copernicus, Galileo, and other astronomers can be used not only to describe planetary motion, but to illustrate how scientific explanations involve debate, political context, cultural perspectives, and ultimate acceptance by the majority of peers.

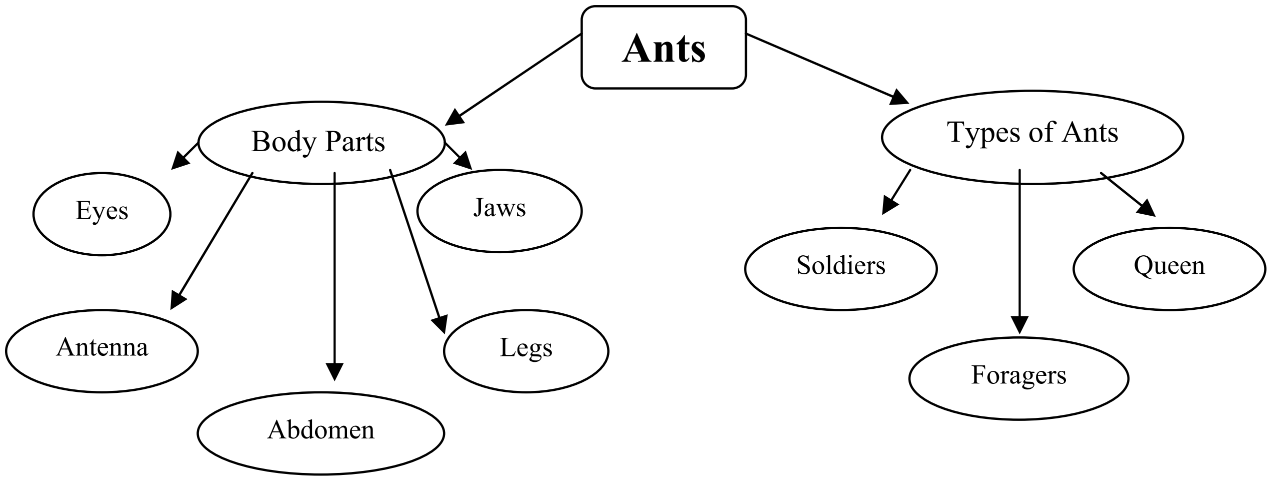


Figure 1. Graphic organizer for *It's an Ant's Life* (Parker, 1999).

While there has been much debate over what is inquiry in science (Leaderman, 2002), there is no question about its importance in science education (National Research Council, 1996). Scientific inquiry involves formulating a question, making a prediction or hypothesis, designing the study, conducting the study, gathering data, analyzing the results, drawing conclusions, and reporting/sharing the findings. Writing, reading, prediction, and creative/critical thinking are integral processes in scientific inquiry. Scientists need to communicate both verbally and in writing to show others what they are doing, or what they found. The science inquiry process has parallels to the literacy process (Akerson & Flanagan, 2000; Casteel & Isom, 1994; Dickinson & Young, 1998). Both processes are a discovery method of inquiry, beginning with an idea or question and ending with reporting of findings. Several steps are involved in organizing the seemingly random process of discovery, which will eventually lead to a solution to a research question—a publication. It is evident that science and literacy are in some ways reciprocal processes. It would be beneficial to teach in a way that accesses both processes to build scientific and language arts proficiency at the elementary level. The benefits of integrating science and language arts at the elementary level would include further development of both science and language arts skills, giving science learning a more important role in the elementary curriculum, and further engagement of students in learning. Effective science instruction requires more than a text-based approach of learning facts following step-by-step procedures. A "minds-on" inquiry-based approach, using skills such as questioning, predicting and experimentation, is a more effective way to teach science.

Integrating science and language arts at the elementary level helps one to have an advantage in a technologically advanced society, as well as meet learning requirements formulated by the national benchmarks (American Association for the Advancement of Science, 1993) more effectively. Several empirical studies have supported the idea that using science and language arts in a complementary fashion at the elementary level has multiple benefits. Romance and Vitale (1992) found significant improvement in both the science and reading scores of fourth-grade students when the regular basal reading program was replaced with reading in science that correlated with the science curriculum. In the El Centro School District in California, where 8 out of 10 students are impoverished, sixth graders who received science-literacy training passed the state's writing test at twice the rate of students who did not (Lundstrom, 2005).

However, because of the *No Child Left Behind* (NCLB) Act in 2001, the focus of elementary education in the US has been on

> Understanding basic science concepts is essential to full participation in life.

language arts instruction, and a problem arises when the science program is left by the wayside. Current research shows that at the elementary level, the bulk of class time is spent on language arts instruction, and not enough on science (Alkerson & Flanagan, 2000; Cunninghan & Allington, 1999; Stefanich, 1992). Understanding basic science concepts is essential to full participation in life. Some researchers have investigated the effects of literature-based science, but these studies did not focus on hands-on science activities tied to the literature (Lesley, 1997). In this study, the research question was: How can elementary pre-service teachers integrate literature into science, and particularly hands-on science?

Methodology

Participants: Family Literacy Day was held at a large university in Chicago, USA during February, 2004, and was open to students from K-6. Three hundred and twenty-six students, from thirty-eight elementary schools in the Chicago area, attended the 3-hour event, along with parents, teachers, family members, and neighbors. At the end, each family completed an evaluation form and the seven pre-service teachers who led the Science and Literacy station wrote brief reflections about their experiences in integrating literacy into their hands-on activities. Their individual activities were also videotaped to obtain observational data that would allow the pre-service teachers to get feedback from peers and the instructor.

The setting: The main hall hosted several different presentations by various authors and illustrators. During these presentations, and in between them, students could walk around the literacy stations in another room, staffed by the School of Education methods course instructors and their students. The stations comprised Movement and Literacy, Mathematics and Literacy, Science and Literacy, Arts and Literacy, Music and Literacy, Language and Literacy, and Electronics and Literacy. The Science and Literacy station consisted of seven different hands-on activities for students. There were two large tables with science fair displays, and seven smaller workstations which branched out from those tables. The main science tables had informational handouts and books for the parents and in-service teachers on how to incorporate literacy with science, while the seven activity workstations were geared towards the children. The seven pre-service teachers, who were taking a science methods course, had volunteered to lead each activity. The pre-service teachers had learned and discussed the "Science and Literature" connection from the science methods course prior to the event. Each pre-service teacher had a small table with their experiment so children could come and see several things at once. The hands-on activities ran simultaneously, and children were able to move from activity to activity, participating in what they wanted to see or touch.

Results

The Science and Literacy station was very popular and interactive. The activities were making craters, compounding Oobleck, shooting off rockets, working with sound, testing surface tension with water, dropping oranges and grapes to test gravity, and trying to see how many books it would take to crush eggs! Families and teachers came with the children, and often asked for more information about the resources and products on display. Pre-service teachers tried to integrate literacy into their experiments using their own methods. For example, one activity was on Isaac Newton and gravity. The pre-service teacher read a rhyming story she had written on Isaac Newton, and how Newton discovered gravity with the apple falling from the tree. The story was going to give the children a general understanding of gravity and how it works. The pre-service teacher followed up her story with an activity that showed how objects of different sizes are pulled by gravity at the same speed. Since an apple was incorporated into her story on gravity, she chose to stick with the fruit theme. She had the children stand on a chair and drop two oranges at the same time to see when they would hit the ground. Then they dropped an orange and a grape simultaneously. She asked for predictions beforehand since these were different-sized objects, and then let them drop the orange and the grape. The children were surprised to find out that both the grape and the orange hit the ground at the same time. After the activity, she explained how it was gravity that attracted the fruit to the ground, and then explained that the force of gravity pulls the orange and the grape at the same speed even though they are different sizes. Since the children were of different age groups, she had to change the delivery of her story based on her audience's age level. Another activity was about sound. The pre-service teacher used a stretched rubber band, a Ziplock bag filled with water, wood, and electronic toys for the children to explore how sound travels through various materials. Her activity let children predict how various sounds were made. The pre-service teacher did not have any storybooks with her to supplement the activity, but she did design both a word search and a crossword puzzle as a means to combine literacy with science. Two word puzzles consisted of science words and concepts that they had talked about during the activity – terms such as vibration, sound wave, air, water, solid, pitch, and so forth. The children were excited and discussed with each other how matching the scientific words helped them to complete the puzzles after the activity. Another activity was to make a product called *Oobleck*, which is a cornstarch, water, and food coloring combination that works as a colloid (has properties of a solid and a liquid). The real goal of the interactive demonstration was to help students practice the skills of description and discussion of what they find in making the Oobleck. In addition, depending on age level and understanding, the pre-service teacher talked about solids versus liquids, colloids (for example, Jell-o, which is a great-tasting colloid), and polymers (for example, the effect of starch molecules and how the more you pull, the more viscous they become). She offered children the opportunity to make their own Oobleck, selecting different colors (red, green, and yellow). She kept explaining about solids and liquids and comparing Jell-o powder and real Jell-o as examples of colloids while students were making their own Oobleck. She also engaged parents in helping their children, since the first attempts to stir the Obleck can be very challenging. There was also a literature connection to Dr. Seuss' book about Oobleck, as well as handouts and brief discussion on safety in the home since Oobleck can look a lot like many of the other things under the sink. She also provided links to many websites on the Internet to get recipes for everything from Play-Doh to paint that they could make together at home. Children were excited to bring their Oobleck home after the activity.

Stories can be used not only to describe planetary motion, but to illustrate how scientific explanations involve debate, political context, cultural perspectives, and ultimate acceptance

A surface tension activity consisted of hypothesizing how many drops of water would fit on top of a penny before spilling over. The majority of the students guessed between two and nine drops. Then they took an eyedropper and began dropping water on the penny while counting each drop. Due to the surface tension of water being so high, an average of twenty-five to thirty drops of water could fit on the penny. While the children were attempting to place the drops on the penny, the pre-service teacher would ask questions about why they thought so many more drops could go on the penny than

Reading, writing, and talking about science will develop scientific habits of mind.

what they predicted. In addition, she had a nickel and dime so they could test if more or less drops would go on them. She brought picture books showing a water strider sitting on top of a pond, water drops on a spider web, and water drops on a blade of grass that she used to also explain how water hold the shape of a drop and forms a skin using surface tension.

In the Making Craters activity, the pre-service teacher asked children to look at different pictures of craters as an engagement activity. She asked what they knew about craters and how they formed. She told the children that they would investigate what creates the surface of the Moon. They performed an experiment that would allow them to see what happens when a meteoroid hits a surface similar to the Moon's surface. The pre-service teacher had the students make predictions and hypotheses about what would happen when the different size meteoroids (rocks) hit the surface of the Moon (sand). The sand in the pan represented the Moon's surface, and the rocks were the meteoroids. After students made predictions about the different sizes of rocks and their impacts, they were ready to begin the experiment. The children experimented dropping three different sizes of rocks from the same height to see what happened to the size of the crators. This activity allowed the children to experiment with one variable of the impacts: the size of the meteoroid. The children discovered that the size of the rock was directly related to the size of the craters (the speed of the rock was not tested in this activity). The children retold the results to the pre-service teacher, saying "the bigger the rock, the bigger the crater." Finally she asked them to research where creators were found, how they were formed, who found them, and then present their findings verbally to the parents/class and then write it down in their science journal.

In the rocket activity, the pre-service teacher concentrated on integrating language arts into a science rocket lesson that focused on Newton's laws of motion. It involved students making their own individual rockets using paper, film canisters, antacid tablets, and water. However, to first understand how the rocket flies, she read information about Newton's third law of motion. The children read the third law, which states that for every action there is an equal and opposite reaction. Applied to this activity, the rocket travels upward with a force that is equal and opposite to the downward force propelling the water, gas, and lid. Depending on the grade level of the class, vocabulary was integrated in the lesson including words such as: *equal, opposite, force, motion, and reaction*. Along with this, the next standard this lesson touched on was communication skills and strategies. The children also worked on applying knowledge, because if the rocket didn't work or didn't go high up, they needed to apply their knowledge to understand why it didn't. The children used the strategy of evaluating data because they needed to be able to explain to the classmates and write in their science journals what they learned from their data and what the data actually meant. After the activity was done, she encouraged 3-6th grade children to do some background research on Newton and see what he did, what his accomplishments were, where he was born, and when he died. She also had the children think about how the law of motion has contributed to space exploration.

Overall, most pre-service teachers were also very thrilled with how engaged the children were in the scientific literacy experiences. The pre-service teachers commented that Science and Literature should be an easy connection for children to make because there is a lot about science in books that go very well with hands-on activities. They also experienced that children learned that they can read science books to gain knowledge on subjects before experimenting with different things. Most pre-service teachers also recommended that the children keep a science journal to write down their observations, predictions, hypotheses, summaries, and conclusions about subjects such as craters, sounds, Newton's law of motion, and other science topics.

Written evaluations from participants revealed that 99% indicated "strongly agree" or "agree" with every item describing the quality, usefulness, and value of the literacy event. Families enjoyed spending the day together, felt they had learned a lot, and were looking forward to trying the activities at home. They were also interested in any future events.

Conclusions

At the event, we provided lists of children's science and literature books recommended by the National Science Teachers Association (NSTA, 2004) as a guide so the parents and in-service teachers could get some ideas on what to read first with their children. Teachers should equip their classroom with a variety of books, articles, magazines and other literature dealing with science and give many opportunities for reading, writing and talking about science. Reading, writing and talking about science will develop scientific *habits of mind*. It was also emphasized that teachers should use a science curriculum which would not only help the students become more science literate, but also be better able to read and write about science.

The pre-service teachers found this experience to be very beneficial in understanding how children learn science, and how they can teach elementary science tied to literature. The pre-service teachers also learned that children can explore literature in math, science, English, and, of course, reading, but many think that literacy can only be manifested through reading, and that is absolutely not true. The children who attended Science and Literacy station had the opportunity to see literacy in hands on/minds on activities, and ultimately, they believed that learning is mostly about exploring. The pre-service teachers wanted to have their own Scientific Literacy events when they are teachers. Over time, we are planning to provide this opportunity for our pre-service students and children on a more frequent basis.

Future events should be held for longer periods of time to enable us to investigate the strengths and weaknesses of integrating literature into inquiry-based science instruction based on audience grade level. We hope more pre-service teachers can participate in future events so they can gain confidence in teaching literature-based science activities/lessons in upcoming student teaching endeavors. Science will be again at the forefront of U.S. classrooms – more dynamic, engaging, and innovative than ever. The *No Child Left Behind* Act mandates that during the 2007 school year, students will be assessed in science for the first time. As the tests loom, the discussion of how best to teach science will take on new urgency. Linking hands-on science with literacy and the curriculum is growing in appeal, particularly among teachers educated as generalists who feel unprepared to deal with the in-depth questions that inquiry and expanded reading can inspire in kids. More systematic professional development opportunities regarding science and literacy connection should be provided so teachers do not feel inadequate in their abilities to teach science. When elementary teachers recognize that their strengths in literacy can be used to help their science teaching, they may be willing to spend more time teaching science with confidence.

References

Akerson, V. L. & Flanagan, J. (2000). Preparing preservice teachers to use an interdisciplinary approach to science and language arts instruction. *Journal of Science Teacher Education*, *11*, 345-362.

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

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

Baker, L. (1991). *Textbooks and text comprehension*. Science Education, 75, 359-367.

Baker, L., & Saul, W. (1994). Considering science and language arts connections: A study to teach cognition. *Journal of Research in Science Teaching, 31*, 1023-1037.

Casteel, C. P. & Isom, B. A. (1994). Reciprocal

processes in science and literacy learning. *The Reading Teacher*, *47* (7) 538-545.
Chall, J.S., Conrad, S. S., & Harris, S. (1991). *Should textbooks challenge student?* New York: Teachers College Press.
Champagne, A. G., & Bunce, D. M. (1991). Learning-theory-based science teaching. *The psychology of learning science*, 21-41.
Cunninghan, P. & Allington, R. (1999). Classrooms that work. New York: Longman Publishers.
Dewey, J. (1966). *Democracy and education*. New York: The Free Press.
Dickinson, V. L. & Young, T. A. (1998). Elementary science and language arts: Should we blur the boundaries? *School Science and Mathematics*, *98* (6), 334-339.
Ebbers, M. (2002). Science text sets: Using various genres to promote literacy and inquiry. *Language Arts*, *80*(1), 40-46.
El-Hindi, A. E. (2003). Integrating literacy and science in the classroom: From Ecomysteries to reader's Theatre. *The reading Teacher*, 56, 536-538.
Enochs, L. G. & Riggs, I. M. (1990). Further development of an elementary science teaching efficacy belief instrument: A preservice elementary scale. *School Science and Mathematics*, *90* (8). 694-706.
Fleener, C. E & Bucher, K. T. (2004). Linking reading, science, and fiction books. *Childhood Education*, *80*(2), 76-83
Gaskins, I., Guthrie, J.T., Satlow, E., Ostertag, F., Sic, L., Byrne, J., & Conner, B. (1994). Integrating instruction of science and reading/writing processes: Goals, assessments, and teacher development. *Journal of Research in Science Teaching*, *31*, 1039-1056.
Hollingsworth, S. (1989). Prior beliefs and cognitive change in learning to teach. *American Educational Research Journal*, *26*, 160-189.
Lesley M. M., Michael P., Jeffrey K. S, & Michael S. (1997). The effect of a literature based program integrated into literacy and science instruction with children from diverse backgrounds. *Reading Research Quarterly*, *3*(1), 54-77.
Leaderman, N. G. (2002). Necessary consensus or consensus to disagree? When theory meets practice. *NARST News*, *45* (1), 1-2.
Lundstrom, M (2005). Link science and literacy (and watch test scores skyrocket). *Instructor*, *114*(6), 25-28.
Meyer, L. A. (1991). *Are science textbooks considerate?* Newark, DE: International Reading Association.
National Science Teachers Association (2004, Spring). *Science and Literature*. NSTA Recommends, 20-24.
National Research Council (1996). *National science education standards*. Washington DC: National Academy Press.
Ogens, E. (1990). A review of science education: Past failures, future hopes. *The American Biology Teacher*, *53*, 199-203.
Parker, S. (1999). *It's an ant's life*. Pleasantville, NY: Reader's digest children's books.
Romance, N. R. &Vitale (1992). *Science and language links*. Portsmouth: Heinemann Publishers.
Vosniadou, S., & Brewer, W. F. (1987). Theories of knowledge restructuring in development. *Review of Educational Research, 5,* 51–67.

Author Information

Hanna Kim received her Ph.D. at the University of Texas at Austin, majoring in science education. She is currently an assistant professor at DePaul University in the Teacher Education Department (Science Education). She teaches science methods for pre-service teachers. Her research focuses on science and literacy, educational technology, and science curriculum reform in CPS. Email: hkim13@depaul.edu.

Understanding Biotechnology: A Necessity for Science Literacy

Judith A. Scheppler, Susan Styer, Donald Dosch
Illinois Mathematics and Science Acadmey

Laboratories in biotechnology ... [can] provoke student thinking about the ethical and social ramifications of the field's advances

Abstract

A hands-on semester-long course or selected laboratories in biotechnology for middle school students, high school students, or college students, provides a way to learn about new technologies and can be coupled with assignments that provoke thinking about the ethical and social ramifications of the field's advances.

Introduction

Recent news reports claim that a human has been cloned, advertise that companies will collect your pet's DNA for future cloning, state that genetically modified "Frankenfoods" have unknowingly entered consumer food products, and assert that stem cell transplants can cure diabetes as well as other diseases. The list of controversial topics and issues presented to the general population continues to grow. Unfortunately, many of these reports are designed to grab attention and sell advertisements, but they do little to inform. Responsible citizens in the twentyfirst century need to distinguish between hype and scientific progress. With advances in sequencing of the human genome and DNA cloning, students need a solid grounding in biotechnology that gives them the ability to think critically about this new information. Only then can they make wise, informed, and ethically sound decisions about technology that will affect their lives and our global community at ever increasing rates.

The History of Biotechnology

Biotechnology is a term used to encompass the use of living things to better our lives. This occurs in industry, medicine, in the environment, and through agriculture. But biotechnology really began when humans first gathered seeds, domesticated livestock, and started breeding animals and plants for desired characteristics and properties over 10,000 years ago. Early uses included fermentation of alcoholic beverages, cheese making, and leavening bread. Ancient China used molds as the first natural antibiotic and plant products as the first natural insecticide.

It has only been in the past one hundred years, however, that humans have gained an understanding of genes and their role in heredity. A working draft of the sequence of the human genome was completed in 2001 (International Human Genome Sequencing Consortium, 2001; Venter, 2001) and in 2003 researchers announced that the Human Genome project was completed. The year 2003 also heralded the fiftieth anniversary of Watson and Crick's *Nature* paper elucidating the structure of DNA (Watson and Crick, 1953). This work, along with many other advances, have led to the ability to deliberately and routinely modify the genomes of organisms so that today we are even able to treat a few human genetic diseases using gene transfer technology (Simon, 2002).

Some Current Advances *or Why Study Biotechnology?*

Replacing dysfunctional genes with healthy copies has been explored as a way of curing some genetic diseases. The first human experiment attempting to replace a defective gene occurred in 1990 when Ashanti De Silva was treated for severe combined immunodeficiency caused by a mutation in the gene for adenosine deaminase (Anderson, 1995; Simon, 2002). Lack of stability and proper expression of the inserted genes, disruption of normal cell function, limitation in cell availability, and the difficulty in returning genes to the body have been cited as stumbling blocks to realizing the promise of *gene therapy* (Verma, 1990). As trials for gene therapy are developed and studied, a better understanding of the risks of the technology have become apparent and questioned (Marshall, 2000).

Genetic vaccines are at various stages of clinical trials. A genetic vaccine is created by introducing the genes for viral, parasitic, or cancer specific proteins into the cells of healthy organisms

Biotechnology and the related field of genetics receive significant emphasis in the advanced placement biology curriculum.

so that they produce these foreign molecules, which enhances the body's own immune response (Weiner and Kennedy, 1999).

While there has been minimal response in the United States markets to the presence of *genetically modified foods*, the markets in the European Union and elsewhere have strongly resisted their introduction. Introducing new genes into the plant creates genetically modified crops. Goals for this technology include the diminished use of pesticides by making the plant more resistant to insect pests (*Bacillus thuringiensis* toxin gene for Bt corn), increased crop yield by selectively inhibiting competitive weeds (glyphosate herbicide resistance gene for Roundup® Ready soybeans), and enhanced nutritional quality (vitamin A synthesis gene producing golden rice) (Brandner, 2002).

The *Human Genome Project* has provided insight into the individuality of genetic expression. With segments of single-stranded DNA from known genes affixed to chips and placed into an array, it is possible for researchers to quickly determine which genes are specifically expressed in any tissue sample (Friend and Stoughton, 2002). Moreover, there is growing evidence to indicate that the extent to which certain genes are expressed is correlated with disease and suggestive of the course of treatment (Friend and Stoughton, 2002; Kolata, 2003). Controlling the expression of genes is also being explored as treatment for viral infections and cancers (Cohen and Hogan, 1994). Treatment with short synthetic segments of DNA can decrease the transcription or translation of certain genes by interfering with regulatory functions. In so doing, viral replication and cancer cell proliferation may be slowed or halted.

The medical research community is optimistic about the use of *embryonic stem cells* for treatment of type-1 diabetes, burns, heart disease, and neurological disorders such as Alzheimer's and Parkinson's diseases. Derived from the inner cell mass of blastocysts (pre-implantation embryos), embryonic stem cells have the ability to grow in culture almost indefinitely and can differentiate into almost any kind of cell, opening the possibilities of using them to replace damaged cells, tissues, and perhaps whole organs (Stolberg, 2001; Trefil, 2001; www.nih.gov).

These advances are only a few that our society is currently grappling with. Our students, no matter where their career path takes them, will need to understand these advances plus many more.

Figure 1. Teachable moments. Three basic biotechnology laboratories can be used to engage middle school, high school, and college students and as a springboard to cover more abstract and complex technologies.

Bacterial Transformation
- Eukaryotes versus prokaryotes
- Evolution
- Drug resistance
- Gene therapy
- Genetically modified organisms

Restriction Enzyme Analysis of DNA
- DNA structure and function
- Enzyme structure and function
- Gel electrophoresis

Polymerase Chain Reaction
- DNA structure and replication
- Genetics and heredity
- Forensics

Biotechnology in the Classroom

Teaching biotechnology, at the middle school, high school, and college levels provides an engaging and interdisciplinary topic for students. Using the print and television media provides a way to intrigue students and to promote critical thinking. Depending on the exact source, these reports may have more or less credibility. All, however, can be used because they gain students' attention and interest. The information provided should be examined critically in the context of what students know and understand. Other reports and credible web sites may be consulted to confirm or refute specific findings.

Students are excited and intrigued by science fiction turned into science fact and practice. Using this technology in simple experiments provides better understanding and a springboard to other topics such as ethics and the societal implications of biotechnology. This interdisciplinary approach encompasses doing basic techniques with writing a paper, reading and discussing literature, and engaging in an independent laboratory investigation. In this way, biotechnology can address the *National Science Education Standards*, especially those concerning heredity, technology, and social perspectives, although others can be covered as well (National Research Council, 1996).

Another reason to include biotechnology education is that biotechnology and the related field of genetics receive significant emphasis in the advanced placement biology curriculum. The molecular biology portion includes bacterial transformation and restriction enzyme analysis of DNA, two biotechnology techniques. The genetics section, consisting of fruit fly genetics (chi-square analysis of genetic crosses) and population genetics (Hardy-Weinberg), can be enhanced by a polymerase chain reaction (PCR) laboratory in which students amplify a polymorphic region of their own DNA and compare the data generated across the class.

Bacterial transformation consists of transferring plasmid DNA into bacteria, which confers upon it a new characteristic such as resistance to an antibiotic and the ability to glow in the dark or fluoresce. Restriction enzymes cut DNA into smaller pieces, a key component to the more complex technique of DNA cloning. PCR is a method of copying and amplifying small, specific segments of DNA. This technique is commonly used in forensics to identify individuals, but has also

Figure 2: A Day in the Life …

Scenario: The year is 2061 and you and the remaining members of your family have just returned from your annual reunion with a surprise discovery, a journal of one of your greatgrandparents. Three entries in the journal particularly inspire your passion for the story of this family member who came before you: the day he/she was diagnosed with cancer, his/her last birthday, and the day before he/she died of cancer. The entry on the day of diagnosis tells you the technology applied to him/her as a patient. The birthday entry tells you the everyday events in the life of an individual. The entry on his/her last day tells you about reflections on the valued place of a living, thinking, cancer-stricken individual in society. You realize the truth of these entries is a measure of the society in which your great-grandparent lived.

Student assignment: You have 45 minutes to relate these days in the life of your relative to your colleagues. In particular, pay close attention to the effect of technology on the life of the individual. Remember: your perspective is from the year 2061, whatever you consider 2061 will become. Also, submit a ten to fifteen page paper supporting and complementing, not reiterating, your presentation. Please provide twenty to thirty references.

Personal data items

	Agnes Li	**Sunshine Carter**	**Ajay Reddy**	**Stanley Miles**
Born	**April 7, 1939**	**January 15, 1968**	**April 23, 1942**	**March 27, 1945**
Died	**December 4, 2003**	**December 5, 2003**	**December 8, 2003**	**December 9, 2003**
Profession	**Restaurateur**	**Actress/receptionist**	**Doctor**	**Farmer**
Cause of Death	**Lung cancer and associated complications**	**Breast cancer and associated complications**	**Colorectal cancer and associated complications**	**Malignant melanoma and associated complications**

been used for a number of applications in biotechnology (Scheppler et al, 2000). These three techniques can serve as the core hands-on portion of a class and used to provide fundamental information about the more complex technologies (figure 1).

Cancer can be used as a platform from which to examine the tools of biotechnology as they are employed by a society entering into the molecular biology age. Early in a course, students can be assigned a group final project (figure 2) in which they must write and present a story of a fictitious relative who died from cancer, *A Day in the Life*. The twist is that the relative lived in our present time, but the students are to write from a perspective of looking back from the year 2061. Students create three days in the life of this cancer patient: the day of diagnosis, the last birthday, and the day before dying. From this future perspective, they are then to discuss how the cancer of their fictitious relative can be cured. This assignment gives a context for learning normal cell physiology, the genetic changes that result in tumorigenesis, as well as DNA manipulation. It also addresses the social impact of technology on individuals in society. Students are thus able to relate a rich story built with support from their accumulated knowledge of biotechnology from an historical perspective of technology, and begin to find their own place in our technological society.

Understanding the molecular processes that result in cancer can be central to the science of the biotechnology course. Students study the cell as it properly functions and as it changes through tumorigenesis. Simultaneously, students encounter the tools of biotechnology, such as manipulations of DNA, molecular cloning, and PCR. By understanding the applications of biotechnology, students will be better able to answer questions about cancer and to understand the processes that are used to gather information relevant to cancer causes and treatments.

Genetically modified organisms (GMO) provide a different aspect for written work. The bacterial transformation laboratory serves as a basis for understanding gene transfer. Students are given the assignment to choose a GMO and provide a written response to the following questions:

1. Describe in what way the genetic material of the organism is modified. This means writing more than " a gene was cut out of one organism and placed in another." Provide some scientific explanation.
2. Describe the new characteristic that the organism has as a result of modification, including how the organism may be used in a new way.
3. Given our limited understanding of the effects that GMOs have on the environment, how can we make decisions about their use? What are the criteria that should be applied and who is responsible for the decision?

Another way in which students can come to understand the social implications of biotechnology is by reading imaginative literature that offers commentary on our cultural values system. For example, Edward Bellamy's technological utopia described in *Looking Backward, 2000-1887* (1881) and Kurt Vonnegut, Jr.'s technological dystopia set in *Piano Player* (1952) establish two very different sociological poles for our consideration. Bellamy portrays a society where technology is the solution to all problems from inequality to urban blight. Vonnegut, on the other hand, devises a foreboding, mechanized human society where only those intellectually worthy of engineering or mechanics have any freedom to make decisions that we would consider to be inalienable rights. Examining the poles of society's technological values system offered by these authors aids students in understanding the individual and cultural values systems operational in the application of technology in western culture and the place of the individual in a technological society.

Figure 3. Biotechnology resources. There are great biotechnology resources available to assist teachers in providing valuable information in this growing area.

Access Excellence	www.accessexcellence.org	Teacher-developed curriculum ideas and other on-line resources
Biotechnology Institute	www.biotechinstitute.org	Publishes *Your World, Our World* magazine for students
Biotechnology Industry Organization	www.bio.org	On-line industry information, lists state biotechnology organizations
Bio-Rad	www.biorad.com	Scientific company with educational division offering kits, equipment, and workshops
Carolina Biologicals	www.carolina.com	Educational company offering kits and equipment
DNA Learning Center	www.dnalc.org	Offers workshops for teachers and on-site labs for students
Edvotek	www.edvotek.com	Educational company offering kits, equipment, and workshops
Foto-Dyne, Inc.	www.fotodyne.com	Scientific company supporting biotechnology education and offering equipment and kits
Modern Biology	www.modernbio.com	Educational company offering kits
New England Biolabs	www.neb.com	Scientific company supportive of biotechnology education
Wards	www.wardsci.com	Educational company offering kits, equipment, and works

We have used a biotechnology course to introduce students to scientific inquiry by incorporating an investigation into the course. At the beginning of the semester, students are informed that they will have the last quarter to pursue a laboratory project. While they are learning some of the basics, they begin to formulate a research plan. They are expected to submit a proposal detailing what they plan on accomplishing. This helps them focus as well as providing the instructor with a list of reagents and supplies to be ordered. Some students will devise very imaginative and original projects, while others will struggle with the freedom of owning and directing their own learning. Some students use the Internet as a source of ideas and protocols while others will stick to conducting a more advanced laboratory from the text. All students have enormous goals. The instructor's role is partly that of expert colleague, but also that of a cheerleader, rewarding what the students perceive as small achievements, promoting student confidence in the laboratory and with their own analytical abilities.

Biotechnology for Middle School

Middle school students are very capable of conducting the same basic laboratories, bacterial transformation, restriction enzyme analysis of DNA, and PCR, as high school students. The content material provided is just not as complex and additional background material will need to be covered, such as the basics of DNA. But making bacteria glow in the dark or seeing DNA on a gel is a sure way of gaining students interest and attention. They are also capable of writing assignments and reading such books as *Eva* (1989) and *The Giver (1993)*.

Biotechnology Resources

Biotechnology can be a very challenging topic to teach. Teachers with many years of experience may not have encountered the discipline simply because it was not part of their science education. Newer teachers may have had the opportunity to perform one or two standard hands-on laboratories in undergraduate or graduate courses, but they may not have been exposed to these laboratories in a way that helped them understand how to teach them.

The past ten years has seen the advent of an increasing number of resources for teaching biotechnology ranging from texts (Alcamo, 2000; Glick and Pasternak, 2003; Kreuzer and Massey, 2001 and 2005; NABT, 2002) and laboratory manuals (Bloom et al, 1996; Scheppler et al, 2000) to centers devoted to biotechnology education and scientific companies that are supportive with useful kits and affordable equipment (figure 3). Some of these companies, as well as other educators, offer workshops at the National Association of Biology Teachers (NABT) and National Science Teachers Association (NSTA) national meetings and other places.

The equipment and materials for basic biotechnology are becoming common in college and university undergraduate courses. Teachers will find local university partners very willing to share resources, knowledge, and perhaps even willing to host a class field trip for a hands-on laboratory. Some university faculty members also offer summer hands-on workshops designed specifically for teachers.

Biotechnology is a field that has been with humankind for a long time and will continue to have a huge impact on our lives and the lives of our future generations. Whether someone is a biologist, physicist, poet, policeman, lawyer, or CEO of a large corporation will not lessen the profound influence that this technology will have on her life. Her education, however, will determine whether it is used wisely and expeditiously and whether she can make informed choices for her own well being.

References

Alcamo, I.E. (2000). *DNA Technology:The Awesome Skill*. Orlando, FL: Harcourt.

Anderson, W.F. (1995). Gene Therapy. *Scientific American.* 273(9), 124-128.

Bellamy, E. (1888). *Looking Backward, 2000-1887*. reprinted 1982. New York: Penguin.

Bloom, M.V., Freyer, G.A.& Micklos, D.A. (1996) *Laboratory DNA Science.* Menlo Park, CA: Benjamin/Cummings Publishing Company, Inc.

Brandner, D. L. (2002). Detection of Genetically Modified Food: Has Your Food Been Genetically Modified? *The American Biology Teacher*, 64, 433-441.

Cohen, J. S., & Hogan, M. E. (1994). The New Genetic Medicines. *Scientific American,* 271(6), 76-82.

Dickinson, P. (1989). *Eva*. New York: Delacorte Press.

Friend, S. H. & Stoughton, R. B. (2002). The Magic of Microarrays. *Scientific American, 286(2)*, 44-49.

Glick, B.R. & Pasternak, J.J. (2003). *Molecular Biotechnology*. Washington, DC: ASM Press.

International Human Genome Sequencing Consortium. (2001). Initial Sequencing and Analysis of the Human Genome. *Nature*. 409, 860-921.

Kolata, G. Breast Cancer: Genes Are Tied To Death Rate. *The New York Times*. Dec. 19, 2002.

Kreuzer, H. & Massey, A. (2001). *Recombinant DNA and Biotechnology, A guide For Teachers,second ed.* Washington, DC: ASM Press.

Kreuzer, H. & Massey, A. (2005). *Biology and Biotechnology: Science, Applications, and Issues.* Washington, DC: ASM Press.

Lowry, L. (1993). *The Giver.* Boston: Houghton Mifflin Co.

Marshall, E. (2000). Gene Therapy on Trial. *Science,*288, 951-957.

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

National Association of Biology Teachers and the Biotechnology Institute. (2002). *Shoestring Biotechnology.* Reston, VA: National Association of Biology Teachers.

Scheppler, J.A., Cassin, P.E., & Gambier, R.G. (2002). *Biotechnology Explorations: Applying the Fundamentals.* Washington, DC: ASM Press.

Simon, E.J. (2002). Human Gene Therapy: Genes Without Frontiers. *The American Biology Teacher.* 64(4), 264-270.

Stolberg, S. G. A Science in Its Infancy, but With Great Expectations for ItsAdolescence. *The New York Times*. August 10, 2001.

Trefil, J. (2001). Brave New World: Everything You Wanted To Know About Stem Cells, Cloning And Genetic Engineering But Were Afraid To Ask. *Smithsonian,* 32(9), 38-44.

Venter, J.C. etal. (2001). The Sequence of the Human Genome. *Science*.291, 1304-1351.

Verma, I. M. (1990). Gene Therapy. *Scientific American*, 263(5), 68-84.

Vonnegut, K. (1952) *Piano Player*. reprinted 1974.Dell.

Watson, J.D. & Crick, F.H. (1953). A Structure for Deoxyribose Nucleic Acid. *Nature*. 171, 737.

Weiner, D. B. & Kennedy, R. C. (1999). Genetic Vaccines. *Scientific American,* 281(1), 50-57.

http://stemcells.nih.gov/index.asp. Accessed February, 2006.

Author Information

The authors are currently at IMSA, where they are engaged in offering biotechnology education and outreach opportunites to middle school and high school students, as well as professional development opportunites to teachers.

Judy Scheppler - quella@imsa.edu

Sue Styer - sstyer@imsa.edu

Don Dosch - ddosch@imsa.edu

Conducting Action Research: A University-School Collaboration in Support of Middle Grade Science

Carole P. Mitchener[1], Wendy M. Jackson[2]
[1]University of Illinois at Chicago; [2]Richard Yates School, Chicago Public Schools

Our primary purpose in doing action research is professional development through teacher education.

Action Research in Education

Action research is an inquiry process used by practitioners to foster change in a given practice. The purpose may vary, as may the scope. Noffke (1997) differentiated among action research for political, professional, and personal purposes. In science education, for example, action research can challenge political practices prompting ability tracking. It can also promote professional development by improving the teaching of an inquiry-based science curriculum. Last, it can provide personal insights about practice, such as one's relationship with science and teaching. While political and personal threads run through our work, our primary purpose in doing action research is professional development through teacher education. In this article, action research refers to a self-reflective inquiry by beginning science teachers to improve their classroom teaching (Hubbard & Power, 1993).

Putting action research into practice has its own challenges. As professionals, teachers continually work at improving their practice. Sometimes they attempt big changes; at other times the situation calls for small adjustments. Current demands on teachers – like high-stakes testing – make it increasingly difficult to engage in methodical and extended attempts at action research. Pressure-driven contexts force thoughtful efforts to take a back seat to extinguishing daily fires. In pressing times, action research is relegated to a luxury, and not an important step in teacher development. Left with the prospect of having to do action research on one's own is daunting.

University-school collaboration provides a much-needed scaffold for doing action research. It offers a framework for investigation, and a structure for the change process that keeps investigations grounded, as well as ordered and moving. Collaborations also serve as a forum for communication and support. This is particularly evident in collaborations that employ a teacher cohort model. A teacher cohort functions as a professional community, where colleagues share improvements, and learn from others' contributions. Members bring different perspectives and new ways of making sense of educational challenges, while maintaining much needed empathy.

Having a shared content focus is another way to support teachers doing action research. While topics are usually self-selected, all cohort members can do an investigation using the same content area or a common topic. In our case, all action research projects were about teaching science, with a specific focus on scientific inquiry. There is an emerging body of literature on scientific inquiry and student learning, and on the assessment of scientific inquiry using decision points along a learning continuum (Duschl, 2003).

In this article, we share how a university-school collaboration supported a cohort of science teachers in advancing their practice of scientific inquiry using action research. The teachers were all middle grade science teachers from the Chicago Public Schools (CPS) in their second year of teaching. The collaboration was between CPS and the Middle Grade Science (MGS) program at the University of Illinois at Chicago.

The next two sections of the article are brief overviews of the MGS program and MGS action research. Then we offer a detailed look at one example, an action research project by Wendy Jackson, a middle-grade science teacher and one of the authors of this article. The article concludes with a discussion of the importance of collaboration in the individual and collective successes of MGS action research.

The MGS Program

Every student deserves a content-rich science education that highlights key concepts, their relationships, and their relevance to everyday living. Each student deserves a science education that uses inquiry-guided curriculum and teaching strategies that deepen personal meaning and extend informed decision-making. All students deserve a science education that acknowledges the importance of prior knowledge in constructing new understandings of science ideas and practices, and the need for multiple opportunities to communicate that knowledge to others through diverse literacies and technologies. Knowing that all students do not receive the science education that they deserve, the MGS program is dedicated to working toward this goal with the Chicago Mathematics and Science Initiative (CMSI) of CPS.

MGS is an alternative-route, teacher-preparation program that includes certification and an optional graduate degree within a three-year induction and mentoring experience. It is designed to recruit career-change professionals from science-related fields to teach science. Many come to teaching with work experience from large corporate and university laboratories, and from small environmental consulting agencies and engineering firms. Since 2002, thirty-six candidates have been accepted into the program. Each teaches for a minimum of three years in a high-need school in the Chicago Public Schools.

Every student deserves a content-rich science education that highlights key concepts, their relationships, and their relevance to everyday.

In the first year, MGS teacher candidates complete certification coursework and student teach in their own classrooms. The second year includes doing an action research project and completing graduate degree requirements. In the third year, teachers do a leadership project at their schools. A centerpiece of the program is the onsite mentoring that the teachers receive across all three years from University of Illinois at Chicago mentors, and for the first two years from CPS mentors. Reflective seminars are ongoing across all three years.

The MGS Action Research Project

Feldman and Capobianco (2000) reviewed existing action research in science education and organized these studies into three domains: a) teacher education and professional development (e.g., van Zee, 1998), b) research on science learning (e.g., Minstrell & van Zee, 2003), and c) curriculum development and implementation (e.g., Pedretti & Hodson, 1995). In the first, the primary emphasis is on teachers collaborating with colleagues to improve practice. In the second, action research by teachers is focused on investigating how students learn. The third focuses on teacher implementation of a select curriculum or particular curricular issue. The domains are

Each student deserves a science education that uses inquiry-guided curriculum and teaching strategies that deepen personal meaning and extend informed decision-making.

presented as distinct, with acknowledgement of overlap. The primary focus of our action research is teacher education and professional development that blurs the boundaries between student learning and curriculum implementation.

In doing action research, MGS teachers generally followed guidelines developed by Brenda Capobianco and her group of science teacher collaborators. Their framework, simply put, is to "identify a starting point, develop a plan of action, collect data, analyze and interpret, and reflect and disseminate" (Capobianco, Horowitz, Canuel-Browne, & Trimarchi, 2004, p.49). To this framework, certain MGS particulars were added. Five key characteristics stand out as being defining elements of our MGS work.

First, as stated earlier, there was a shared focus on scientific inquiry across MGS action research projects. Duschl (2003) argues, "The focus on scientific inquiry needs to be on attainment of evidence and how it is used to generate and justify explanations" (p. 41). He offers an evidence-to-evaluation (EE) continuum to use in assessing students on their "use of scientific information and the construction and evaluation of scientific knowledge claims" (p. 43). His EE continuum references three decision-points: "data to evidence, evidence into patterns and models, and patterns and models into explanations" (p. 47). MGS teachers used these transformations to reflect on their teaching of scientific inquiry. For example, one MGS teacher realized that she had not been explicit with her students about the difference between data and evidence. Collected data must be scrutinized to determine their validity as evidence that informs a specific investigation. She made this differentiation between collected data and valid evidence the basis of her action research.

Second, to identify a starting point we used a problem-solving approach. MGS teachers identified an area in how they taught scientific inquiry that warranted improvement. They had used a problem-solving approach several times the prior year. MGS teachers had critiqued a videotaped teaching episode and had written an analysis including needed improvements. Similarly, they had critiqued their lessons and assessments using data from student work. MGS teachers had also redesigned a curriculum unit they had recently taught and proposed improvements based on that experience. An example of how a problem-solving approach was used for action research follows. An MGS teacher was having difficulty getting students to go beyond recipe-like steps in experimentation. He recognized this as a problem when he noticed that his students, when confused and did not know what step to perform, stopped all activity until he came to help. This problem served as the impetus for his action research. He went on to develop an experimental-design protocol that, instead of taking students from one step to the next, offered them various tools they could use to conduct experiments and develop meaningful understandings.

A third characteristic of MGS action research projects was a reciprocal design. With "reciprocal" we refer to the mutual influence between teacher learning and student learning. The action research that was designed and implemented to study changes in teacher learning was being shaped by, and was shaping, changes in student learning. Thus, data had to be collected on both teacher and student change. For example, if the teacher was implementing a new strategy to increase student questioning, she collected data on changes in student questioning over time in relation to how her practice was changing, and what she was learning.

Fourth, seldom does action research involve only one attempt at implementation. This was particularly true with MGS action research. MGS action research occurred in cycles. Given its extended timeframe (fall and spring semesters), projects evolved through a series of cycles. A cycle includes the sequence of steps specified by Capobianco et al. (2004), with the last step (the dissemination one) being only present in the last cycle of the series. A cycle begins with a problem and moves to the development of a plan of action that is then implemented and analyzed for its effectiveness. With implementation, improvements are often accompanied by an emerging new problem or a revision of the original one. The new second cycle focuses on this newer problem and requires its own plan of action, thus starting a different cycle. In MGS action research, the year-long projects often developed into four cycles. Studying the various projects, a pattern emerged across these cycles. The second cycle was usually a variation of cycle one's original problem and action plan, while the third and fourth cycles differed, consisting of rethinking of the original problem and how to tackle it. The third cycle often became a teacher-learning investigation carried out by the teacher to learn more about the nature of the original problem. Teachers collected data to deepen their own understanding prior to entering a fourth and final cycle of classroom intervention.

The fifth and last defining characteristic of MGS action research was ongoing group-mediated reflection. Teachers met in reflective seminars to share their thinking and action-research projects with cohort members. Reflective seminars met every other week over the academic year. Teacher discussion was driven by written updates and case presentations of action research. In the fall teachers presented their initial ideas and formulated proposals. In the spring teachers put their plans into action and discussed implementation and analysis issues. These seminars proved especially valuable when action research projects seemed vague and ill-defined. For example, when an MGS teacher presented graphs showing improvements in students' quarter grades from one grading period to the next, cohort members discussed their difficulty in making a tight connection between this grade improvement and the implemented action plan. This exchange served as an example of the limitations that action research projects face when plans lack specificity.

All students deserve a science education that acknowledges the importance of prior knowledge in constructing new understandings of science ideas and practices.

It is important to note that not all projects include all five signature elements of MGS action research or address them to the same degree. To get a general idea of how these characteristics informed the development and execution of an MGS project, we offer a detailed look at Wendy's action research project. It begins with a brief bio about Wendy's professional experience and educational background prior to MGS. Her action research account begins with reflecting on her experiences as a first-year teacher, and how that experience informed her action research goal for her second year of teaching.

Wendy's Action Research Project: A First-Person Account

Wendy's Bio: Prior to entering the MGS program, Wendy Jackson developed programs, taught classes and conducted research at the university level in the fields of conservation biology, *environmental science, and sustainable development. She brought to these positions a doctorate in zoology, experience living and working in developing countries, and experience working with governmental and non-governmental agencies to promote environmental stewardship. After working with college-age students and adult learners for many years, she decided to focus her attention and energy on teaching pre-college students in an urban setting. She now teaches science to 7th and 8th grade students.*

In my first year of teaching, I felt I succeeded in providing my students with rigorous, hands-on lessons that required them to engage in the process of scientific inquiry. My students learned a lot about science and they grew to find science interesting. However, I doubted that many of them ended the year with a sense that science was particularly relevant to their own lives. I seldom saw evidence in either written work or class discussions that students were extending their learning outside of the science classroom. While my students could examine evidence to detect patterns and eventually develop explanations, that is, they could make Duschl's (2003) transformations along the EE continuum, they failed to do so in the most important context—issues that affect their own lives. My action research goal for my second year was to make my science lessons more relevant to the lives of my middle-school students, and for them to appreciate science as a "way of knowing."

An Initial Attempt

At the start of my second year, in line with my preference, my school adopted the "Science and Life Issues" (SALI) curriculum that is part of the Science Education for Public Understanding Program developed by the Lawrence Hall of Science. Much of this curriculum focuses on the human body, and the units and lessons are structured around such issues as heart disease, contagious diseases, and how people with various diseases and conditions have been treated in society. I believed that by using SALI, with its issue-oriented focus, I would be well situated to take the first step toward achieving my action research goal.

After a few weeks, however, it became apparent to me that using the SALI curriculum was not sufficient for allowing students to see science as personally relevant. Students' scores on written assignments that required them to extend their scientific knowledge to real-life issues continued to be lower and more variable than I had hoped and expected. Class discussions still tended to take the form of me asking a question and one student answering; these questions did not generate many additional questions by students or encourage students to respond to one another. Clearly, I needed to discover other ways to encourage my students to internalize science as a way of understanding, and to use it as a way of addressing issues and problems in their own lives.

A Reworking

In furthering my action research project, I started keeping track of occasions where students spontaneously showed some evidence they were thinking about what a science lesson meant to them personally. I noted the particular context, what I had been doing at the time, and whether/how other students were engaged. I noticed that students frequently made comments as they walked in the door at the start of class. Sometimes they mentioned something they saw on television that addressed a topic we had been studying in class. At other times they mentioned that a family member was sick, and they asked me questions about that particular ailment. Other students sometimes entered this brief conversation. I also noted that many comments or questions came right after I began introducing the day's lesson. Sometimes these comments were tangential to that day's lesson, but they were relevant in the larger context. I began to realize that I was not taking full advantage of these occasions when students were making initial connections to the science lessons. I was not letting these superficial connections deepen and grow. I then reworked my action plan so that I could provide greater opportunities for these occasions. Building off the SALI curriculum, I chose two additional actions to include as part of my action research.

One of the actions I took was to illustrate how science is relevant to me personally, and to model how I use the process of scientific inquiry to address and solve problems in my own life. For example, during class discussions on diseases, I discussed some of my own health issues and used examples from my family and friends. I also deliberately incorporated science terms into my speech, even when discussing non-science topics. I used words such as evidence, data, and hypothesis [from the start of Duschl's (2003) EE continuum] for students to see how the scientific process is relevant to everyday issues. I rephrased students' comments using science vocabulary, even when they were not directly related to science.

A second action I took was to spend more time both at the beginning and end of class on discussions about the lesson, allowing productive conversations to expand beyond the time I had originally planned. I often began a discussion by using a concrete example to which the students could easily relate. For example, in one instance we were discussing the trade-offs involved in taking medicine for, say, a headache. Because the concept of a trade-off was difficult for my students, I used an analogy they could relate to. If they were given $20 for their birthday, they wouldn't be able to buy everything on their wish list; they could buy a couple of CDs or a video game, but not both. They would have to trade-off having new music to listen to for a new game to play or *vice versa*. This example helped them to realize that taking medicine involves a trade-off. You may get rid of your headache, but you may develop a stomach ache because of the side effects from the medicine. In this case, you are trading off getting rid of one kind of discomfort at the expense of acquiring another; you may not be free from both discomforts.

As the unit on diseases progressed, I noticed that class discussions went from one or two-word responses to extended discussions among students that illustrated they were making explicit connections between science concepts learned in class and their lives outside of school. I continued to keep track of their spontaneous connections, as well as how other students were drawn into these extended conversations. Students were demonstrating that science inquiry can be applicable in their own lives. Here is one example that was especially informative, along with my reaction and interpretation of this discussion:

Upon entering the classroom, Maria shared a personal experience that was directly relevant to that day's lesson on diseases and disease carriers:

Maria: Look! I got a TB test.
Teacher: Why did you get that?
Maria: To see if I have the disease.
Teacher: Do you have symptoms?
Maria: No!
Teacher: Then why did your doctor test you?
Angel: To see if she's a carrier.
Teacher: What's a carrier?
Students: Someone who has the disease but doesn't have symptoms.
Juan: Isn't that the problem with AIDS?
Teacher: Explain what you mean by that.
Juan: That you can have AIDS but not know it, and give it to someone.

Maria's spontaneous sharing her TB test with the class provided an excellent opportunity to probe the students for their understanding about disease carriers, and to see if they could extend what they had learned about carriers to a real life example. Other students were easily drawn into the discussion. Juan then extended his understanding by asking about AIDS, a disease that students are very curious about. He was moving along the EE continuum as he was able to see patterns (Duschl, 2003).

At the end of my action research project it was clear to me that even given valued curriculum materials, students will not automatically engage in a lesson just because it appears relevant to them on the surface. Students must have specific and numerous opportunities to link their personal experiences and knowledge to the science. This is an inherent limitation in any published curriculum. It is also the reason I teach. Through teacher modeling, I could demonstrate how science is relevant to me and encourage students to do the same. Through focused class discussions and targeted questions, I could motivate students to become more interested in science and see the relevance of it to their lives. Both of these actions helped my students internalize scientific inquiry as a way of knowing, and use it as a means for making sense of issues in their own lives.

> "The focus on scientific inquiry needs to be on attainment of evidence and how it is used to generate and justify explanations."

The success of my action research project and those of my MGS cohort members was due in large part to having conducted it as part of a university-school collaboration. The MGS program and faculty provided us with the support, structure, and at times motivation to engage in this sustained reflective activity. Having a forum, such as the cohort, in which to brainstorm ideas, troubleshoot problems, and compare notes was essential for our projects to be meaningful and useful. With so many competing demands for our time, it would be easy for this type of activity to remain superficial or simplistic. With weekly meetings, progress in working toward our action research goals seemed steady. This was true even when our action research projects seemed to stall; input from other MGS members and faculty often provided an invaluable sounding board to allow the project to overcome any temporary barriers. It was a great morale booster for me to be on a shared journey with other MGS teachers working toward the same goals in the same challenging settings. In the end, we were able to improve our effectiveness as science teachers and help provide high quality science education for students in Chicago.

The Importance and Relevance of Action Research

The problem Wendy tackled through action research involved scientific inquiry and creating a bridge between her classroom lessons and the real world of her students. In the previous year, Wendy worked with her students on learning the basics of scientific inquiry that included careful data collection, methodical data recording, and multiple data representations. With practice, her students learned these basics, and Wendy saw an opportunity to introduce more advanced dimensions of scientific inquiry. She successfully introduced topics such as differentiating evidence from data and using evidence in the constructing of a concluding argument. While she was pleased with the progress her students were making in using scientific inquiry within class activities, she was equally troubled by their lack of progress in using scientific inquiry in addressing issues in their lives. This discrepancy highlighted for Wendy that she had not yet realized an important goal for her and her reason for wanting to become a science teacher. She wanted to make science relevant to the everyday lives of her students. She wanted to help her students think of and use science as a way of knowing their world, much like how she has come to "see" science.

While her students could make sense of how scientific inquiry was applicable in class activities, they were not making a bridge to how these understandings and skills applied to their everyday lives. In particular, Wendy noticed that it was when *she* attempted to make these extensions after doing a science activity that students offered only short responses of a generally superficial nature. In contrast, Wendy noticed that when *students* spontaneously initiated discussions that were science-related, she often heard that they used scientific inquiry in relation to their lives. Wendy wondered how a different curriculum might increase classroom opportunities for students to make these everyday connections.

In her action research project, Wendy's first plan of action was to find a new curriculum. The SALI curriculum resonated with her philosophy of teaching science as a way of knowing. Its issue orientation extending across a year-long program created opportunities for Wendy to do the same. Throughout the lessons, this curriculum also included a scientific inquiry framework with basic and some advanced dimensions. Wendy preferred this curriculum because of these strengths. In teaching it, however, she also learned about its weaknesses. Wendy experienced dissonance that often comes when implementing published curriculum materials, even well-respected ones. The benefits only go so far.

Wendy began rethinking her action research. There were still things she valued about this new curriculum, but it was not helping her in the way she had hoped. While her students were now talking and writing about science in relation to issues such as diseases and the environment, their responses continued to have little or no connection to their own lives. The students were not creating a bridge to *their* lives. In the MGS reflective seminar, Wendy was reminded that she had commented during an earlier meeting that when her students offered spontaneous comments about science, she often heard that they were using scientific inquiry in making sense of their daily experiences.

Wendy refocused her action research efforts to study these rich spontaneous instances. She recorded them over time and examined what led up to these instances and what followed. Her investigation led to a reworking of her action research. While still using SALI, Wendy added elements of her own. She added two specific actions: making teacher modeling explicit and maximizing opportunities for student discussion. In turn, her students began sharing more and richer connections that they were making, thus allowing science to inform their daily lives.

Acknowledgements
The authors would like to thank Dr. Maria Varelas of the University of Illinois at Chicago for her very helpful suggestions in editing this manuscript. This work is supported in part by the National Science Foundation under STEMTP Grant No. DUE-0302119, and Noyce Grant No. DUE-0335748. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References
Capobianco, B., Horowitz, R., Canuel-Browne, D., & Trimarchi, R. (March, 2004). Action Research: Understanding the necessary steps for developing and implementing productive action plans. *The Science Teacher.* 48-53.

Duschl, R. A. (2003). Assessment of Inquiry. In J. M. Atkin & J. E. Coffey (Eds.), *Everyday Assessment in the Science Classroom*. Arlington, VA: National Science Teachers Association Press.

Feldman, A., & Capobianco, B. (2000). Action Research in Science Education, *ERIC Digest: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.* ED463944.

Hubbard, R. H., & Power, B. M. (1993). *The Art of Classroom Inquiry: A Handbook for Teacher-Researchers*. Portsmouth, NH: Heinemann.

Minstrell, J., & van Zee, E. H. (2003). Using Questioning to Assess and Foster Student Thinking. In J. M. Atkin & J. E. Coffey (Eds.), *Everyday Assessment in the Science Classroom*. Arlington, VA: National Science Teachers Association Press.

Noffke, S. (1997). Professional, personal, and political dimensions of action research. *Review of Research in Education, 22*, 305-350.

Pedretti, E., & Hodson, D. (1995). From rhetoric to action: Implementing STS education through action research. *Journal of Research in Science Teaching, 32*(5), 463-485.

van Zee, E. H. (1998). Fostering elementary teachers' research on their science teaching practices. *Journal of Teacher Education, 49*(4), 245-254.

Author Information
Carole P. Mitchener: cmitchen@uic.edu,
Wendy M. Jackson: wjackson@att.net

Author Guidelines

Share with us your teaching ideas for curriculum, laboratory experiences, demonstrations, assessment, portfolios, and any innovations that you have found to be successful with science students. Photographs for the cover are also needed. Please send to the editor, Judy Scheppler, at quella@imsa.edu, or to the appropriate area focus editor. Your manuscript should:

Be typed or printed, double-spaced copy with standard margins,

Be less than 3000 words in length, although there is no strict length guideline; articles of substance of most any length will be reviewed and considered for publication,

Be submitted electronically, as an email attachment or on disk (IBM or Mac), saved in Word format,

Include a title page with the author's name and affiliations, a brief biographical sketch of three or four sentences, home address, home telephone number (If there is more than one author, send all information for each), and email address (if applicable),

Include sketches, photographs, figures, graphs, and tables when appropriate. These should be numbered and referenced in the text by number. Any sketches, figures, graphs, or tables should be included at the end of the document on separate pages. They should not be embedded in the text. Photographs should be jpg images, included as separate files. Photographs, sketches, and so forth should be back and white, of good composition, and high contrast,

Include references if necessary, in the format of your choice (APA style is preferred),

Include a statement indicating whether or not the article has been published or submitted elsewhere.

The *Spectrum* is published three times a year. Materials submitted must reach the editor by the following dates: February 15, June 15, November 15. Materials, including photographs, will be returned only if accompanied by a request in writing and a self-addressed stamped envelope.

Advertising

Index to advertisers:

Environmental Education Association of Illinois

EEAI Spring Conference Scheduled
Getting Back in the Flow - A Confluence of EE Ideas
May 4-6, 2006

The 2006 EEAI Annual Conference, "Getting Back in the Flow — A Confluence of EE Ideas," will focus on the partnership of formal and non-formal educators and their impact on environmental education. The conference will be held May 4-6, 2006, at the Pere Marquette Park near Grafton, Illinois. This 3-day networking opportunity will include a pre-conference Leopold Education Workshop, valuable concurrent presentations, and field sessions to local, cultural and natural resource-rich sites. Attendees will also enjoy the annual EEAI membership meeting and awards presentation, resource sharing, and fun after hours entertainment. Dr. Michael Wiant, Director of Dickson Mounds Museum (Lewistown, IL) will kick off the conference as keynote speaker. CPDU's will be offered to formal educators. Accommodations will be available at the Pere Marquette Lodge and Conference Center. More details will be posted as they become available at the EEAI website: www.eeai.net, or contact Natalie Albers at noel897@earthlink.net.

www.eeai.net

The Illinois Association of Biology Teachers Wants You!

Are you a new biology teacher? Or are you an experienced teacher, just looking for a few new biology tricks? Do you have tips to share? Then IABT is for you! Find us at:

The web: www.iabt.net/
Email: iabtnews@earthlink.net
Executive secretary and state sponsor: Philip J. Mccrea
(mccreap@newtrier.k12.il.us)

It's a Biology Thing!

Please Patronize our Advertisers

IPRB

Illinois Petroleum Resources Board

Illinois Petroleum Resources Board

Restoring the Land – Increasing Awareness

The IPRB is governed by an unpaid, 12-member board made up of independent oil and natural gas producers and royalty-owner representatives.

The IPRB was formed to clean up abandoned well sites and provide public awareness and education programs throughout the state. Funding for IPRB programs comes from voluntary contributions of oil and natural gas producers and royalty owners in Illinois.

Our educational goals demonstrate and inform the public of the importance of Illinois oil and natural gas and are funded by the Illinois oil and gas industry. The FREE educational programs are designed to increase awareness about the science and business aspects of the Illinois oil and gas industry. Over 6000 products are made from petroleum: medicines, cosmetics, plastics and gasoline are just a few of the products that we use everyday!

For more information on the IPRB and how we can visit your classrooms, conferences, or special events, please call the Illinois Petroleum Resources Board at 1-618-242-2861 or via email at www.iprb.org and arrange for us to visit!

… A traveling **"Field Trip"** for your school or event!

Charles Williams, Executive Director
Nancy Karch, Executive Assistant
Phone: 618-242-2861 Fax: 618-242-3418
Website: www.iprb.org

IPRB
P. O. Box 941
Mt. Vernon, IL 62864

A Vision of Excellence:

Building the Future through Science Education

ISTA 2006 Conference on Science Education

Friday and Saturday, November 3 and 4, 2006
Preconference: Thursday November 2, 2006

Location: Peoria Civic Center
and
The Hotel Pere Marquette

Earlybird Regisration Deadline 10/02/06
ISTA member - $100
Nonmember (includes membership) - $135

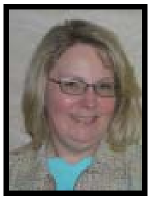
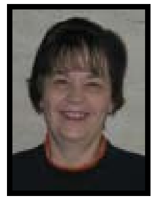
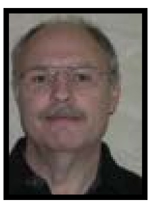
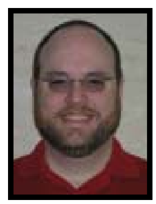
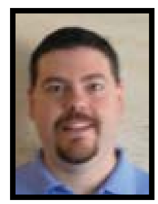
Advance Registration Deadline 10/23/06
ISTA member - $115
Nonmember (includes membership) - $150

Full Rate Registration (After 10/23/06)
ISTA member - $125
Nonmember (includes membership) - $160

See conference information in the front of this issue for further details and for a registration form.

http://www.ista-il.org/conference/index.htm

ISTA Regional Directors

						
Susan Dahl	Larry McPheron	Randal Musch	Linda Shadwick	Kathy Costello	Vicki Tripp	Denise Edelson
Region 1	**Region 2**	**Region 3**	**Region 4**	**Region 5**	**Region 6**	**Region 7**
						
Tom Kearney	Donald Terasaki	Coleen Martin	Susan Golden	Tom Foster	John Giffin	J. Brent Hanchey

ISTA SPECTRUM DISTRIBUTION CENTER
UNIVERSITY OF ILLINOIS
COLLEGE OF EDUCATION
51 GERTY DRIVE
CHAMPAIGN, IL 61820

NON-PROFIT ORGANIZATION
U.S.POSTAGE PAID
CHAMPAIGN, IL61820
PERMIT #75