SPECTRUM

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The Journal of the Illinois Science Teachers Association

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Spectrum

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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).*

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SPECTRUM

The Journal of the Illinois Science Teachers Association

Winter 2006

Volume 31, Number 3

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Raymond J. Dagenais, Ed.D.

Illinois Mathematics and Science Academy

One of the major events in science education took place in our state last November. The National Science Teachers Association, in collaboration with the Illinois Science Teachers Association, held the NSTA Midwest Area Convention at Navy Pier in Chicago. The theme of the convention was "World Class Science" and attendees were treated to a spectacular menu of workshops, presentations, and keynote addresses.

Convention participants had the opportunity to see and hear about the most current science education equipment, supplies, and resources as they strolled through the exhibition hall chatting with the hundreds of vendors that were present, displaying their products and passing out numerous "freebies" to teachers eagerly looking for new classroom ideas. The thousands of attendees created a noisy buzz as conversations about experiments, classroom practices, and science education strategies filled the hallways and open areas of the convention facilities. It was an enlightening and energizing experience.

Much of the success of this event can be attributed to the Illinois science educators that presented sessions at this convention. This is a sample of the kind of behavior that demonstrates professional growth beyond the classroom. Through the generous support of the Exxon Mobil Corporation, ISTA will be recognizing seven K – 8 teachers of science in the spring of 2006. The award consists of a $1000 check which will be presented to one K-8 teacher of science from each of the seven ISTA regions in the State of Illinois. (Look for the 2005-2006 ISTA/ExxonMobil Outstanding Teacher of Science Awards program application elsewhere in this issue of the *Spectrum*.)

Recognition for outstanding accomplishment does not stop with Illinois science educators. ISTA is proud to sponsor the Exemplary Science Student Award. 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 ISTA secretary, Sherry Duncan, at sjduncan@uiuc.edu. This award program is supported by contributions from the Illinois Petroleum Resources Board.

All growing things need nourishment. Attending meetings and conventions, making presentations, writing notes or articles for publication, or simply being proactive in helping other science educators understand the benefits of membership in ISTA are forms of nourishment that fuel the growth of our professional development. Working together we can strengthen ISTA so that it can continue to offer a myriad of opportunities for others as well as ourselves.

Yours truly,
Ray Dagenais

2005-07 ISTA Executive Committee

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

Secretary
Kendra Carroll
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jcarter@pekinhigh.net

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aecKoch@aol.com

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mlisowski@eiu.edu

ISTA Welcomes Denny Moore to the ISTA Executive Board

The Illinois Science Teachers Association welcomes Denny Moore to the ISTA Board. Deb Greaney has decided to step down as ISTA vice president, and Denny will be filling the role of ISTA vice president through March 2007. The board thanks Deb for her service and commitment to ISTA.

2005-07 ISTA Committee Chairs

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

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Crone Middle School
anna_zucczrini@ipsd.org

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

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dsaki@hotmail.com

Region 2 Director 05-07
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lamcp@hotmail.com

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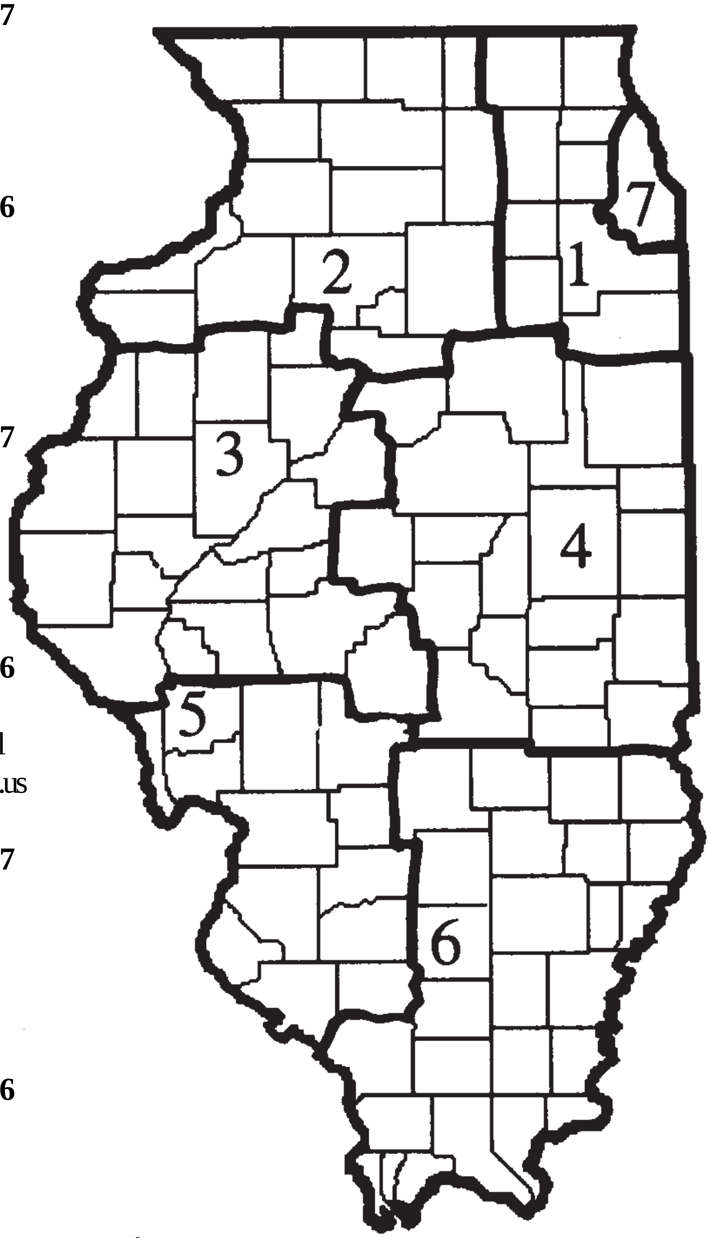

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Susan E. Golden
Professional Development Institute
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Region 5 Director 04-06
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Highland High School
lbasden@highland.madison.k12.il.us

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

Region 6 Director 04-06
Jacquelyn S. Meadows
Egyptian Com. Unit School
wbdoodle@yahoo.com

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

Region 7 Director 04-06
Renee Bearak
Ames School
rbearak@cps.k12.il.us

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

Watch for the results of the 2006-07 ISTA elections.
Voting results will be posted on the ISTA web site:
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: Postmarked by Wednesday, March 15th, 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.

Science in the South 2006

Science in the South, which is the tenth annual regional conference on science education, will be held at the Southern Illinois University Carbondale Student Center on March 10th, 2006. As in previous years, K-12 teachers will enjoy hands on activities, networking, sharing, activity-oriented workshops, make-and-takes, and review new technology and exhibits.

Complete information, including brochures, call for presentations, mail-in registration forms, and on-line registration may be obtained at: http://www.dce.siu.edu.

For additional assistance call the SIUC Division of Continuing Education at (618) 536-7751.

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* and *ISTA ACTION*; 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* and *ISTA Action*; 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 Membership Renewal

Renewal forms have been sent out to all 2005 members. This will be the last issue of the *Spectrum* that 2005 members will receive if membership is not renewed.

Send in your membership fee, right away, to:

Sherry Duncan
ISTA Membership Secretary
University of Illinois at Urbana-Champaign
Children's Research Center
Support Services
51 Gerty Drive, Room #61
Champaign, IL 61820
MC-672

For more information contact Sherry at sjduncan@uiuc.edu

Important information regarding the Fall ISTA conference will be coming up in future issues of the Spectrum.

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.

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

Program Summary:
The Illinois Science Teachers Association, with the generous support of ExxonMobil, is accepting applications from K-8 teachers of science who have demonstrated "extraordinary accomplishment" in the field of science teaching. These accomplishments are intended to be something that goes beyond the classroom and enriches the lives of students. Examples include personal or community-wide achievement which is science related (grants for the school, working on environmental projects, and so forth). It could be working with other teachers or community members to develop a product or process related to science education. It could also be the creation of a science group at the school that enriches and extends beyond the school day.

Award:
The award consists of a $1000 check, which will be presented to one K-8 teacher of science from each of the seven ISTA regions in the State of Illinois.

Eligibility:
Current ISTA members who are K-8 teachers of science and live in one of ISTA's regions.

Award Submission Requirements:

- Current ISTA membership.
- Full time teaching assignment.
- Written narrative (maximum of 500 words) describing the teacher's extraordinary accomplishments in the field of science teaching.
- Evidence to support the description of the extraordinary accomplishments; Examples include copies of newspaper articles, journal articles, grant applications and acceptance letters, letters from community agencies, action research reports, photos, and so forth. Do not exceed more than ten printed pages of evidence. Evidence will not be returned.
- Vita (one page, single sided) containing teaching experience, professional activities, formal and continuing education, awards, and published material.
- Two letters of support from individuals who can attest to the impact of the extraordinary accomplishments in the field of science teaching.
- A completed application form with required supplementary materials submitted by March 1, 2006 to:

Eeva Burns
ISTA Awards Chair
34699 N. Hwy 12
Ingleside, IL 60041

Winners will be notified by May 1, 2006.
For more information, contact Eeva Burns at eevaburns@comcast.net.

2005-2006 ISTA/ExxonMobil
Outstanding Teacher of Science Awards
Application Form

ISTA Region:_______

Name:____

Position (grade and subject taught):____________________________________

School Name/Address:____

____

School Phone Number:____

Email address:____

Home Address:____

____

Home Phone Number:____

I certify that the information provided in this award application is true and accurate.

Signed:____ Date: _________
(Applicant)

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 to send email or by posting ideas or questions on the Illinois message board.

In Illinois, ISTA implements the BaP program. The recently formed ISTA professional development committee will oversee the development of the state program. The committee is made up of the following science educators: Kathy Costello, Denise Edelson, Joe Jakupcak, Kevin Kuppler, Jackie Meadows, Carol Van De Walle, and Anna Zuccarini,

The program is growing in Illinois and we encourage you to participate as a point of contact (PoC) or a key leader.

Volunteer to be a Point of Contact

Is your school without a BaP leader? ISTA invites you to consider volunteering to serve as a point of contact. As each school joins the network, BaP become a more powerful means of communication. You and your colleagues will become less isolated and benefit from the information flowing through this conduit.

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.

As PoC you will:

- Attend a training session offered by a key leader, or work through an online tutorial (in development).
- Receive standards based educational information on behalf of your school and share the information with your colleagues electronically.
- Circulate BaP online information (eblasts).
- Take advantage of opportunities to participate in professional development and to represent inquiry-based science education.
- Share information on professional development opportunities and effective science teaching with your teaching colleagues.
- Participate in science teacher associations.
- Share emailed information that is targeted for your group.
- Be a visible representative for science education by helping your colleagues become more aware of resources and opportunities for professional development.

To volunteer to become a PoC go to the Building a Presence web site at 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 name and/or 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.”

Once you have submitted your information, you will be contacted and given a login and a password that will enable you to make changes in your profile and communicate with others who are part of the network.

Volunteer to be a 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 a key leader position.

As a key leader you will:

- Have the opportunity to develop your leadership skills and participate in professional develoment meetings specifically for key leaders.
- Recruit points of contact.
- Be an active participant in the online network receiving and distributing standards-based educational information.
- Maintain lines of communication with your points of contact through the BaP network.
- Be knowledgeable about state and national science standards and be an advocate for exemplary science teaching and learning.
- Participate in science teacher associations.
- Check PoCs periodically to keep their BaP online contact information up-to-date.
- Gain professional recognition.

If you are interested in taking on this responsibility please contact me, at lipscomb@imsa.edu, and include the following information:

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

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

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

When is it Time for Science?

Raymond J. Dagenais, Ed.D.

Illinois Mathematics and Science Academy

The title of this article begs the question, “When should we be teaching science to our children?”

Even before birth human beings may recognize natural phenomena such as pressure and temperature differences, and spontaneously react to changes in such things. These are learning experiences. It can be argued that as the brain continues to grow and develop, connections are beginning to be formed and subconscious memories created. Information gathered through the senses may be stored in unarticulated patterns in the brain. Here is the foundation for a scientific understanding of nature.

The cover photographs in this issue of the *Spectrum* show children engaging in the study of our world. Innate curiosity fuels the desire to investigate the nature of objects and how these things work. Children’s first teachers are the care giving individuals that provide for and protect them. Perhaps, more often than not, these individuals may not realize that by supplying a safe and enriched learning environment they are facilitating the learning of science.

There is a vast array of scientific understandings waiting to be uncovered. As children explore and investigate they formulate ideas and understandings that may be incomplete or downright wrong. Ideas about our surroundings and the way things work become established by building schemata. A schema is a mental codification of experience that includes a particular organized way of perceiving cognitively and responding to a complex situation or set of stimuli (Webster’s Ninth New Collegiate Dictionary, 1988). New experiences offer the opportunity for schemata to be expanded, substantially modified, or thrown out altogether. This is the challenge that defines the work of teachers of science.

Every dedicated teacher of science wants the best for his or her students. That would include a comprehensive and deep understanding of the concepts and principles of the life, physical, and Earth/space sciences, and the nature of science along with the skills and abilities to engage in scientific inquiry. Such expectations can lead to a scenario of “just-in-case” teaching as opposed to “just-in time” teaching.

“Just-in-time” teaching employs developmentally appropriate learning experiences that are designed to pique the interest of the learner in the same way that the unarticulated curiosity of the young child promotes inquiry and investigation. The intrinsic motivation prompted by the curiosity inherent in “just-in-time” teaching is diminished in a smorgasbord of decontextual “just-in-case” teaching. The vacuum of context leaves the learner with an unconnected assortment of facts that may be remembered just in case a situation arises that requires this knowledge. “Just-in-case” teaching comes about as an attempt to deliver the “stuffed curriculum” in the short amount of time teachers have with their students. The useful result of such an approach is questionable.

As young children grow older they develop increased capacities to make connections and learn. One description of these capacities is found in the work of Jean Piaget (Piaget, 1983). Without going into the specifics of the various stages of development, it might be said that learners display stages of conceptual development that are earmarked by abilities to deal with increasingly sophisticated and complex material and situations. One of the important attributes of this development is language acquisition.

The transition from the unarticulated curiosity of young children, through the carefully articulated questions posed by teachers of science, to the self-formulated questions of the scientifically-minded individual can depend greatly on the conceptual development of the learner. At very early ages, it is not apparent that children formulate well articulated questions to drive their inquiry. As learners display behaviors indicating more highly developed conceptual capacities, teachers of science can introduce scenarios and situations of increasing sophistication and complexity. Even if the objective of a lesson might be the knowledge or understanding of a simple scientific fact or skill, if it is embedded in a complex situation where there are numerous extraneous or competing variables, learners may not have achieved the developmental capacity to sort out the meaning of the lesson.

Teachers of science need to take into account the developmental level of the learner as lessons are being planned. It is by no means the case that just because students cannot use the appropriate language or mathematical skills that learning experiences cannot be designed to assist students as they engage in their personal scientific inquiry. "Effective teaching requires that teachers know what students of certain ages are likely to know, understand, and be able to do; what they will learn quickly; and what will be a struggle" (National Research Council, 1996).

Learning environments that are rich in physical objects to investigate can support the information gathering and classification of very young children. These kinds of experiences are not relegated to just young children. Any circumstance that is new to the learner can employ concrete learning activities. More mature learners can move more quickly from this level to more abstract stages of learning by building upon the knowledge they have acquired. Establishing an experience base upon which to build more complex and sophisticated knowledge is key to being able to understand our world. Considering the notion that human beings begin their investigation of nature pre-birth and continue it throughout life, it might be said that the learning of science goes on all the time.

"Just-in-case" science teaching needs to give way to "just-in-time" science teaching. So, the answer to the question, "When should we be teaching science to our children?" may be answered by the statement, "When it is time for science."

References:

National Research Council. (1996). *National Science Education Standards.* Washington, D.C: National Academies Press, p62.

Piaget, J. (1983). "Piaget's theory." In P. Mussen (ed). *Handbook of Child Psychology*. 4th edition. Vol. 1. New York: Wiley.

Webster's Ninth New Collegiate Dictionary. (1988) Merriam-Webster Inc.

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.

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. Also, from time to time teachers create and/or provide valuable professional development opportunities for one another. Thinking about and sharing these activities or ideas with colleagues provide professional development opportunities for all involved in the sharing. If you have an idea you would like to share, please send it to me at lipscomb@imsa.edu.

In this issue teachers from elementary, middle, and high schools around the state have shared some great ideas that you may want to incorporate into your repertoire. A sincere “Thank You” to those who submitted ideas and information for this issue.

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An important teaching strategy that we all should remember…

Sharon Binter, science teacher and department chair at the Avery Coonley School in Downers Grove writes: “*Remember the Five Ps* has been my motto for teaching science for years. What are the five Ps you might ask? They are Prior Practice Prevents Poor Performance. No matter how many times you’ve done a demonstration or presented a lesson for labs, you need to review the steps and go through them again because you may see a different way to present an idea or make it more interactive or interesting.”

+++++

After school science and math club + community service = fun…

Susan Kautzer, seventh-grade science teacher and point of contact at Dupo Junior High School in Dupo writes that she and Beth Lenz, her math teaching colleague, worked with the students in their SMAT club (Science Math Adventure Team) to host a family math and science night at the local grade school. The students hosted ten different stations. She says that they did an excellent job of helping parents dive into science and math activities with their children. In some cases, even the grandparents were involved. The students really enjoyed themselves and the fifty to sixty or so families that attended seemed to have a great time.

The uniqueness of the family night was that every activity was presented by a member of the SMAT club. The students were providing a community service so they could attend an adventure in the spring. Susan continues, “We came up with the idea to involve students in math and science outside of the classroom. We plan on taking the kids caving in the spring and we are also planning a Saturday to make hot air balloons.” A requirement for the students to participate in these extra, fun activities is that they participate in a community service activity, such as this.

“This was our first year for the SMAT club and the family science night as well,” writes Susan. “So far we have been really pleased with the success and enthusiasm the students have shown. This could also be an excellent way for a teacher to give students extra credit or leadership opportunities. It really was an enjoyable evening.”

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Recommendations for useful web sites….

Liz Martinez, seventh-grade science teacher and point of contact at Gregory Middle School in Naperville recommended a graphic organizer web site found at http://education.bjbarton.com/Graphic_Organizers.html. The site provides a large selection of printable organizers that are arranged according to the categories: Common Multipurpose, Compare and Contrast, Study and Work Habits, Research, Sequencing, Hierarchies, Cause and Effect, and Concept. A preview of each is available on the web site so that you don't have to wait to download the pdf or Word version.

Chemistry teacher and point of contact Darwin Smith, who teaches at Hamilton High School in Hamilton, writes, "Here is a website that I have found quite useful in teaching orbitals to chemistry students: www.shef.ac.uk/chemistry/orbitron . It has some items that are quite advanced, but it has excellent illustrations of the orbitals themselves, including f and g orbitals which are not found in most textbooks. It also has great material on hybrid orbitals if someone teaches that in their discussions about bonding."

Tom Kearney, biology and animal behavior teacher at Andrew High School in Tinley Park, is also an ISTA region 1 director and key leader. He sends an electronic newsletter to his points of contact and other science educators several times a year. Following are four of the web sites he recommended in his fall newsletter.

One is called "Ideal Bite" at http://www.idealbite.com/. Tom writes that it is a "super site for getting ideas for how to live a 'green' life." You also can sign-up for free daily email updates that give some really good ways to live your life in a more environmentally friendly way.

The Exploratorium is a museum that also has a great online resource section found at http://www.exploratorium.edu/. Tom says, "If you are into gardening, check out the science of gardening. This site will also send out regular free email updates on a variety of different science ideas."

FunBrain.com at http://www.funbrain.com/teachers/index.html is an interactive site that can be used by teachers and students at all grade levels and parents. The "FunBrain.com Games Finder" allows the user to choose games by the age of the player or by subject area. In addition to math and science games and activities, this site includes language arts, social studies and art and music games and activities.

A great place for biology resources is http://www.biologycorner.com/, and can be used by teachers of all grade levels. Scroll to the bottom for some newer lessons. The "Isopod Behavior Lab - rollypolly lab for AP Biology" is supposedly for AP level—but Tom says that he thinks his granddaughter's kindergarten teacher could adapt this lab for her students. Tom writes, "I plan on trying the 'Sex and the Single Guppy' with my Animal Behavior class. The website title says biology, but check out "Smog City"—maybe something for the Earth and Space people. I like the "ready made" worksheets for the different activities and great interactive visuals."

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A professional development opportunity…

Yvonne Twomey, at the Lederman Science Education Center at FermiLab in Batavia, and Lee Marek, who teaches at the University of Illinois at Chicago, sent information about an extraordinary summer opportunity: Science History Tour 2006 – The Age of the Earth and the Evolution of Life.

They write, "We are planning a two-week trip to the northern part of Britain, including a visit to the Orkney Isles, with an interesting focus on archeology, astronomy, Earth science, and evolution. As usual though, there will be something for everyone, from architecture to zoology.

"The trip will start on July 12 in the UK and end there on July 26. The itinerary will include Glasgow (recently designated as the City of Culture), Edinburgh with its Scottish Parliament, and numerous smaller Scottish towns, including Inverness (Nessie may be seen?). We will study the work of many scientists along the way, including Lord Kelvin, James Watt, Charles Darwin, the Scottish chemist Joseph Black, Scottish geologist James Hutton, and numerous others. In the north of England we will visit Durham, Newcastle, Leeds, York, and many small towns and villages which have connections with science. Lectures, visits to lovely gardens and to historic science sites, museums, and mines, as well as activities of a cultural nature will all be included. Accommodations will be in comfortable welcoming hotels, where all rooms have private bathrooms.

"If you are interested in joining our friendly and interesting group of science teachers for this trip, please let us know. For further information and/or to be put on the mailing list, contact: Yvonne Twomey (P.O. Box 4707 Naperville, IL 60567-4707, email: ytwomey@mindspring.com) or Lee Marek (phone: 630-420-7516, email: LMarek@aol.com). Graduate credit is available. CPDUs are also available for teachers."

Editor's Note: Yvonne Twomey and Lee Marek are extraordinary science teachers who together have been providing unique opportunities for teachers to study the history of science for the past nine years. Yvonne and Lee both taught chemistry at Naperville North High School, but are now involved in activities outside the high school classroom. Yvonne is currently on a leave of absence to study for a master's degree in the history and philosophy of science at the University of Durham in the UK. In addition to teaching at the University of Illinois at Chicago, Lee is a team leader for the Flinn Foundation Summer Workshop Program. As a former participant of one of their tours, I can say that it was an extraordinary learning experience.

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An "Excellence" opportunity for teachers and students alike…

Susan L. S. Bisinger, from the Illinois Mathematics and Science Academy in Aurora, shares an opportunity that provides ongoing professional development and networking with other teachers throughout Illinois that directly and immediately impacts students at your school.

She writes, "Although science clubs or math clubs may be found in some middle schools and junior high schools, after school programs that address the needs of middle-level students (grades 6, 7, and 8) who are interested and talented in science and mathematics are rare. The Illinois Mathematics and Science Academy's IMSA Excellence 2000+ (E2K+) is a middle school enrichment program in science and mathematics. IMSA E2K+ has two components. One is an after school enrichment program for middle school students who are talented, interested and motivated in mathematics, science and technology. The second component is an ongoing professional development community for participating teachers.

"Being a part of IMSA E2K+ offers many benefits to Illinois schools, students and teachers:

- Support for your school's efforts to serve the needs of talented, interested, and motivated learners.
- An opportunity to partner with IMSA and become a recognized model of excellence, enhancing the school's appeal to students, parents, teachers and investors.
- High quality, engaging learning experiences that help students "learn how to learn" and provide a strong foundation for future study of science, mathematics and technology.
- Opportunities for mathematics and science teachers to strengthen their knowledge and skills.

- Access to exemplary professional development programs and materials, along with the opportunity for teachers to develop as leaders in their school and profession.

"Schools become part of the program by application. Application materials can be found on our web site at www.imsa.edu/programs/e2k/whatsNew.php and are due by March 15, 2006. If your application is accepted, IMSA E2K+ can start at your school during the 2005-2006 academic year. Schools will be notified by May 1, 2006 of their selection.

"We invite you and your school (or group of schools) to become part of the *IMSA E2K+* network. Check out our Web site www.imsa.edu/programs/e2k for more information about IMSA Excellence 2000+. Complete the application and take advantage of this "Excellence" opportunity!"

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If you have lab or classroom management hints, great websites you have used, science activities, lessons, or demos 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 Illinois Mathematics and Science Academy, 1500 West Sullivan Road, Aurora, IL 60506-1000.

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

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Environmental Education Association of Illinois: Committed to Serving Illinois' Educators since 1972

Sarah Livesay, EEAI secretary

The Environmental Education Association of Illinois (EEAI) serves the classroom teacher; the naturalist; the 4-H leader; the home school parent, and dozens of additional professionals that have an impact on the environmental literacy of our citizens. In order to address member-driven needs for all of Illinois, EEAI has divided the state into five distinct regions (North-East, North-West, East-Central, West-Central and South). Within each region exists two (three in the North-East) membership-elected regional directors whose sole responsibility is to evaluate the needs of their communities and make available professional development opportunities and/or educational resources to best serve these needs. To ensure the continued service to the regions, each director creates an annual plan of workshops, inservices, and field trips to occur within their region; on most occasions these events have little or no cost to the participant. EEAI's status as an ISBE certified professional development provider allows educators to receive hands-on environmental training while earning recertification units.

In addition, EEAI is a partnering agency for many statewide initiatives to further the environmental education outreach within the state. In 2003, EEAI assisted the Illinois Environmental Education Advancement Consortium with the establishment and promotion of the Illinois Environmental Education Database at www.illinoisee.org; this website is a one-stop shopping warehouse of environmental education information where educators can search for professional development opportunities, classroom programs and educational materials available. Also, EEAI has supported the Illinois Department of Natural Resources PROJECTS curriculum since its adoption into the state began in 1981.

Every spring, the Environmental Education Association hosts a conference in order to educate, energize and enhance the environmental education community. The conference locations rotate annually throughout the five regions. The 2006 Conference, "Getting Back in the Flow - A Confluence of Environmental Education Ideas," will be held in the West-Central region at Pere Marquette State Park on May 4-6, 2006. One popular component of the conference is an annual silent auction which raises hundreds of dollars to fund the annual EEAI mini-grant program, which distributes numerous $200 grants to educators statewide.

In addition to these annual conferences, and continuous regional events provided by local directors, EEAI publishes a quarterly newsletter for members full of pertinent EE news, materials and events. The EEAI Board of Directors, along with members and partners statewide invite all those interested in the promotion and cultivation of environmental education to let us *serve* you! Visit www.eeai.net for membership or additional information.

EEAI Conference - May 4-6, 2006
www.eeai.net

Articles

Meteorites and Moon Rocks

Brian Poelker

Midwest Central Middle School

The combination of meteorites and moon rocks provides the hands-on basis for students to explore the solar system.

Introduction

The direct hit of Comet Shoemaker-Levy 9 on Jupiter in 1994 has made students, the public, and Hollywood aware that there are objects in space that can impact Earth with devastating consequences. This, and the "hits" of past impact events like Meteor Crater and Chuxulub, provides a hook for the study of meteorites and what they tell us about the origin of our solar system. To most students, meteorites are "rocks from space" in museums. However, the Internet has made common meteorites readily available through dealers at an affordable cost to teachers. Also, NASA makes both their lunar rock and meteorite disks modules available, free of charge, to teachers who complete the moon rock training course.

Most of the information we have about the solar system, and the universe, comes in the form of spectra of light, gathered by satellite and telescope. However, rocks from space are short-changed in the curriculum as they have provided a wealth of direct first-hand information on the formation of the early solar system and the structure of its solid bodies. The combination of meteorites and moon rocks provides the hands-on basis for students to explore the solar system.

Meteorites

Meteors are dashes of light in the night time sky. They are usually the size of a grain of sand and burn up in the Earth's upper atmosphere, at about a 75km elevation. Meteorites are stones that have survived a fall through our atmosphere. Points of origin include the Moon, Mars, asteroids, and the original solar nebula. Meteorites are generally classified into iron, stony-iron, and stone; further subdivisions of each category are based on the chemistry or mineralogy of the meteorites. As a general rule, iron meteorites come from the cores of large asteroids or protoplanets, stony-irons are from the core-mantle boundary of asteroids, and stony meteorites are from the surface of the asteroid or Mars.

Stony meteorites often include round chondrules. The chondrules are condensed crystals, usually of olivine or pyroxene, from the early formation of the solar system. Chondrules have been recreated in laboratory conditions giving us clues to temperatures and pressures present in the solar nebula. Chondrites have a radiometric age of 4.55 billion years old. They are subdivided by the amount of iron they contain and the amount of alteration of the chondrules by water or secondary heating. The letters "H," "L," and "LL" designate the amount of iron present. H chondrites have a high iron content, 25-31%, with abundant iron flakes visible. L chondrites have a lower iron content, 20-25% ,with fewer flakes. LL meteorites, low iron and low metal, have the lowest iron content of the chondrites, 19-22%. The numbers 1 and 2 indicate aqueous alteration; these meteorites have abundant water and few chondrules. Numbers 3 and 4 reveal abundant chondrules. Meteorites in classes 5 - 6 have been altered by heating and the chondrules are less distinct.

Stony-iron pallasites are from the core-mantle boundary. When cut and polished they contain a beautiful mixture of green olivine crystals interspersed in a nickel-iron matrix. The other stony-iron class, the mesosiderites, contain broken pieces of stone and metal in a 50/50 mix. Iron meteorites are very dense and usually exhibit a wonderful crisscrossing Widmanstatten structure. This pattern is produced by two nickel-iron alloys, taenite and kamacite.

Another type of stony meteorite is the achondrite, meaning without chondrules. These rare meteorites provide further evidence of the formation and evolution of the parent body. Eucrites are basaltic, indicating a molten or volcanic origin. Howardites are soils. Diogenites are examples of the core of the parent body. These stone meteorites have been linked to the asteroid 4 Vesta as their surface reflection spectrum closely matches that of the asteroid and 4 Vesta has a huge impact crater.

There are many rare types of stony meteorites that provide extraordinary insights to the formation of the Earth and the solar system. The Murchison meteorite, a carbonaceous chondrite, contains hundreds of organic molecules that were formed in outer space. Among these molecules are several amino acids, some of which are the same as the ones making up the proteins of your cells. Other amino acids in the Murchison meteorite are not found in any organisms on this Earth. When students hold a carbonaceous chondrite, they are literally holding a piece of the sun. These special chondrites do not contain the gases of the Sun, but the ratio of the solid atoms matches the ratio of those atoms in the Sun quite nicely.

The Allende meteorite is the most common carbonaceous chondrite. It fell in the same year as Murchison, 1969. A couple of tons of Allende have been collected. In Allende, scientists discovered irregular inclusions in the matrix of the meteorite. Analysis of these calcium-aluminum inclusions (CAI's) shows that they contain unaltered concentrations of atoms formed in a supernova explosion. Material in these inclusions condensed before the Sun began to shine and the Earth formed.

Rocks from Mars

Thirteen special achondrites are grouped to form the SNC-association. The meteorites are named for the locality where the type specimen was found. "S" is from Shergotty, India. "N" from Nakhla, Egypt. "C" is from Chassigny, France. While most stony meteorites coalesced in the early solar system, these have much younger radiometric ages, about 1.3 billion years old. All three types are igneous, with varying amounts of oxidation and water. The last episode of volcanic activity on the Moon ended around three billion years ago and the asteroids are not large enough to produce volcanic activity during this time period. Venus is a candidate because of its volcanoes, but Venus has a very thick atmosphere and a higher surface gravity which would make it more difficult for a meteorite to be ejected from its surface. This makes Mars, with a thin atmosphere, low surface gravity, water ice polar caps, and high volcanoes, the prime candidate for their origin. Water and carbonates are associated in the molecular structure of the minerals of some. Oxygen isotope analysis differentiates these rocks from Earth and lunar samples. The air trapped as the molten rock cooled is a close match to the sample analyzed by the Viking Lander on Mars.

Hands-on Lab Stations

It is generally not practical at the middle or secondary school level to have large quantities of meteorites available to all lab groups of a class. To solve this problem, I have divided the room into four stations, each of which has enough lab equipment for two teams of four. Students rotate from station to station to complete the work. Each station takes two class periods.

Station 1: Observations and Questions

Materials: Stereoscopes, meteorites

Students observe different meteorites, record differences and similarities. Students also write one question about each meteorite for later classroom discussion. (At this point all students know is that the rocks they are viewing are meteorites. Student observations and questions will be discussed to emphasize classification characteristics at the end of the lab work.) If the Internet is available in the classroom, students can check out some of the web pages listed in the resource section of the article. The meteorites need not be large for this station. I have found that fragments viewed under stereoscopes work wonderfully. Meteorites viewed under the scope at this station at Midwest Central Middle School, include fragments of Murchison and Allende (carbonaceous chondrites), Tuxtuac (stony LL-group), Ghubara (stony L-group), El Hammami (stony H-group), Vaca Muerta (stony-iron), Brahin (pallasite), Gibeon (iron), Millbillillie (HED Eucrite) and Zagami (SNC achondrite). If possible include a stone showing flow lines, where the crust melted as it entered the atmosphere. A comparison of H, L, and LL chondrites shows great differences in the iron content of the stony meteorites. The Gibeon meteorite has a great Widmanstatten pattern. Affordable fragments can be purchased from dealers listed in the Norton book or at the website below. This station will be a success even if you can obtain only a couple meteorites (stony and iron) for students to view and compare.

Station 2: Effect of Mass and Height on Cratering

This station allows students to test variables relating to crater formation.

Materials:

- pan of sand (a box lined with a plastic trash bag works well)
- triple beam balance
- baggie with steel ball bearings of four sizes - extra-large (about 50g), large, medium, small (different sized rocks will work fine also)
- ruler and meter stick
- magnet

Procedure:

The effect of *mass* on crater size, trials 1-4

a. measure and record the mass of each ball

b. measure the height from the rim to the sand with a ruler, record data under height dropped

c. drop the X-large ball into the sand from rim height as follows:

1. place the ruler or meter stick across the top of the pan
2. drop the ball from the ruler
3. use the magnet to remove the ball without disturbing the crater

Sample Data Table

Trial	Ball size	Mass	Height dropped	Crater diameter
1				
2				
3				
4				
5				
6				
7				
8				

4. measure the diameter of the crater with the small ruler and record (do not touch the sand with the ruler)
5. repeat procedure "c" with the smaller three steel balls

The effect of *height* on crater size, trials 5-8
a. Use *only* the extra-large ball.
b. Drop the extra-large ball from 12, 24, 48 and 96cm heights above the sand. Be sure to measure and record data before proceeding to the next trial.
c. Create a data table to organize your information
d. When the table is completed, *graph* trials 1-4 and trials 5-8 on *separate* graph papers.

Questions:
Use your graphs to answer the following questions.
1. What is the independent variable in trials 1 - 4?
2. What is the dependent variable in trials 1 - 4?
3. What is the independent variable in trials 5 - 8?
4. What is the dependent variable in trials 5 - 8?
5. How does the mass affect the crater size?
6. If you double the mass does the diameter of the crater double? Prove your answer with data.
7. How does the height affect crater size?
8. If you double the height does the diameter of the crater double? Prove your answer with data.
9. Based on graph #1, how big a ball would be needed to make a crater 3.75cm in diameter?
10. Based on graph #2, what height is needed for the X-Large ball to make a crater 6.25cm in diameter?
11. Explain how you were able to find the answer to numbers 7 and 8.

This simple experiment effectively introduces students to the concept of controlling variables, independent and dependent variable; their relationship to graphing are clearly depicted.

Station 3: Identification of iron meteorites

This station permits students the opportunity to identify meteorites based on their characteristics. This is a modified version of a presentation made by Carl Wenning of Illinois State University. The physical appearance of meteorites varies considerably. Furthermore, they often resemble some terrestrial rocks and man-made slags. Identifying meteorites, therefore, can be rather difficult. Instead or relying on one characteristic, we can be more sure of a specimen's identity if we compare several characteristics of the specimen to characteristics of known meteorites. This lab consists of several possible meteorites. The student's job is to determine the characteristics of each specimen and conclude if the specimen is a possible meteorite or not. Small Diablo Canyon meteorites, from Meteor Crater, are ideal for this lab. Look for specimens with distinct regmaglypths, diagnostic "thumb prints" created by melting as the meteorite passed through the atmosphere.

Materials:
- At least one iron meteorite; Canyon Diablo, Campo del Cielo, and Sikhote-Alin meteorites are widely available from dealers at a reasonable price.
- *Meteor-wrongs*: rusty stones, tektites, magnetite, glass slag, galena, and hematite work well. Place each specimen in a plastic bag with an identification number for data tables.
- triple beam balance
- magnet
- graduated cylinder
- beaker of water

Characteristic 1: Magnetism

The first, and simplest, test is magnetism. *Iron meteorites are strongly magnetic*. Some terrestrial minerals, like magnetite, as well as some man-made slags are also magnetic. Most meteorites have various amounts of iron and will be magnetic. Achondrites, carbonaceous chondrites, and some low iron chondrites are not magnetic. High iron chondrites, stony-iron, and iron meteorites are magnetic with iron meteorites being strongly magnetic.

Examine each of the specimens with a magnet. Create a table and record your data. The presence of magnetism alone does not tell if a specimen is a meteorite or not. It only tells the possible type of meteorite. This test combined with others will help you reach your conclusions.

Meteorites provide direct access to the remnants of the protosolar system

Characteristic 2: Exterior and Broken Surfaces

An unbroken meteorite will be encased in a fusion crust. This outer layer is made of molten and solidified natural glass, often with veined flow lines. Fusion crusts are usually black. Over time the fusion crust weathers and the meteorite often turns a dark brown or rusty color. As meteorites fall though the atmosphere the outer surface becomes very hot. Because of the heat, iron meteorites often have pits, resembling thumb prints. These are known as regmaglypts (reg' - ma -glipts). Examine your specimens for fusion crust, color, and regmaglypths. Create a table and record your data.

Characteristic 3: Density

(Teacher Note: Iron meteorites are subject to rusting if exposed to water. You may wish to provide the volume of each possible meteorite along with the identification number. If the volume is provided, have students measure a sample rock by volume displacement so they understand how the number was determined.)

The density of a substance is its mass divided by its volume. Iron meteorites feel heavy compared to most rocks because they have a greater density. Most rocks of the Earth's surface have a density of about $3 g/cm^3$. Iron meteorites have a density of about $7.7 g/cm^3$.

Measure the mass of each possible meteorite and calculate the density. Create a data table to record your measurements.

Station 3 Summary

Meteorites can be identified by several characteristics. No one thing will prove that a rock is a meteorite. However, a combined set of characteristics, like those you just described will help identify a possible meteorite. Look at the tables you made. List the number of each specimen and tell if it is a meteorite or not. Provide proof for each opinion.

Station 4: NASA Lunar Disk

The NASA lunar disk certification program permits you to borrow the rocks from NASA free of charge. The rocks and lunar soil are encased in a clear lucite disk. NASA also provides a video about the lunar rocks, a slide set and a loose-leaf file folder with much data about the rocks in the disk.

Materials:

- NASA Lunar Disk
- terrestrial rock hand samples: basalt, breccia, anorthosite
- terrestrial rock thin sections: basalt, breccia, anorthosite
- 6 pieces of polarizing film
- 3 microscopes
- 1 stereoscope

Set up the thin sections to display diagnostic minerals. Under cross-polars anorthosite exhibits the black and white stripes of twinned crystals, breccia will appear as a black and white jigsaw pattern, and basalt will exhibit black ilmenite crystals and colorful crystals of olivine and pyroxene. 100x or 200x will be the optimum magnification for the slides. View the NASA lunar rocks using the stereoscope.

Student Directions for Identifying Moon Rocks Using Polarized Light.

1. In microscopes 1, 2, and 3 the rock slides are set up in the best location possible. Do not move the slides under the stage clips. Look at each of the rock slides using plane polarized light . This light is polarized in one direction as polarizing film is placed under the microscope slide.
2. Place the second polarizing filter on top of the slide and rotate it to get the best view. Look at each of the rock slides using cross polars. Describe the patterns in each rock. Draw and color.
3. Look at rocks A, B, and C carefully and look at the details in your drawings. Find patterns that the

rocks and the slides have in common. Match the slide to the letter of the rock. Write the letter under the drawing. Explain the reason for your choices. Check with your teacher before proceeding.

4. The three rocks are breccia, basalt and anorthosite. Find patterns that the Earth rocks and the Moon rocks from NASA have in common and identify each of your drawings by name. Write the name of the rock under the drawing. Explain the reason for your choices.

Summary

Upon completion of the activities, student work can be checked for accuracy. Question and answer sessions allow the teacher to expand on student observations, providing age appropriate information from the introductory material.

Meteorites provide direct access to the remnants of the protosolar system, and in rare cases, Mars, Moon, and possibly the asteroid 4 Vesta. The meteorites contain not only the chemical composition of the early solar system, but analysis of chondrule formation provides the physical conditions as well. Meteorites contain the iron and rock that built our Earth, the water that formed our oceans, and the carbon and amino acids needed for life. Meteorites also pose a danger to living things. If Shoemaker-Levy 9 hit Earth instead of Jupiter in 1994, this would be a very unpleasant place to live. Over 100 Earth-crossing asteroids have their orbits mapped. There are many more.

Students can physically handle material that is 4.6 billion years old, and in the case of Allende CAI's, older than that. Students simulate the creation of craters, controlling variables, in their experimentation. With the help of NASA, students can view the Moon from a new point of view. The activities provide students a first hand opportunity to observe, question, measure, and identify the rocks that made our world.

Resources

Dodd, Robert T. (1986). *Thunderstones and Shooting Stars*. Harvard University Press. Cambridge, Massachusetts. 196pp.

McSween, Harry. (2000). *Meteorites and Their Parent Planets*. Cambridge University Press. Cambridge, UK. 310 pp

Norton, O. Richard. (1998). *Rocks From Space*. Mountain Press Publishing Co. Missoula, Montana. 447 pp.

Weaver, Kenneth. (1986). "Meteorites: Invaders From Space." *National Geographic* 170(3). P 390-418.

Wenning, Carl. Lecture Notes. Illinois State University.

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Internet Resources

http://cass.jsc.nasa.gov/lpi.html (Lunar and Planetary Institute)
http://www.hq.nasa.gov/office/codef/education/fieldcenterdetails.html
(NASA Education Field Centers, Lunar Certification)
http://seds.lpl.arizona.edu/sl9/sl9.html (Comet Shoemaker-Levy 9)
http://www.barringercrater.com/ (Barringer Meteor Crater)
http://www.meteorite.com/links.htm (Meteorite and Astronomy Links, includes Dealers)
http://www.meteoritecentral.com/ (Meteorite Central, current information, chat, links)
http://www.jpl.nasa.gov/snc/ (Mars Meteorites)
http://near.jhuapl.edu/ (Near Earth Asteroid Rendezvous)
http://impact.arc.nasa.gov/index.html (Asteroid Comet Impact Hazards)
http://xlr8.lpl.arizona.edu/spacewatch/ (The Spacewatch Project)

Physical Science Teaching Strategies - A Sample of the Literature with Recommendations for Teachers

Kevin C. Wise
Southern Illinois University

The physical sciences are integral parts of Illinois school curricula.

The physical sciences are integral parts of Illinois school curricula and curricula throughout the nation and around the world. The Illinois Learning Standards and Benchmarks incorporate physical science concepts and principles from the early elementary through the late high school levels. Concepts and principles related to matter, energy, force, and motion are keystones of the Illinois Science Standards (Illinois State Board of Education, 1997). Beyond being part of school curricula, these concepts and principles are among the big ideas in science that students need to acquire for understanding and interpreting the world around them. There is no question that the extant learning standards have focused our attention on these ideas in the physical sciences. Now the question as educators becomes: How do we teach these ideas? Whether a third grade teacher or a high school physics teacher, How does one engage students in developing and refining their conceptual understandings of physical science concepts?

Purpose and Procedure

The purpose of this article is to review and synthesize a small sample of journal articles, representative of the last ten years, of successful teaching strategies reported in the physics education literature. This paper does not endeavor to present a comprehensive synthesis of the science teaching strategies literature, but rather seeks to present a snapshot of a sample of the relevant literature in the physical sciences. To draw on the widest range of ideas about physical science teaching strategies, the articles sampled and reviewed in this paper were drawn from an international journal entitled *Physics Education*. The work of physics educators from various countries, primarily the UK and the United States, are published in this journal. In this case, volume 35 of *Physics Education* was randomly selected from the most recent ten volumes (years) of the journal and it was examined for reports of successful strategies for teaching physical science concepts. What follows is a description and synthesis of the teaching strategy reports identified in this volume.

Review of the Literature

Eight articles clearly describing successful strategies for teaching physical science concepts were identified in the six issues of the selected volume of *Physics Education*. Reports dealing with instructional programs were excluded from this review, as were reports of proposed but untested teaching strategies. The physical science concepts described in the selected teaching strategy articles included the topics of electrical capacitance, variables effecting height and rebound time of a dropped ball, temperature and heat, effect of angle of incline “launch” on speed of a ball across a table, waveforms, wave vibrations, action of an electrical battery, electricity, and radioactive decay. One article described a teaching strategy for more than one concept. Seven teaching strategies described in the articles are pertinent to Illinois Learning Standard 12 C: “Know and apply concepts that describe properties of matter and energy and the interactions between them” (ISBE Science section). Two teaching strategies related to Illinois Learning Standard 12 D: “Know and apply concepts that describe force and motion and the principles that

The physcial science concepts described included the topics of electrical capacitance, variables effecting height and rebound time of a dropped ball, temperature and heat, effect of angle of incline "launch" on speed of a ball across a table, waveforms, wave vibrations, action of an electrical battery, electricity, and radioactive decay.

explain them" (ISBE, science section) are described in the articles. All but one of the articles describes teaching strategies supportive of Illinois Science State goal 11: "Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments, and solve problems" (ISBE, science section).

Here is a brief summary of the teaching strategies described in the articles selected from volume 35 of *Physics Education*.

1. Students build capacitors from aluminum foil and paper, measure capacitance with a multimeter, and investigate the effects of the size and spacing of the foil and paper components on capacitance (Swinscoe, 2000).

2. Using a microcomputer based simulation, students observe the effects of different variables on the rebound height and rebound time of a squash ball (Evans, 2000).

3. Through guiding questions posed by the teacher, and inquiry investigations with hot and cold water, ice, other materials, and thermometers, students develop and verbalize concepts about heat, temperature, and thermal equilibrium (Carlton, 2000).

4. Students make and test predictions concerning how the angle of incline of a launched ball will effect its travel time across a flat tabletop. Data are collected using digital stopwatches and summarized in graphical form (Lattery, 2000).

5. Students sketch waveforms for given equations and use graphing calculators to check the accuracy of their drawings. Waveforms are further observed and investigated by the students using springs, tuning forks, and hand bells (Raggett, 2000).

6. Students observe characteristics of wave patterns by placing vibrating tuning forks in front of computer monitor screens for enhanced visualization (Harrison, 2000).

7. An explanatory account or verbal model of the internal workings of a battery is presented to the students by the teacher (Scaife and Dove, 2000).

8. Each student is given a unique problem, called an individual work assignment. One of these assignments is an electricity problem where each student is to solve for a unique value such as current drawn by a light bulb or the cost of the electricity for operating a particular device. The second unique problem given to each student is based on a microcomputer simulation of radioactive decay (Evans, 2000).

Taken as a group, these reports of successful physical science teaching strategies appear to have some significant educational characteristics in common. Seven of the eight articles describe teaching strategies that engage students in using technological tools of science ranging from simple thermometers to microcomputers. Seven of the articles also report a teaching strategy wherein students are using scientific thinking processes such as observation, prediction, data collection, and graphing. In six of the eight articles reviewed, students are involved, at some point during instruction, in investigating natural phenomena directly or through computer simulation. In five of the articles reviewed, students are described as actually working with physical materials related to the concept or principle under investigation. Half of the reported teaching strategies suggest interaction among students as part of the teaching and learning process. Most strikingly, all of the teaching strategies reported in these articles appear to aim toward having students develop a working conceptual knowledge of the topic being studied so that they can express verbally what was learned, or demonstrate it mathematically.

While only a small sample of articles was selected for review and synthesis here, the present sample, nonetheless, represents the published work of experts in physics education over the period of one year. Without question one may argue the merits of a larger sample size than was used in this review. On the other hand, if this sample and review is viewed as the starting point, or snapshot, as it is intended to be, then useful information has been produced. A micro-sample such as this gives us a sense of literature while being economical from a time requirement standpoint.

Recommendations for Teachers

The eight articles selected here for review and synthesis have some notable characteristics in common that can inform us as educators in the development and implementation of successful teaching strategies for the physical sciences.

- From the reports reviewed, it appears that teaching physical science does not primarily involve lecturing to students about difficult to explain and understand ideas, nor does it necessarily involve mathematical computation. Rather the reports in the literature reviewed herein show physical science concepts and principles taught effectively through the active engagement of students with the phenomena. This hands-on / minds-on approach to teaching physical science is as applicable at the early elementary school level as it is at the late high school level.
- Successful teaching of physical science concepts and principles requires the use of physical materials in most cases. Concepts and principles can be effectively taught using common materials such as aluminum foil, paper, batteries, bulbs, wire, plastic tubs, rubber balls, glass jars, wood ramps, springs and tuning forks, and so forth, as described in the present studies.
- Measurement appears to be a critical part of successful physical science instruction. Strategies for teaching physical science concepts and principles should involve students in using devices such as rulers, clocks, scales, balances, cups, spoons, thermometers, graphing calculators, and computers as is grade level appropriate. Items such as these are the tools and technologies of science that are important for student to learn to use.
- Successful physical science teaching strategies engage students in investigation of phenomena. Whether testing predictions or making and recording observations of objects and events, student inquiry and investigation are common elements of teaching and learning physical science concepts and principles. Students should be encouraged to collaborate in their investigations.

- Finally, physical science teaching strategies should be aimed at having students portray, describe, explain, make predictions about, or complete computations related to the concept or principle being studied. At early elementary grades, students can model their

All of the teaching strategies reported in these articles appear to aim toward having students develop a working conceptual knowledge of the topic being studied so that they can express verbally what was learned, or demonstrate it mathematically.

understanding of a concept by drawing pictures, for example. At the late high school level, on the other hand, students might use a mathematical model or make predictions and test hypotheses to demonstrate conceptual understanding of a physical science concept or principle.

Summary

So how do we go about teaching the physical sciences? The prevailing theme here is getting students involved in asking questions and seeking answers about real world phenomena related to matter, force, energy, and motion and expressing findings. Use Internet resources, journal articles, and activity books for investigation ideas related to the learning standards. Have your classroom stocked with things that can be studied and measuring devices of all kinds. Don't feel bound to one textbook nor compelled to explain things to students. Better they tell you what they are finding. And once the students start investigating phenomena, the learning possibilities are endless.

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Literacy Infusion in a High School Environmental Science Curriculum

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Introduction

It is generally agreed that project-based, inquiry approaches to learning science allow students to develop scientific habits of mind through longer and deeper engagement with scientific ideas. When participating in inquiry science investigations, students learn to develop questions about interesting scientific phenomena, synthesize multiple sources of information into useful and usable data, and analyze data and communicate results to their teachers and peers. Through participation in inquiry science activities, students have opportunities to do more of the "work" of scientists instead of simply reading about scientific discoveries in traditional science textbooks (Rutherford, 1964; Loucks-Horsley & Olson, 2000). Inquiry science materials are now, more than ever before, adopted by local school districts for use in K-12 classrooms. Yet, many students come to science classrooms ill-prepared to participate in an important element of the practice of science, in general, and of science inquiry in particular, that is, reading and writing in science.

Inquiry science materials represent an opportunity for students to engage in science activities such as reading and analyzing primary texts (for example NASA public reports about global warming) and Internet charts and graphs (that is, hypertext and hypermedia), apply this information to investigations, and document and analyze their results. However, these materials, often written by science writers for highly literate audiences, are frequently inaccessible to students with poor reading and writing skills. How do teachers support students' reading and writing in science classrooms? How do teachers know what features of inquiry science materials should be modified in order to best serve the reading and writing skills of low readers and second language learners with poor academic language skills? How do teachers retain a focus on science concepts and scientific processes while helping students learn to be more deeply engaged with text?

Project-based, inquiry approaches to learning science allow students to develop scientific habits of mind through longer and deeper engagement with scientific ideas.

In this article we discuss an intensive collaboration between university researchers and three teachers, Borg, Dowling, and Evans, to design literacy supports, using reading-to-learn tools. We began by identifying and analyzing the elements of an inquiry-based, environmental science unit that would likely be problematic for readers with literacy challenges. We then developed literacy support tools that were integrated into the unit, and introduced the unit into twelve high school classrooms in the

Many urban students come to high school ill-prepared to tackle the sorts of reading and data analysis tasks that are required of inquiry science units.

2005-06 school year. We begin this article with a description of the curriculum and describe our basic approach to developing reading-to-learn skills in high school science. We then describe our curriculum design experience including our design decisions, and we elaborate on the integration of the reading-to-learn tools into the inquiry science curriculum. We briefly discuss our pilot activities, preliminary hypotheses, and early results. Finally, we reflect on the broader implications for the design of highly integrated literacy support materials and tools to support science inquiry.

The Investigations in Environmental Science Curriculum

Investigations in Environmental Science (IES), formerly piloted as Learning about the Environment (LaTE)[1], is a high school inquiry-based environmental science curriculum. It makes use of geographic visualization and data analysis tools (Edelson, 2005). Students, typically ninth graders, are invited to take on the role of environmental scientists. They are introduced to several problems that must be addressed through an environmental science decision-making model. For example, students are asked to find a location for a new Florida school. The location must take into account the amount of space the school will need, but must also consider the importance of protecting land and native species which live in, and near, the potential locations for the new school. The curriculum involves three distinct investigations, including a land use investigation unit, an energy use investigation unit (generation of electricity in four different regions of the United States), and a water use investigation unit.

Students learn about the importance of the intelligent use of land, energy and water in sustaining the environment. Students participate in activities that aim to develop their higher-order thinking skills. They analyze data and text-based information and learn how to use scientific evidence to support environmental decision-making. They read a variety of materials that will inform their decisions, and use computer tools for visualization and analysis of geographic data. They learn to synthesize information from several sources, accumulated over the course of the unit, and to make claims and provide evidence for their claims. Finally, students learn to communicate this information in useful ways to their peers. At the end of each unit, students must make recommendations for sustainable uses of resources.

The IES activities address authentic environmental issues and examine concerns that currently face the human population and that will face our students into their adult lives. The opportunity to read about and analyze data and text from a variety of sources is of great benefit to students. However, students must have good strategies in reading-to-learn (Feathers, 2004; Yore et al., 1997; Yore, 2000) in order to take full advantage of the units' activities (that is, decision-making, data analysis and synthesis, and communication) and to ensure their development of the conceptual underpinnings of environmental science. Many urban students come to high school ill-prepared to tackle the sorts of reading and data analysis tasks that are required of inquiry science units.

Curriculum Design, Reading-to-Learn Tool Integration in the IES, and Support of Science Learning

To paraphrase Block and Pressley (2002), we teach students to read because we want them to gain knowledge through texts. That is, we want students to comprehend what they read. In order to gain knowledge through texts, students must have a tool kit of resources available to them whenever they read. Adolescents benefit from explicit instruction in strategies to improve reading comprehension (Block & Pressley, 2002; Feathers, 2004; Gomez & Gomez, 2002).

In order to design a program in which we could effectively integrate reading-to-learn tools into high school science classrooms, we brought together three critical ingredients: an inquiry science curriculum that was text rich (IES), several ideas for support tools (annotation, double entry reading logs, summarization), and a collection of individuals with diverse expertise (high school science teachers and researchers).

We worked within a collaborative design structure called a *work circle*. A work circle brings together people with diverse expertise to design materials and to address challenging issues like reading in science. Our work circle consisted of five individuals: three high school science teachers with experience teaching inquiry science curricula and two researchers. Borg and Dowling had taught the IES curriculum for several years. Borg and Evans had worked with our research group the previous year piloting the Summary Street tool. In the past, all of them incorporated literacy support into their science teaching practice. For example, Borg encouraged students to document the words they did not know. Evans worked closely with the special education teacher in his school to support

Table 1. Excerpt from Teacher Chart: How tools are integrated into the unit

Lesson	Length	Main Concept Question and Answer	Literacy Support Tool	Other Suggestions
New School 1a: Overcrowded?	3 paragraphs	**What is the environmental problemidentified in the letter?** Overpopulation and the resulting competition for resources.	**DEJ (Double-Entry Journal)** - what is the problem/what does it have to do with the environment **DEJ** - vocabulary	The DEJ template for this lesson is in the teacher binder.
Populations 4a: Reindeer on St. Matthew Island	6 paragraphs with map, picture, graph	**What are factors that limit the population?** Availablity of food and water, shelter, availability of a place to give birth, predators	**DEJ** - Main idea/supporting idea <u>Summary Street</u>	Comparing human carrying capacity to this graph, Where are we on that graph?
Resources 1d: Arable Land	3 paragraphs, one map	**How much of our land is ecologically productive?** Only a small percentage of our land can be used to grow crops.	**DEJ** - Main arguments/supporting evidence	Help kids with vocabulary and concepts.

We teach students to read because we want them to gain knowledge through texts.

students' science text reading. Dowling, with her honors students, sought to provide challenging texts for students to read. The two researchers brought curricular design and literacy expertise, as well as literacy infusion in science experience to the group. We met monthly in full-day meetings for six months, crafting the program and discussing challenges and hopes. After the six month work circle period, Borg, Sherrer, and Gomez developed an on-going professional development component for other teachers.

The IES curriculum involves extensive reading, and much of the text is difficult for ninth grade urban science students. This made it the perfect curriculum around which to build a reading-to-learn program. Over time, the work circle collaborated on two critical tasks—they identified ways to support pilot classroom teachers in the use of these reading-to-learn tools and they carefully structured the unit so that the reading support was closely woven into important science concepts. Table 1 illustrates our organization guide for pilot teachers so that they can easily follow the integration of the literacy support tools in the IES unit.

The support structures for the pilot teachers took various forms. First, we created annotation templates for each important IES text. These templates would act as a guide (not answer key) for the pilot teachers as they taught students active reading skills. Second, we closely connected each reading task to the science content. Borg, Dowling, and Evans identified a main concept for each lesson. This list of concepts acts as a key for the pilot teachers to use to build a concept map for each chapter, as well as for the entire unit. This concept map ties the day-to-day work into the bigger picture of the chapter and the unit. Finally, we developed explicit strategies and processes that students learn to use to understand the text—tools that we present below. Each of these tools addresses a reading-to-learn skill and can also be used for peer editing and peer assessment. Each is designed to provide teachers with concrete and quick feedback about how well students have read the science text and their conceptual understanding of the science issues addressed in the text.

Reading-to-Learn Support Tools

Annotation

Annotated texts are readings that have been subjected to content analysis. Texts often contain an explicit or implicit hypotheses, claims, evidence, inferences, predictions, and evaluations, all of which are critical science skills that the Illinois Literacy Standards identify as necessary for ninth and tenth grade science learning. However, this information is not always explicitly pointed out in the text. Text annotation makes the author's message more explicit. Teachers can use annotated texts to scaffold readings for their students. They also can use annotation as a tool that students learn to use themselves while actively reading.

First, students are asked to quickly skim the text. As they are skimming they are to make note of the headings and subheadings in the text. Next, students are asked to annotate (by marking on the text) one or more of the following items:

- Titles
- Headings
- Subheadings
- Main Argument
- Evidence/Supporting Ideas
- Transition Words
- Difficult Vocabulary Words
- Difficult Sentence Construction

Students are usually asked to use a standard format for annotating, for example, circle headings, underline main arguments, double underline evidence/supporting ideas, triangle difficult vocabulary words, and write the letters "SC" over sentences with difficult sentence construction. Students then review their annotations with the teacher or as a peer editing activity.

Table 2. Sample Double-Entry Reflection Logs

Argument/Evidence Double Entry Journal

Please write the main arguments you find while you're reading on the LEFT side of the page and write evidence to support those arguments on the RIGHT side of the page.

Main arguments from the article	**Evidence from the article to support each main argument**
1) St. Matthew Island could easily support 1600-2300 reindeer. 2) The population of reindeer got out of control fast. So fast that it almost caused them their extinction.	1) The biologists believed that the carrying capacity was 1600-2300 reindeers. Biologists still believe that if they bring the reindeer they would thrive. Their estimated capacity includes the factors of enough food, shelter, areas of giving birth, and kind predators. 2) By 1963 the population grew to 6000. Between the years of 1963 and 1966, the population kept on growing causing the exhaustion of food resources on the island. This caused starvation and only 42 survived.

Vocabulary Double Entry Journal

While you're reading, please write the vocabulary word or words you find hard to understand on the LEFT side of the page. Then write what you think the work means on the RIGHT side of the page.

Hard to understand vocabulary words from the article	**What I think each word means**
thrive	will be able to live
degrading	producing, increase
abundance	decrease of ...
availablity	availability, can do something

Double-Entry Reading Logs

Double-entry reading logs are reader-response materials that provide a structure for students to monitor and document their understanding of science texts. They are an opportunity for students to actively read and reflect on their reading. The variety of double entry reading log structures allows teachers to focus student reading on a particular idea or skill (vocabulary, main ideas with supporting ideas, and so forth). Table 2 provides two examples of double-entry reflection logs. In the first example, students are asked to write the main argument and the supporting ideas. The student in this example identified what he believed was the main argument from the article and listed two supporting ideas. In the second double-entry log, a student was asked to identify all the vocabulary words in the text that were difficult or unknown to him. In the second half of the log, the student was asked to write his definition based on his prior knowledge and the context of the article. The student's definitions suggest that he needs further support if he is to develop a firm grasp of the concepts in the article and in the larger curriculum (as these words appear in several other texts in the unit).

Summary

Effective summarization is an important skill in science inquiry. In summarizing, students must comprehend the text, identify main ideas, differentiate secondary ideas, and condense the information in a succinct and logical way. In our reading-to-learn approach in science, we give students opportunities to summarize the IES text in two ways: first, through teacher-guided summarization skill development, and second, through the use of the Summary Street tool.

We have integrated materials into the IES which provide explicit guidance to science teachers about how to help students write good summaries (see table 3). The guidelines give students an opportunity to craft a summary with support from their teacher and their peers. This whole class guided activity can be repeated as often as is needed to help students grow confident in capturing and reporting, through summary, the gist of a science text.

The Summary Street[2] tool is a web-based tool that supports student summarization by giving feedback on content, spelling, redundancies, and irrelevancies. Summary Street allows students to get instant and private feedback on their work. Student engagement with the tool provides teachers with the opportunity for one-on-one interaction with students (Kintsch et al., 2000).

How the Tools can be Used

The reading-to-learn tools are designed to be used individually or in combination. For

Table 3. Summary Writing Steps

Activity	Classroom formation	Tools needed
Brainstorm with class elements of a good summary	Whole class	Chalk board
Show them the list of what Summary Street thinks a good summary has	Whole class	Summary Street's list of elements of a good summary
Synthesize these elements with what they have done in the past for other teachers	Whole class	Information from other teachers
Pass out article	Whole class	Paper copy of article for each student
Do some pre-reading: read titles, subtitles, make predictions about what the article will be about	Whole class	
Read the first paragraph together	Whole class	
Have each child, independently, identify the main idea in the first papagraph	Whole class	
Discuss as a class	Whole class	

example, a teacher may begin by asking students to annotate a lesson on gopher tortoises and their preservation and later in the class period ask the students to complete a *vocabulary* double-entry log about the text. Similarly, a teacher may ask the students to complete an *argument and evidence* double-entry log about an IES article, assign students to write a draft summary for homework, and then ask students to revise their summary using Summary Street the next day. The combination of reading-to-learn activities allows teachers to quickly understand what students have learned about the content and what might need to be reviewed before delving into more complex ideas in the unit.

Current Pilot Activities

We have begun piloting the literacy support tools in twelve ninth grade science classrooms at a large public high school in Chicago. We are observing how three science teachers guide their students in annotation activities, the use of double-entry reading logs, and summarization. We are particularly interested in learning more about the relationship between the literacy support tools. For example, when students highlight the main idea, evidence, and challenging vocabulary, as they annotate their IES article, do they write better summaries? When students use the main idea/evidence double-entry reading logs, do these logs help students write better summaries about the same article? Are all three tools essential to supporting students in science? Do some combinations help students learn more effectively than others?

Very early results suggest that the literacy support tools are helping students, especially struggling readers, become more conscious of what they are reading, and their teachers believe that they are beginning to learn to read science text more purposefully. For example, recently during a visit to a pilot classroom we saw students use Summary Street while constantly referring to their annotations of an IES article. When we asked students about this activity several said that underlining (marking up) the main argument and supporting ideas helped them plan their summaries better. On another occasion we saw students using their double-entry journals to hand-write summaries. Again, when we asked the students they indicated that the double entry journals helped them see and remember the main ideas. The pilot teachers agree.

At the end of the year, we hope to see gains on post-tests in science that show students' environmental science knowledge. We also hope to see improved responses to the end-of-the-chapter analysis questions (questions that query students about what they have learned in each lesson) and increasingly high-quality reading and writing associated with the IES decision-making activities during the year. Furthermore, during the monthly professional development sessions, the pilot teachers share with researchers and peers what components work well and identify areas in which they need more support and the development team needs to articulate and strengthen further.

Concluding Thoughts

In order for students to be successful in high school science, they need to have the skills to read scientific text. Classroom teachers can form work circles within and across grade levels to identify the challenging reading-in-science elements in curricular materials. Teachers can infuse various literacy supports, including those we described in this article, into their daily classroom practice. Teachers often worry that there is barely enough time for science learning without the addition of reading activities. Our collaborative work circle group has taken this challenge to heart. We believe that when students learn to read more effectively, they will learn science more deeply. Thus, less time must be spent on reiterating concepts that students should have learned days or weeks before. Developing students' reading-to-learn skills in content areas like science is a win for teachers and students alike.

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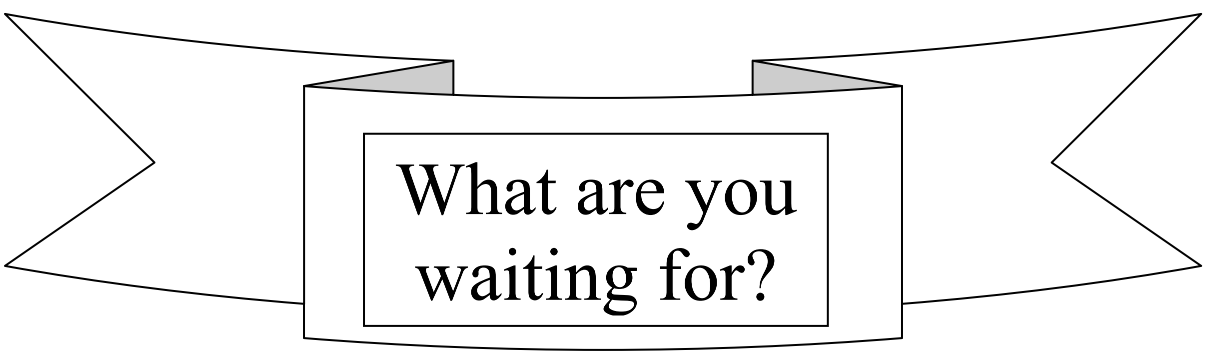
Endnotes

1) http://www.worldwatcher.northwestern.edu/late/LATEpublicpage/Index.html

2) http:lsa.colorado.edu/summarystreet/, also http://lsa.colorado.edu/summarize

3) Williams is the former surname of K. Gomez.

K. Gomez can be reached at kimwillg@uic.edu



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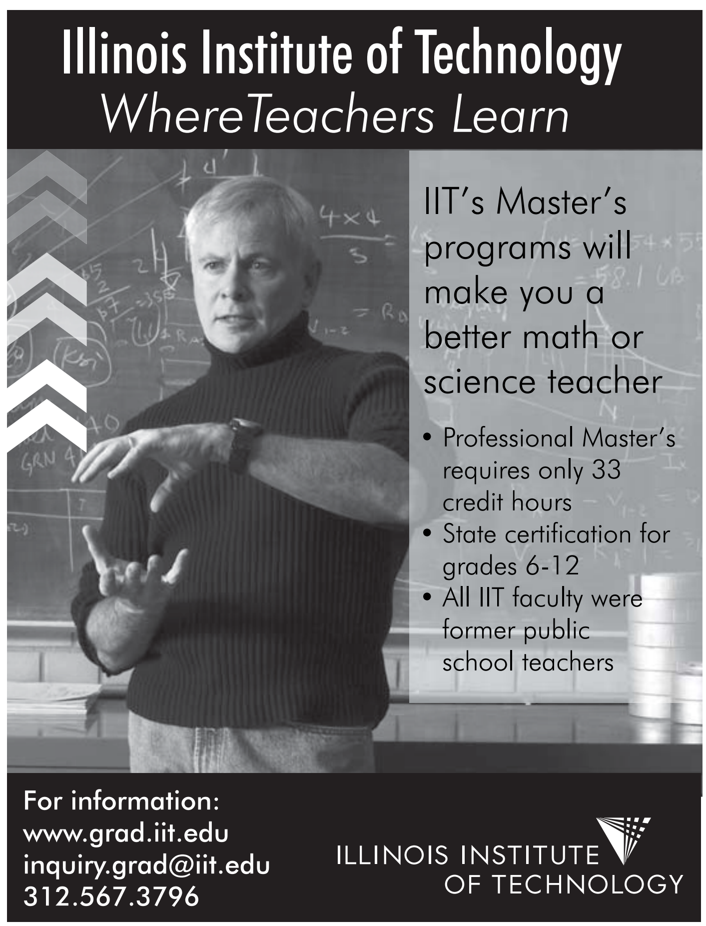

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No Costs: Supported by grant from the U.S. Department of Education – Funds for the Improvement of Education, the online resources and workshops are offered at no charge to Illinois educators.

http://21cif.imsa.edu

IMSA®

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

Illinois Science Teachers Association

ISTA

www.ista-il.org

NSTA Midwestern Area Conference

ISTA past president Marylin Lisowski enjoys the conference with other science educators.

Diana Dummitt, conference chair, with Illinois colleagues Doug Dirks, Edee Wiziecki, and Carl Koch at the NSTA Midwestern Area Conference.

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