

SPECTRUM

Winter 2008, Vol. 33, No. 3

ista

The Journal of the Illinois Science Teachers Association

In this Issue:

Teachers for Tanzania
Cool Communities
Science Parking Lot
Roombas!



Plan Ahead:

Science in the South - March 7, 2008

ISTA Conference 2008 - November 13-15, 2008

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Spectrum

The Journal of the Illinois Science Teachers Association
Volume 33, Number 3

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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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Cover photos courtesy of Donna Engel. See article "Teachers for Tanzania: Sharing Passion for Science Education" on pages 14-16. Starting top left and going clockwise:

Salome Lally (Kimandolu Secondary School), and Donna Engel with their electric chair; Donna Engel with Mwangaza guards Bonifas and Kennedy reading storybooks to practice their English skills; Teachers for Tanzania Alexa Schlosser, Laurie Tessmer, Donna Engel (Minooka Community High School) attending a football match with students from Ilburo Secondary School Arusha, Tanzania; Tanzanian classroom.

The Illinois Science Teachers Association recognizes and strongly promotes the importance of safety in the classroom. However, the ultimate responsibility to follow established safety practices and guidelines rests with the individual teacher.

The views expressed by authors are not necessarily those of ISTA, the ISTA Board, or the *Spectrum*.

The *Spectrum* is printed on recycled/recyclable paper

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The Journal of the Illinois Science Teachers Association

Winter 2008

Volume 33, Number 3

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President's Corner

Jill Carter

Pekin Community High School



Greetings Fellow Science Teachers!

I'd like to take this opportunity to publicly thank someone who has done a tremendous amount of "behind the scenes" work for the benefit of ISTA over the past few years. Dr. Raymond Dagenais agreed to take on the role of executive director when Diana Dummitt announced her departure from her role with ISTA early in 2005. During this time Ray was also president of the organization. Ray has done a fabulous job coordinating our annual conferences, organizing our board meetings, corresponding with countless individuals, attending functions as the official representative of our organization, and many day-to-day duties too numerous to mention here. Thank you, Ray. We all appreciate your tireless efforts! Ray is currently serving ISTA in his role as past president and is in charge of our annual elections.

I'd also like to thank Carl Koch, ISTA treasurer. Carl has kept the books, written the checks, and taken care of other financial matters for us. Carl has chosen to "retire" from our organization. He, too, has done a great job for ISTA. Thank you!

We will miss you both.

Please welcome Harry Hendrickson as our new executive director. Many of you know Harry from his past employment with the Department of Natural Resources. Harry brings many great ideas to our organization. Our new treasurer is Dr. Bob Carter. Bob is an environmental education instructor at Northern Illinois University. We're thrilled to have both of you on board!

Jill

Jill presents Steve Kolsto, from the Illinois Environmental Protection Agency, a plaque expressing ISTA's thanks and gratitude. They offer grants of up to \$500 through the Education Assistance Program (LEAP). The grants provide funding for lake/lake watershed related educational field trips, equipment, and activities. Steve accepted this award on behalf of IEPA Director Doug Scott.



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ISTA Thanks

Andrew Apicella for his service to ISTA as vice president this past year.
Donna Engel for agreeing to complete the 07-09 vice president term.
Carl Koch for serving as ISTA treasurer these past many years.
Bob Carter for agreeing to take over the responsibilities of ISTA treasurer.
Ray Dagenais for serving as executive director for the past three years.
Harry Hendrickson for taking on the role of executive director

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WRITE FOR THE SPECTRUM!

This issue of the *Spectrum* is packed with lots of tips, ideas, and great information for science educators at every level.

You don't have to ... travel to Tanzania to assist fellow educators.

You don't have to ... be an elementary or middle school teacher to enjoy the books that Jean Mendoza reviews for us.

You don't have to ... vacuum to get the messages that Roomba lends us about education.

Your don't have to ... drive to use the Science Parking Lot

Please write for the *Spectrum*. You have wonderful ideas, curriculum, a new spin on teaching a tough concept, and much more to share with your veteran colleagues and especially our new science educators. The *Spectrum* has plenty of options for you, whether it is through a short tip in Teacher-to-Teacher or an entire article. Send your contributions to (me) Judy Scheppler (quella@imsa.edu) or to one of our focus editors. (Their information is found on page 32.)

<p>ISTA</p> <p>Thanks</p> <p>Dr. Raymond Dagenals</p> <p>for</p> <p>Serving as ISTA Executive Director</p> <p>Helping to Ensure ISTA's Financial Health</p> <p>Encouraging the Growth and Development of the Spectrum</p> <p>Inviting and Encouraging Greater Participation from Members</p>	<p>ISTA</p> <p>Thanks</p> <p>Carl Koch</p> <p>for</p> <p>Serving as ISTA Treasurer</p> <p>Streamlining Budget Documentation</p> <p>Being a Steward of ISTA Financial Investments</p> <p>Serving as Liaison Between ISTA and Auditors and Vendors</p>
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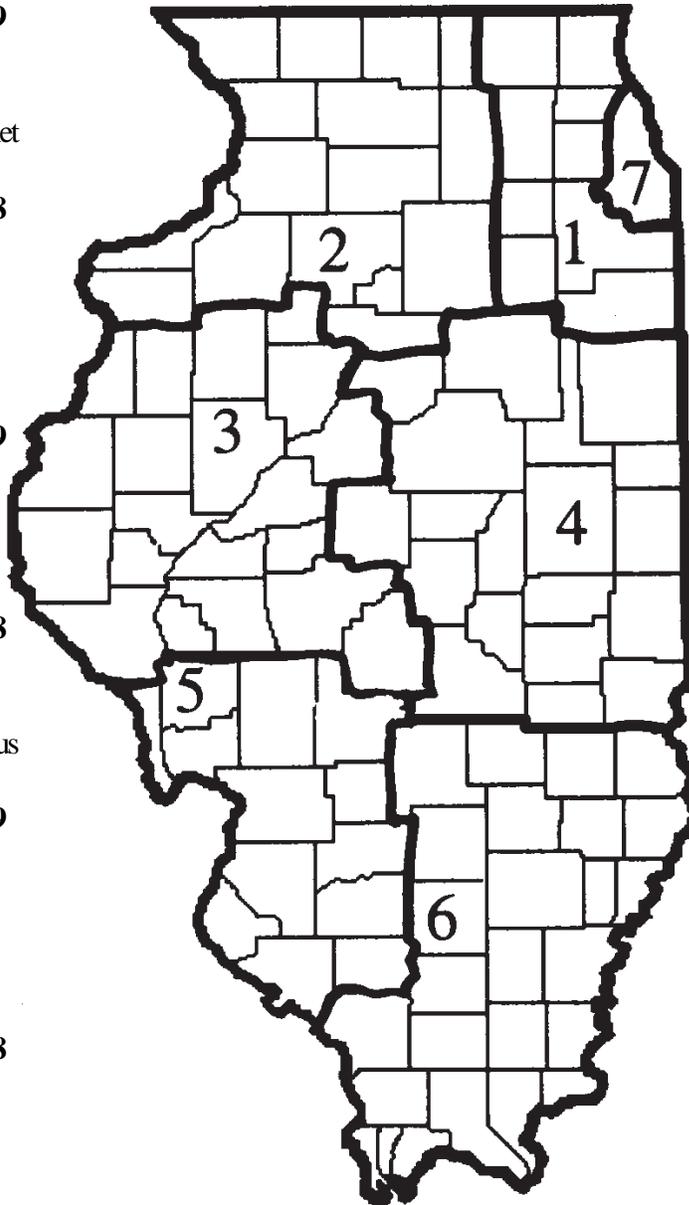
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<http://www.ista-il.org/>

Illinois Science Teachers Association

2008 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

- Elementary Level
- Middle Level
- Secondary Level
- Community College
- College/University
- Industry/Business/
Government
- Other _____

- Elementary Sciences
- Life Science/Biology
- Physical Sciences
- Environmental Science
- Earth Science/Geology
- Chemistry
- Physics
- General Science
- Integrated Science
- Other _____

- Teacher
- Administrator
- Coordinator
- Librarian
- Student
- Retired

Send form and check or money order, made payable to Illinois Science Teachers Association, to: Sherry Duncan (email: sjduncan@insightbb.com), ISTA Membership, PO Box 295, Urbana, IL 61801.

Membership Option (see below) _____ FFSE Membership Yes/No _____ Amount Enclosed _____

ISTA Membership Categories

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

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

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

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

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

Fermilab Friends for Science Education (FFSE): Thanks to an ISTA-FFSE board agreement, for Options 1, 4, and 5, teachers may receive a regular \$10 membership in the FFSE for an additional \$4. See <http://ed.fnal.gov/ffse/> for membership details.

ISTA / ExxonMobil Outstanding Teacher of Science Awards Program

The Illinois Science Teachers Association with the generous support of ExxonMobil announces the 2007 - 2008 ISTA / ExxonMobil Outstanding Teacher of Science Awards Program. Applications will be accepted 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 which enriches and extends beyond the school day.

The 2007 – 2008 program consists of seven one thousand dollar prizes. One \$1000 award will be presented to one K – 8 teacher of science from each of the seven ISTA regions in the state of Illinois.

The awards are intended to recognize “extraordinary accomplishment” in the field of science teaching. Applicants must provide evidence that demonstrates accomplishments that go beyond normal classroom teaching.

Criteria for consideration include:

1. Current ISTA membership
2. Full time teaching assignment
3. Teaching assignment in the ISTA Region for which application is submitted
4. Written narrative (maximum of 500 words) describing the teacher’s “extraordinary accomplishments” in the field of science teaching
5. Evidence that supports the teacher’s description of “extraordinary accomplishments” in the field of science teaching
6. Two letters of support from individuals who can attest to the impact of the “extraordinary accomplishments” in the field of science teaching
7. A completed application form with required supplementary materials submitted by March 1, 2008 to:

Dr. Sher Rockway
ISTA Awards Chair
34136 N. Lavender Circle
Grayslake, IL 60030

**Winners will be notified by April 15, 2008.
For more information contact Dr. Rockway at
sher_rockway@comcast.net.**

2007-2008 ISTA/ExxonMobil Outstanding Teacher of Science
Awards Application Form
Application Due Date March 1, 2008

ISTA Region: _____

Name: _____

Position (grade and subject taught): _____

School Name/Address: _____

School Phone Number: _____

Email address: _____

Home Address: _____

Home Phone Number: _____

I hold 2008 calendar year membership in ISTA: _____

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

Signed: _____ **Date:** _____

(Applicant)

Cool Communities Working Together with Science Teachers

ISTA has been invited to organize a special opportunity for members of our organization to implement class projects that partner with your local municipalities during the spring and early summer of 2008. The East Richland School District in Olney is expanding its Mathematics and Science Partnership to allow for mini-grants that provide seed money to address challenges that face Illinois communities with their students and community leaders. ISTA is partnering with the Illinois Municipal League to emphasize how our members are vital community members and the impact of working together will powerfully affect our Cool Communities. By the time you receive this issue of the Spectrum, all details for the mini-grant program will be posted on the ISTA web page (<http://www.ista-il.org>). We are posting reference materials and possible sources of expertise and ideas for your applications to receive funding up to \$500 for community environmental research, action plans, and implementation.

Inspiration for Projects

- *Is there a climate change community issue that can provide the setting for you and your students and your local community to work together to resolve?* You don't need to have the Arctic ice cap in your back yard! You can consider any facet of these seven global issues: energy, waste reduction, urban design, nature, transportation, environmental health, or water, as described in the introduction to the San Francisco Urban Environmental Accords, United Nations Environment Program, World Environment Day, June 5, 2005. <http://wed2005.org/pdfs/Accords.pdf>.
- *Is our community a Coolcities member? Has our mayor signed the U.S. Mayors Climate Protection Agreement? Would this be a Cool challenge?* (See: Coolcities: Solving Global Warming One City at a Time, Sierra Club, <http://www.coolcities.us> and/or U.S. Congress of Mayors, U.S. Mayors Climate Protection Agreement, http://www.usmayors.org/uscm/resolutions/73rd_conference/env_04.asp; Newsweek, April 16, 2007 issue.)
- *Could we take on the Fairchild Challenge?* The Chicago Botanic Garden in Glencoe, Illinois is organizing a series of ten contests including events for T-shirt design, recycled artwork, a poetry slam, picture book design, photojournalism, civic engagement, and so forth, all focusing on a variety of Illinois-specific ideas. At this point, the competition is designed for high school groups, but there are allowances for elementary or middle school possibilities. You can find out more by contacting Tree Sturman (tsturman@chicagobotanic.org or phone: 847/835-8343).
- *What is our school's carbon footprint and what might we do to reduce it?*
- *How can our community become more aware of its greening/cooling responsibilities?*
- *What about organizing a Lights Out Campaign, already happening in many US cities? Or a Household Hazardous Waste Pick-up?*
- *Can we address the challenges of greenwashing—questioning the environmental-friendly claims on common products?*

Timeline

February 15:	Applications due (postmarked by February 15)
February 28:	Notification of selection; Project work begins immediately
July 15:	End date for all projects

You can access application instructions on the web at <http://www.ista-il.org>. Your application must include a letter of commitment from your local community partner and your application (within a maximum of two pages) should address:

- your choice of community issue,
- how the investigation will be accomplished,
- the prescribed timeline,
- the direct connection to your standards-based curriculum,
- the assignment of responsibilities,
- projected expenses and explain their justification,
- the possibilities for local media coverage.

Submit five copies of your application, postmarked by February 15, to ISTA Executive Director Harry Hendrickson, 218 Cumberland Drive, Rochester, IL 62563.

ISTA expects to be able to fund up to thirty projects, hoping for a wide geographic distribution of selected projects. We think that the competition will be high. We hope to pursue possibilities for sustaining this project over time, based on your interest levels. Project proposals that will receive the highest priority will incorporate the following components:

- A strong link between student and community leaders investigating community environmental issues.
- A creative and focused plan that can be accomplished in the established time frame. Projects that propose possible longer-term sequencing or stages are encouraged.
- Alignment of the authentic student investigations to the Illinois Learning Standards, possibly extending current curriculum beyond the classroom.
- Commitment from local community or municipality for matching funding or in-kind services.
- The budget request is based on the “best bang for the buck!” This includes consideration for the anticipated number of students who will be involved.
- Local media coverage is incorporated into the design.

We look forward to this chance for statewide action - thinking globally, acting locally. For further information contact Harry, email: hhendrickson@insightbb.com or phone: 217-498-8411.

Eco-Competition for Illinois High Schools The Fairchild Challenge at the Chicago Botanic Garden

We are entering a new environmental era in which science must recruit the fields of economics, sociology, psychology, literature, art, education, and communications to address the critical issues of our, or any, time. The urgency of global crises like climate change underscores the indispensability of a society that is literate in both science and culture. At the Chicago Botanic Garden, we believe that scientific learning is rooted in critical thinking, engagement, and open discourse. To that end, the Chicago Botanic Garden offers the Fairchild Challenge, an innovative outreach program that empowers high school students to exercise their imaginations and voices on behalf of the environment.

In his book *Beyond Ecophobia*, author David Sobel addresses a common fear: that the environment is too complex to consider and therefore impossible to change. The Fairchild Challenge confronts this fear, by providing ten meaningful and achievable ways for teachers and young people to engage with environmental issues and work toward change. At the onset of every school year, the Chicago Botanic Garden presents high schools with ten multidisciplinary challenges. To participate in the Challenge, a team of teachers from at least two disciplines must first submit a registration form indicating their school’s interest in the program. Students must then work as teams or as individuals to fulfill the requirements of each project they elect to undertake.

At the time of this article, twenty-nine high schools have taken on the Challenge to design tee shirts, plan an eco-event, design billboards, perform at an environmentally-themed poetry slam, craft children's stories, rock the eco-vote, design Earth-friendly classrooms, photograph their neighborhoods, and volunteer at environmental organizations. When due dates arrive (March and April 2008), participating schools select and submit their best projects from each category to the Garden. Teams of professionals within the appropriate fields of expertise then evaluate these projects. Through this process, every entry will earn points for the school and for the students involved in creating each submission. Points are tallied and on May 4th, during a springtime ceremony at the Chicago Botanic Garden, prizes will be awarded to schools as well as to individual students for their efforts and achievements. For those who thrive on competition, the Challenge offers significant prizes. However, no one leaves the Garden without recognition and a sense of accomplishment.

The Chicago Botanic Garden celebrates the Fairchild Challenge's unique capacity to serve a diverse array of teachers and students. Diane Lebyrk, a science teacher in the Chicago Public Schools, endorses the program: "I enjoyed the process and satisfaction of knowing that my students gained a better understanding of our environment. I would highly recommend any teacher to give the Challenge a try this year. I know that I will be on board again!" Says one of her students: "The Fairchild Challenge has taught me to reach out within myself. ... I personally want to get into environmental science. [The Challenge] allows me to learn more about it." The program also appeals to students of the humanities. A junior from Lake Forest High School reports: "This was just a great experience for me. I've been writing poems for years. ... This is the first time I've ever performed, and it was such a rush ... I've never felt anything like it." Art students should consider the feedback from another student who said that "... it was great to be able to use graphic design to convey a message, especially an important one like environmental sustainability. Whether you're artistically inclined or talented, or if you're good at writing, or journalism, or interviewing, it's a great way to get involved and use your talent for good."



The Chicago Botanic Garden makes every effort to enable participation by any school regardless of their resources, expertise, or geographic location. The Garden also offers supply scholarships, in-school workshops, transportation stipends, and personal attention to questions, concerns, and special needs. The Illinois Science Teachers Association encourages schools interested in participating in the Challenge to apply for up to \$500 from the Cool Communities mini-grant program. For more information, please contact Harry Hendrickson at hhendrickson@insighbb.com. There is still time to sign up and participate in the 2008 program! Teachers interested in learning more about the Fairchild Challenge should visit the Garden's website: www.chicagobotanic.org/fairchildchallenge or contact Tree Sturman at 847-835-8343 or tsturman@chicagobotanic.org.

The Fairchild Challenge program was designed and initiated in 2002 by Fairchild Tropical Botanic Garden in Coral Gables-Miami, Florida, which continues to support expansion sites in the United States and internationally. The 2007-2008 Fairchild Challenge at the Chicago Botanic Garden is presented by National City.

Updates From President-Elect Gwen Pollock

NSTA Board of Directors

I am constantly being amazed by the unbelievable quality, sincere dedication, and sheer quantity of resources that are being shared through NSTA. At this point, I want to draw your attention to just a couple of resources that might be particularly pertinent to you. You may want to study a new position paper on the Liability of Science Educators for Laboratory Safety (<http://www.nsta.org/about/positions/liability.aspx>). You may want to share this particular position statement among your colleagues and administration for some very important conversations. NSTA offers a new and wide range of opportunities for science educators at all levels through the NSTA Learning Center—you need to check into the new Science Objects and Science Packs. I attended the celebration for the Toyota TAPESTRY grant recipients and was completely WOWed. The application material is found at <http://ecommerce2.nsta.org/toyota/> and is due on January 28, 2008. I am also learning about the leadership opportunities for you, the real experts, to become active at the national level for committees, task forces, and elected positions.

Illinois State Board of Education

I have to share about the wonderful work that has been achieved through the Mathematics and Science Partnerships grant program from ISBE. This grant program is a part of NCLB and has provided an unbelievable set of professional development opportunities for over 1000 K-12 teachers in the state for the past four years. I can't even begin to innumerate the diversity of settings—from nanotechnology clean rooms, to barges on the Mississippi, to the logistical inner-workings of Caterpillar and Walgreens, to observatories in Japan, with advanced technologies with direct connection to classroom calculators, GPS units, and biotechnology. Teachers have been studying and researching and testing themselves to become better and better and help their students achieve more effectively. Colleges and universities, regional offices of education, school districts, and others have been partnering in meaningful settings to expand our horizons for the math and science of our futures. I am in awe.

We have now begun an even deeper set of opportunities for teachers to complete graduate degrees with specific endorsements in the sciences and mathematics in twenty-four new partnerships. More information about the school recruitment phase for these partnerships is found at: http://www.isbe.net/curriculum/math_science/School_Recruit_rfp.htm. Please contact me about your interest in these programs; some of the cohorts have already been filled, but many places are still open. The alphabetical listing for the partnerships follows:

- Aurora University leaders will focus on four programs including an elementary mathematics, and science program and three separate, but interconnecting, secondary programs for mathematics and biology at the Aurora campus in northern Illinois, as well as a program focusing on Earth/space sciences with colleagues at George Williams College and Yerkes Observatory.
- Bradley University in Peoria will focus on a new elementary mathematics and science program and a new environmental sciences program.
- DePaul University in Chicago will create a new middle school mathematics program, along with a new environmental science program.
- Illinois Institute of Technology in Chicago will create a new physics education masters degree program with special attention to middle school teachers.
- Illinois State University in Normal will work on four new partnerships. New interconnecting programs are being planned in elementary mathematics and science, industrial technology and pre-engineering, chemistry, and secondary mathematics.
- Loyola University in Chicago will focus on Earth/space sciences, mathematics, and chemistry programs.
- Northern Illinois University in DeKalb will begin work on secondary biology, secondary mathematics and industrial technology/ pre-engineering programs.
- Southern Illinois University in Carbondale adds a new program for elementary mathematics and science teachers. They are also focusing on a special program for teachers in the health science technologies.
- Southern Illinois University in Edwardsville will create a secondary mathematics program.
- The University of Illinois in Champaign will begin work on two new programs; one will be in physics education with a focus on the twenty-first century critical technologies and the second will focus on the needs of elementary mathematics and science teaching and learning.

In closing, the plans for 2009, as the Year of Science—the two hundredth anniversary of the birth of Lincoln and Darwin, the one hundred and fiftieth anniversary of the creation of the National Academy of Science, and the four hundredth anniversary of the astronomical telescope - present some extraordinary chances for the focus on teaching science, especially in Illinois. Best wishes for the New Year.

2007 ISTA Conference Vendors

American Association for Lab Animal Science of Chicago
Bedford, Freeman and Worth Publishing
Bio-Rad Laboratories
Camp Invention
Carolina Biological Supply Company
CPO Science
Delta Education/FOSS
Eastern Illinois University-College of Science
Energy Concepts, Inc.
Environmental Education Association of Illinois
Explore Learning
Fermi National Accelerator Laboratory
Fisher Science Education-Fisher Scientific
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Texas Instruments
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University of Illinois at Urbana-Champaign Engineering Council
Vernier Software and Technology
Wilderness Classroom Organization

2007 Conference Thank You's

J. Patrick McGinn - ExxonMobil

The Illinois Science Teachers Association wishes to extend its deepest gratitude to J. Patrick McGinn and ExxonMobil for their generous support of science education in Illinois. This year, Patrick was our keynote speaker at our annual conference on science education, presenting "The Future of Energy: What Will Your Students Drive in Twenty-Five Years?" Patrick has relocated to Texas as of early January 20068. ISTA wishes him nothing but the best in his future endeavors.

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VWR Education

ISELA Pre-Conference

This year's pre-conference workshop was Designing for Science. ISELA and Gerry Munley did a terrific job of lining up speakers that gave all participants usable ideas and resources for science teaching and learning.

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Randal Musch
Gwen Pollock
Linda Shadwick
Troy Simpson
Donald Terasaki
Amanda Ward

Thanks to All!

**Our sincere
apology if we
have missed
your name.**

Teachers for Tanzania: Sharing Passion for Science Education

Donna Engel
Minooka Community High School

Can you imagine a classroom where the windows are gaping holes and the outdoor elements are felt each day? Can you imagine a classroom where girls sit upon rocks as they are considered second-class citizens and unworthy of whatever chairs are in the room? Can you imagine a classroom without necessities like paper, pencils, books, maps, electricity, or supplies? Can you imagine a classroom where teachers are orators passing down limited knowledge of their subject area and legend is blended with knowledge?

All of this is probably more than any of us can imagine. To the thirty-six million people living in Tanzania this is reality, not imagination. Tanzania currently is experiencing an educational famine. Due to insufficient training, lack of funds, and years of economic constraints, Tanzania ranks lowest worldwide in its ability to educate its children. There is a shortage of schools, books, supplies, and trained teachers. Most teachers have little more than a junior college degree.

A dream began in 1995 to form global partnerships with American teachers willing to share their expertise and having a desire to reach across an ocean to help peers. First, teachers participate in an online program with teachers in Tanzania developing specific lesson plans and attending training in the Tanzanian school system. Then, they travel to Tanzania where they model best practices and collaborate with local teachers to train teachers throughout Tanzania. Some of the teachers coming to the training will have traveled over one hundred miles on foot to reach the center.

Last summer I, along with two of my colleagues, had the privilege to travel to Arusha, Tanzania to work collaboratively with science teachers developing lesson plans and teaching pedagogy to fifty-four biology and chemistry teachers working in the Evangelical Lutheran Church of Tanzania (ELCT) schools in Tanzania through Mwangaza, a joint partnership of Evangelical Lutheran Church of America (ELCA) synods in the United States and ELCT synods in Tanzania.

It is hard to capture the essence of the program and the warmth of the people on paper. Perhaps the first words I received from my online partner sums it up. They were, "You are most warmly welcomed to my home." My partner, Salome Lally, has been teaching for nine years. She teaches all levels of chemistry and is a matron at her school in Tanzania. She has two children. We are both working mothers.

Her enthusiasm for our project came through from the moment I clicked on her first message. My messages to her were filled with questions about conditions in her school and her classroom. Salome has fifty students in her classroom (double the maximum capacity for safe laboratory conditions), no overhead projector, one textbook for every six students, no Internet access, no fax machine, and limited lab supplies. She does have a degree in education but not a major in chemistry.

Questions swirled through my head each time I typed more information for her. Will she have the copper wire necessary to do the lab? Does she understand the activity series I just sent her? Am I overwhelming her with my resources?

As I typed from the comfort of my home, Salome had to go to an Internet café each day, a quarter of an hour from her home to receive my messages. Once again, I am reminded how richly blessed I am, and I am amazed at her dedication to this project and to her students. Each day she would stop at the Internet café and click on my messages.

It is easy to see the differences in our lives but I am reminded of what we have in common. We share a desire to teach. We share a desire to make a difference in the lives of our students. We both want what is best for our students and for our own children. This connection allows us to bridge a gulf as wide as an ocean.

I wish I could say that I arrived in Tanzania with peace of mind, but I arrived in Tanzania sleep deprived and terrified. It was unbelievably dark and as I stumbled down the airplane stairs into a field- I could only imagine the bugs and snakes crawling and slithering around me. Our team dealt with customs, luggage retrieval, and questions from officials we did not understand, being stopped by the fake police, and the longest bumpiest ride up a dirt trail with our hearts in our throats and our stomachs bouncing everywhere. We were gripping each other by the time the gates opened to Mwangaza.

Then the most amazing thing happened. We were welcomed home. With a simple phrase, “Karibu Sana Tanzania,” and a warm handshake, we were escorted from the dark into the light. This light comes from within the people of Tanzania. You can see and feel the light in their smiles, in their handshakes, in their willingness to share what they have to make you comfortable, in their voices as they sing and praise God, in their total acceptance of you – a stranger from a foreign land.

It would be very easy for me to dwell on what the people of Tanzania do not have. It was devastating to me as a teacher to see schools surrounded by barbed wire, textbooks that were thirty years old, bare walls, minimal to non-existing supplies, lack of technology, lack of formal knowledge, and unimaginable poverty. But I would like to spend some time telling you about what they do have and why the work of Mwangaza is so important.

First, they have a thirst and love for knowledge: I want you to imagine a sponge. It is dry until it is dipped in water, and then it has the ability to soak up water and expand. The minds of Tanzania are like that sponge. We met students from the Ilburo Boy’s Secondary School, which is next door to the Mwangaza Learning Center. As soon as these students learned we were from America, they wanted to ask question after question to learn. Not only were the students like this, but also our guards. Each night after our work with the teachers was done, we would sit with our flashlights huddled under an outside light, teaching our guards to read simple children’s books. To these men, reading about Winnie the Pooh and Cookie Monster was a gateway to not only their future but to their children’s future.

The second reason this work is so important is the remarkable work



Emanuel Makoninde putting the finishing touches on the Hoffman apparatus.

ethic of these teachers. I was on the chemistry team and our topic was electrolysis. After showing them a picture of a Hoffman apparatus, they decided to make it themselves. They had to walk over an hour to their lab to find the material to make the tubes and the connectors, then walk another hour back to the center to gain my approval. Next, we had to make sure it worked. We were really struggling and I was ready to throw in the towel, but not the Tanzanians. After sending me to La La Salama (peaceful sleep) and with a promise of a celebratory dinner if they could get it to work, the Tanzanians worked through the night until the apparatus met my approval. It was an incredibly hard struggle but they were not ready to give up.

We witnessed this same work ethic as men and women struggled with new technology. For some of these teachers, this was the first opportunity they ever had to touch a computer. To witness their joy as they sent their first email or learned the skill of surfing the Internet for resources for their classrooms was truly incredible. When the power went out, they continued to work in the dark developing their own lesson plans to take back to their classrooms. With borrowed flashlights and sitting on the floor, they searched the new American textbooks we had brought with us for ideas.

Finally, the people of Tanzania have open hearts and minds. They want to improve. To them, this week of training is a gift. We were continuously thanked for bringing our knowledge and our skills to them. This week was also a gift to us. To be surrounded by dedicated and passionate professionals searching for ways to teach their students and improve their country was simply the most amazing journey of my life. I cannot wait to go back and continue my journey with my new friends.

How can you become involved?

- Donate teacher editions/resource materials;
- Become an online partner with a Tanzanian teacher;
- Design online lesson plans for use by seminar participants;
- Invite Teachers for Tanzania to speak at your school.

More Information

www.mwangaza-partnership.org

www.mwangazaeducationforpartnership.org/education.html

See the photos of “Teachers for Tanzania” found on the cover.

Author Information

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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 sherryduncan@insightbb.com.

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

Teacher - to - Teacher

Educators Share Information, Lessons, and Tips

Mary Lou Lipscomb

Illinois Mathematics and Science Academy

Professional development involves more than going to workshops. It involves all the ways that teachers learn to perfect their skills as educators. As lifelong learners, teachers accumulate a wide variety of knowledge and skills which are used to create ideas, activities, or entire units. Whether used to spark or maintain interest, keep things moving, or help students understand a concept in a way that is unique or different, sharing these ideas, activities, or units with colleagues provides professional development for all involved.

A sincere “Thank You” to all of the teachers who have shared ideas with colleagues through Teacher-to-Teacher.

A World in Motion

Greg Reiva, physics and physical science teacher and a point of contact at Streamwood High School in Streamwood, writes, “For over eleven years I have advocated for and implemented project-based science within the physics, chemistry, and physical science curriculum at Streamwood High School. I support an inquiry approach to learning science in the classroom and I aspire to bring to my students a learning experience that can help them face the problems and challenges in a rapidly changing technological world.

“A few years ago, at an NSTA Conference on Science Education, I met Darlene Geweth, an educational program representative from SAE International. She offered a truly unique opportunity for my students



to do engineering-based projects in the classroom which utilized proven design materials, curriculum, and technical support. These engineering-based projects are part of *A World in Motion*® (AWIM). The best thing about AWIM is that it is free to science teachers of grades 3-12.

“I have implemented the SAE International *A World in Motion*® lessons and activities in my physical science classes at Streamwood High School over the past several years. It has been a tremendously successful learning opportunity that addresses the diverse abilities, interests and needs of my students.”

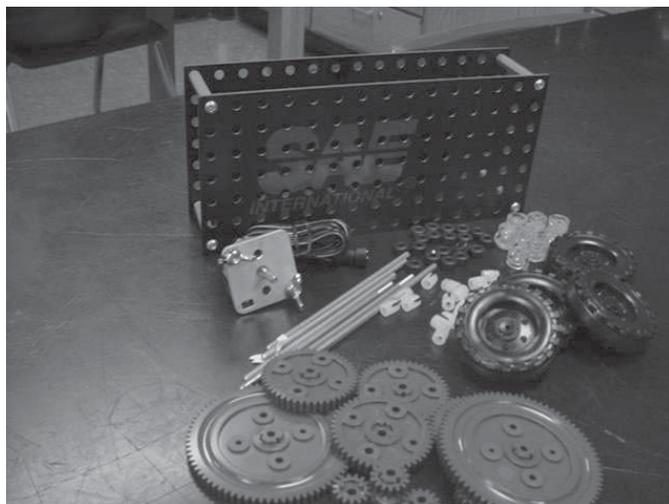
AWIM employs an engineering based model for learning science and addresses state and national standards. The materials provide the students with a learning experience that is hands-on, inquiry driven, and leads to higher levels of critical thinking. The concepts of motion, force, work, and energy are explored by the students as they are designing, building, and testing motorized vehicles and airplanes. The activities stress team work, creative thinking, and are performance-based in their assessment. It is the type of curricula initiative that can be considered the hallmark of what is needed today in science education.

Throughout the lessons, the students are exposed to overarching questions in science that are answered only through thoughtful inquiry employed while doing the science, not just reading about it in a book or being lectured on it by a teacher. It demands that students use the skills and abilities they have developed over the years as learners and to continually learn from each other.

Through this scientific investigative and design team work students discover that science can be exciting and challenging and that it can be worth their effort to do their best.

The designing, building, testing, questioning, and redesigning of engineered prototypes develops the self-efficacy of students both as learners in school and as people in society. This experience and the achievement reached by students in this performance-based approach to learning will enhance within each student the skills and abilities to take on future challenges in their lives, to be successful, and to be recognized for their achievement.

Inquiry-based science education provides powerful learning experiences for students as it helps them to navigate their interests while providing a boost in confidence to help them achieve their potential as individuals. The merits of learning science through hands-on experiences such as provided by *A World in Motion* are the true essence of what science education should be about in the twenty-first century.



To find out more about *A World in Motion*® and to get the free materials for your classroom visit their website at <http://www.awim.org/>.

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If you have lab or classroom management hints, great websites you have used, science activities, lessons, or demonstrations that you have found to be effective with your students, please send them to me electronically at lipscomb@imsa.edu.

Articles

Getting Pre-K and Elementary Science Content Through Recent Picture Books

Jean Mendoza

Millikin University

Lois Ehlert brings informational content to preschool age children through simple text, brilliant colors, and imaginative collage

What do autumn leaves, the movement of the Earth, a chorus of frogs, and an amazing friendship between an orphaned pygmy hippo and an ancient tortoise have in common? They are all featured in recent award-winning children's books that are likely to spark a young reader's (or listener's) interest in *things scientific*.

In *Leaf Man* (2005, Harcourt), author-illustrator Lois Ehlert continues her tradition of bringing informational content to preschool-age children through simple text, brilliant colors, and imaginative collage. This time she uses playful language and a hint of personification in her writing, accompanied by scenes constructed of real leaf specimens and other autumn-related items. The narrator finds a leaf "man" who like any bunch of fallen leaves, must "go where the wind blows." Ehlert assembles found items to represent her main character and the scenery through which he passes:

over the marsh, the prairie meadows, a lake.... The Leaf Man's journey invites explorations: Can children locate leaves and seeds outdoors that look like the ones Ehlert has used? Can they spot random bunches of leaves that resemble people, animals, plants? If they make their own Leaf Man on the playground, will it stay or will the wind carry it away? Is that Leaf Man really alive, and how can they know? What are some other changes autumn brings? The book's beautiful end papers – rich-hued photocopies of leaves, labeled with care – can serve as a model for children's own displays of leaf collections.

On Earth (2005, G.P. Putnam's Sons) is for somewhat older children, though preschoolers may connect better with it than with other books containing information about the Earth's rotation, its orbit around the Sun, and so on. With imaginative illustrations and precise yet poetic word choice, author-illustrator G. Brian Karas manages to infuse factual information about our home planet with a sense of mystery, excitement, and even awe. The first line, "On earth, we go for a giant ride in space, spinning like merry-go-round," is the caption for a colorful two page spread of children on a wind-swept grassy hillside. Turn the page and there's an engaging two page diagram illustrating how the Earth "spins on its axis and circles the sun in a great sweep."

Throughout *On Earth*, Karas uses specialized vocabulary – axis, rotation, revolution, orbit (there's even a glossary) – but manages to translate the terms into a child's "here and now" through pictures and text that emphasize children's day-to-day experiences: watching shadows grow long, celebrating a birthday, walking to the school bus.

Kara uses
specialized
vocabulary - axis,
rotation,
revolution, orbit -
but manages to
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into a child's "here
and now"

Teachers may find that the illustrations offer opportunities for "science talk" with children; they are somewhat impressionistic, with human figures standing disproportionately large on the Earth. The final picture in the book even invites discussion of a controversy: students who are up-to-date on their astronomy may note that Karas' solar system seems to include Pluto as a planet. But some astronomers believe it is not; what (an intermediate-grade teacher might ask) has led them to that conclusion? A teacher might use the same illustration to raise a question: How much "to scale" is that representation of our solar system? Students can then go to a Web page that can rapidly calculate relative size of planets and the scaled radius of their orbits: http://www.exploratorium.edu/ronh/solar_system/index.html. The class could follow up by creating their own scale model, or taking a field trip to one of those models in Peoria (starting in Lakeview Park) or at Parkland College in Champaign.

Back on Earth, the story of the friendship between a young pygmy hippopotamus and a giant tortoise (Owen and Mzee respectively, to their human caregivers) made headlines for several years and continues to generate great interest among children and adults alike, thanks in part to three photo essays about the pair:

- *Owen & Mzee: The True Story Of A Remarkable Friendship* by Isabella Hatkoff, Craig Hatkoff and Dr. Paula Kahumbu, and Peter Greste.

- *Owen & Mzee: Language Of Friendship* by Isabella Hatkoff, Craig Hatkoff and Dr. Paula Kahumbu, and Peter Greste.

- *Best Friends: Owen and Mzee* by Isabella Hatkoff, Craig Hatkoff and Dr. Paula Kahumbu, and Peter Greste. (This is a sturdy board book, with a lower reading level than the first two Owen and Mzee books.)

The co-authors include a child (Isabella Hatkoff), her father (Craig Hatkoff, children's book author and co-founder of the TriBeCa film festival), the manager of the facility where Owen and Mzee have been housed (Dr. Kahumba), and an internationally known photojournalist (Greste).

As many children now know, the baby hippo that came to be known as Owen was orphaned in the 2004 tsunami that devastated parts of Asia and Africa. When he was rescued (and a difficult and traumatic rescue it was), he was taken to Haller Park in Kenya where he immediately astonished the staff by bonding with an ancient Aldabra tortoise. Perhaps more astonishing was the big reptile's tolerance of his new admirer. Observers were also surprised by the mode of communication the two eventually used to communicate with each other.

A class can also follow the story of Owen and Mzee online. Many fans were disappointed to learn that Owen and Mzee have been separated so that Owen can be with another orphaned hippo. While human beings may feel sentimental about the "remarkable friendship," there were risks involved for both Owen and Mzee, and the staff at Haller Park decided the separation was a wise move.

When sharing the Owen and Mzee books, teachers might want to especially call students' attention to the way the books avoid the temptation to anthropomorphize the animal "protagonists." The authors stick to descriptions of observable behaviors; they may speculate, but they do not pretend to get inside the mind of either creature. In fact, the books are good examples of how to tell a non-fiction "story" through written and photographic documentation. Students may want to try the same methods to report on behavior of pets or other animals they can observe regularly. Students who are already competent readers (say, in fourth grade through middle school) may wonder why their teacher is sharing a picture book with them - "Those

are for little kids!” But the teacher can invite discussion of the value of photo essays for people at any age. After all, adults are captivated by the pictures of Owen and Mzee together, just as children are!

Another feature of the book that might interest older elementary students is the fact that it is dedicated to the memory of nearly two hundred and fifty employees of the Lafarge Group who died or who are still missing after the same December 2004 tsunami that left Owen stranded. Though the public imagination abroad has been captured by Owen and Mzee, the effects of the tsunami are still being felt among families living where it struck. Students in fifth grade or middle school might want to investigate the geological and human factors that made the tsunami so devastating. A class might even look into several events, such as major earthquakes or Hurricane Katrina, and compare the factors that make each one something that humans term “a disaster.”

Life-and-death drama on a smaller scale is the subject of yet another award-winning picture book: *Song of the Water Boatman and Other Pond Poems* (2005, Houghton Mifflin), written by Joyce Sidman, and illustrated by Beckie Prange. (*Song* is a Caldecott Honor Book; it was honored for its illustrations though it did not win the top award.) Beckie Prange’s hand-colored woodcuts capture the beauty of a pond, and the tension of the struggles that go on above and beneath its surface. Richly detailed double-page spreads greet the reader at every page-turn; hues of green, brown, and blue abound – just as a child would see up close in a real pond. Joyce Sidman’s captivating poems vary in length, style, and topic, but all are accessible to young readers or listeners. The first poem, *Listen for Me*, has a predictable structure and repetitive rhymes that invite choral reading:

“Listen for me on a spring night/ on a wet night/ on a rainy night./ Listen for me on a still night,/ for in the night I sing.”

A whole-class read-aloud of the six stanzas of *Listen for Me* is especially apt because the poem’s subject is spring peepers, the tiny frogs whose choruses can fill the spring night by a pond. Other poems must be seen as well as heard to get their full effect. In *Spring Splashdown*, about a family of wood ducks,

Owen and Mzee
book authors avoid
the temptation to
anthropomorphize
the animal
protagonists,
sticking to
observable
behaviors

placement of the phrase “leaping, leaping” on the page illustrates the fall of the fluffy ducklings from the nest to the pond’s surface – a fall they must take in order to survive. The final poem, *Into the Mud* has its own special shape, mimicking the appearance of its subject, a painted turtle going into hibernation. Sidman brings in humor to these pond stories – as in *Diving Beetle’s Food-Sharing Rules*, which, as the reader soon learns, do not involve sharing at all.

Song of the Water Boatman is in a category of books that some people call “science poetry” – writing that makes use of imagery, metaphor, simile, and evocative word choice to impart or support factual information. Carolyn Lesser, Douglas Florian, and Thomas Locker have all produced picture books that do this. (Check them out, if you haven’t already!) What sets *Song* apart from many such books is that an informational paragraph accompanies each poem, set off to the side in a plain typeface, so that its explanatory text is readily accessible but not visually part of either the poem or the illustration. Books by the other poets mentioned are likely to have their strictly-informational text in the back of the book. Having the information near the poem makes it easy for a teacher/reader to share as needed; but setting it apart on the page makes clear that it can be addressed at another time, separate from the poetry, or used immediately to enhance the meaning of a poem. The book’s final page is a glossary not directly connected

Flotsam is fantasy
that relies on the
reader's awareness
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technology to make
the story work

to any of the poems, but still featuring Prange's woodcut decorations.

Teachers in elementary schools may feel forced to exclude science content while they spend hours preparing children for language arts portions of standardized tests. Books like *Song of the Water Boatman* may be the answer to the question, "Where's my time for science?" Its illustrations, poems, and informational text together provide biology content along with potential language arts lessons.

Finally, in 2006, the book that took the Caldecott Medal for illustration is one that teachers might use to engage young people's scientific imagination, though perhaps not in the same ways as the other books discussed in this article. David Weisner's *Flotsam* (2006, Clarion Books) is fantasy that relies on the reader's awareness of biology and technology to make the story work. Weisner's previous award-winning work has included *Tuesday* – when frogs levitate on lily pads – and a postmodernist approach to page boundaries in *The Three Pigs*.

In *Flotsam*, he takes the audience on a wordless exploration of the possible (and the not-so-possible) fruits of curiosity and the investigative process. The story's main character, clearly a budding naturalist, brings a microscope and other equipment to the beach. There his attention is captured by a vintage camera washed up on the sand, somewhat the worse for wear. The story turns on what the boy does next, and what he discovers afterward. To say more is to give away too much!

Because the story is told solely through illustrations arranged like a comic book or graphic novel, young people may want to invent their own narratives, or simply let the pictures speak for themselves. After students get to know *Flotsam*, a teacher might take off from the story to introduce topics such as the ways technology can change the ways we see the world. Microscopes let us inspect and try to understand worlds that are invisible to our naked eyes. Photography allows us to make and keep visual records across time. Sometimes Nature renders technology irrelevant – it can wash away a photographic record. The natural world holds many wonders yet unseen, or perhaps seen thanks to technology, but misinterpreted. The students are likely to have their own stories to relate about such things.

Because Weisner plays with what we know, or think we know about what goes on under the sea, sharing *Flotsam* with a class of, say, middle-schoolers also invites them to consider such questions as, "What if we're wrong? What if the limitations of our technology lead us to misunderstand the world — thoroughly or at least partly?" (By the way, it's a good idea to have the students find out what the term "flotsam" means; even some adults are unclear about it.)

When sharing any of these books with a class, be aware that children above about third grade sometimes have a prejudice against picture books. Proficient readers who rely on text rather than illustrations may act as if these books are too young for them. At such times, a teacher may want to remind a class that one picture truly can be worth a thousand words; that pictorial representations are essential to scientific record-keeping; and that a good scientist tries to make use of *all* clues he or she can find when studying the world. *Flotsam*, the Owen and Mzee books, *On Earth*, and *Leaf Man*, each in its own way, can help a teacher bring science into the lives of students.

Do *Spectrum* readers have stories about sharing any of these books with children? Jean Mendoza would like to hear them! Contact me at jmendoza@millikin.edu, and be sure to put "*Spectrum*" in the subject line.

Buzz, Crawl, Creep: Scientific Processes Through Literacy Strategies

Stephanie L. McAndrews

Southern Illinois University Edwardsville

Wouldn't you like more buzz, crawl, and creep in your classroom? As a result of the No Child Left Behind legislation and a stronger emphasis on reading and writing in the curriculum, science has often been placed on the back burner. Many children however, would be more engaged in meaningful reading and writing experiences if they were based on topics of interest and importance, including science and technology. According to Romance and Vitale (2004), through integration, teachers can increase the amount of time for meaningful learning in science, reading comprehension, and writing composition. Effective reading, writing, and oral language strategies can enhance the development of conceptual understanding of science and critical thinking.

The 5-E instructional model was initially designed as an instructional model for teaching science (Trowbridge and Bybee, 1996). The five elements of this model include: engage, explore, explain, elaborate, and evaluate. However, by applying this model to reading comprehension and writing composition during science investigations, children will not only gain essential science processes and concepts, but they will also enhance their literacy development.

A single integrated unit of study of arthropods can incorporate numerous literacy and science standards and objectives. This article provides examples of how to integrate reading with hands-on science investigations based on the National Science Foundation science content standards (National Research Council, 1996) and the English Language Arts Standards (National Council of Teachers of English and the International Reading Association, 1996). The examples are based on a sample unit on arthropods for grades three to five.

The 5-E
instructional model
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for teaching science

During the arthropod unit, the students will plan and conduct research on arthropods and issues related to them. They will ask questions, make predictions, observe, collect field and text data, and document arthropod characteristics, behaviors, and interactions with their environment. To answer their questions and learn more about arthropods, students will be conducting six investigations.

1. Collect field data about arthropods and their environment in a one meter by one meter plot out in the field.
2. Use a variety of collection techniques to obtain samples and classify arthropods from multiple environments.
3. Observe, care for, and document the life cycle of Painted Lady Butterflies in the classroom.
4. Investigate one order of arthropods (Insecta will be divided by taxonomic class) using multiple resources. Students will write a report and prepare a power point presentation for the class.
5. Investigate one health or environmental issue related to arthropods and make a three fold brochure explaining the problem or relation between arthropods and people.

6. Create an arthropod resource guide including a taxonomy of arthropods, the classes of arthropods, the characteristics and behaviors of arthropods, examples of arthropods, labeled diagrams of arthropods, diagrams of metamorphosis and incomplete metamorphosis, and a glossary.

The arthropod unit will be outlined using the 5E model: engage, explore, explain, elaborate, and evaluate (Trowbridge and Bybee, 1996). While each of these stages can be accomplished in a given lesson, they are recursive throughout the unit. Examples of specific literacy strategies are described under each step of the 5E model. These strategies can be used for several of the different investigations above.

Engage

This stage creates interest, generates curiosity, raises questions, and elicits responses that uncover what the student knows about arthropods. In this stage students will be introduced to each of the six investigations.

1. List-Group-Label Strategy (Taba, 1967 in Tierney and Readence, 2005). To introduce the unit,

bring in specimens and pictures of arthropods, but do not identify them. Ask the students: What do you know about these animals? List the comments on post-it notes. Help the students group the statements and then make labels for the categories such as: What are they called? What does it look like? How are they different? Where does it live? What does it do? What are examples of other related animals?

2. Inquiry Chart Strategy (adapted from Hoffman, 1992 in Tierney and Readence, 2005). To study a topic in-depth using hands-on research and information from multiple texts, students need to begin by developing research questions. Create the I-Chart (figure 1) and brainstorm guiding questions with the class. These questions can be for the arthropod research or the health and environmental issues investigations. Example questions: Why are spiders not classified as insects? How can you get sick from mosquitoes?

Gather resources to help students investigate their answers. Some answers may be obtained from collecting data out in the field. The teacher then asks students about their prior knowledge on that topic and records it under the correct guiding

Figure 1. Inquiry Chart.

I-Chart							
Sources	Topic	Question 1.	2.	3.	4.	Interesting Facts & Figures	New Questions
	Guiding Questions	Why are spiders not classified as insects?					
	What we know	They have 8 legs.					
	1. Field data	Their bodies are divided into 2 segments.					
	2. Text book	All are flesh-eaters, and most are ruthlessly efficient killing machines.					
	3. Trade book	They also have 4 other appendages that flank the mouth and work as fangs, feelers, or claws.					
	4. Internet site http://www.kidport.com/RefLib/Science/Animals/Arachnids.htm	The first of legs are used for holding the prey and feeding.					
	Summary						

question. Additional information is recorded under interesting facts and students' new questions. Students then read from a variety of sources and the teacher records what they learned. The students generate summary questions for each of the guiding questions. The students then compare the information from each of the sources with their prior knowledge. The students continue to pose new questions and research to answer them. The inquiry chart can become an individual or group research project. Finally the students report their findings to the whole class.

3. Group Investigation Approach Strategy (Walker, 2004)

Students will select a class of arthropods to study and present a topic in cooperative groups. Students will be placed in groups and will choose an Arthropod class to research: Tribobida (extinct), Arachnida, Myriapoda (Chilopoda and Diplopoda), Crustacea, and Insecta. Class Insecta can be divided into smaller groups by orders. The students conduct preliminary research and develop a list of questions to investigate, which is then organized by key categories and subtopics. Research groups are organized around subtopics: morphology of animal structure, habitat, behavior, food sources, defenses, interaction with humans and other animals, and so forth. This investigation will continue through the explore, explain, and evaluate stages. *Explore*: Students select appropriate resources to read. *Explain*: They summarize their learning and share it during reporting sessions. Each group prepares a product (web page, PowerPoint, poster, and so forth.) to share the information they learned about their subtopic. *Evaluate*: Together with your students develop summary questions to ask the class. Students write a reflection about what they learned from each group.

4. Think-Pair-Share Strategy

Before going into the field, students will read two articles to prepare them for their field investigation. The first article, *Some Clues to Describing and Understanding Organisms* (American Museum of Natural History, no date), provides ways to look

for clues and questions to guide students in Arthropod observations:

- Describe how and where the arthropod goes (to flowers, in open, under plants or stones, or waits).
- Describe how it eats (chew, pierce, suck) and what it eats (same or different plants or animals).
- Describe how it lives (alone or in groups).
- Describe what it does (eat, mate, care for eggs, fight, interact with others, get eaten).
- Describe how it is built (mouth parts, legs, stingers, and eyes).

The second article explains the best ways to catch arthropods in the field, such as aerial netting, sweep netting, beating, hand collecting, pitfall trapping, and Berlese funnel (American Museum of Natural History, no date). After reading each article, the students will think about what they read, pair up with a partner, and share how they can describe their arthropods and how they might try catching arthropods.

Explore

Encourage students to work together without giving direct instruction during reading, writing, and field experiences. Observe and listen as they interact. Ask probing questions to redirect students' investigations in their text reading and in the field.

1. Journal Writing Strategy: Students document their field experiences in their journal. On the front cover students write "Field Journal," "Scientist:" and their name. On the first page students write the procedures used for mapping out their meter-square plot and their research questions. On page two they record the location, description, and make a scale drawing of their plot. For each observation the time of day, temperature, and weather conditions are recorded. Also included are drawings and descriptions of plants, animals, evidence of animals, minerals, and evidence of humans. Finally, for each observation students describe any animal behavior observed.

Topic: Order Hymenoptera		Date:	
Question 1 Why are leafcutter ants different shapes and sizes?	Resource Bingham, Morgan, and Robertson (2007). <i>Buzz</i> . P. 90	Summary Because they have different jobs to do: Queen, guard, leaf cutter, prince, gardener and nurse.	Connection or Example: This is similar to bees with a queen, nurse bees, and worker bees.

Figure 2. Sample Page of Notes.

2. Learning Log and Entomology Resource Guide: (McAndrews, in press). Students will document their learning from texts first in their learning log and then synthesize it in their Entomology Resource Guide. The learning log is dated each day and begins with maps of background knowledge and lists of student questions. Figure 2 shows a sample page of notes. There can be more than one resource and summary for each question. Notes can also include drawings, graphic organizers, and terminology. One useful tool for children’s arthropod identification is The Field Museum’s *Underground Adventure Soil Critter Field Guide* (2005). A more complete guide is the *National Wildlife Federation Field Guide to Insects and Spiders and Related Species of North America* (Evans and Tufts, 2007).

Explain

Students will use their journals and other resources to answer their research questions, explain their investigations, complete their arthropod resource guide, and demonstrate their understanding of the identified arthropod science objectives.

There is considerable vocabulary and concept development required when learning about arthropods. There are three strategies that are helpful:

- Students sort arthropod vocabulary words by meaning in the Idea Web.
- In the Morphology of Words strategy students break words up into meaningful units such as English, Latin, or Greek prefixes, suffixes, and roots. (Morphology has two definitions: in linguistics it is the study of the structure of words; in science it is the study of the structure of animals.)

- Using the semantic feature analysis grid, students classify arthropods by their characteristics.

1. Idea Web Assessment: (Ogle and Correa, 2007). Use as a pre-test for prior knowledge and a post-test on knowledge learned. Instruct students to choose words from the lists and put them under the appropriate category or concept. They may use as many of the words as they know but only use each word once. Some categories will have blank spaces. The correct answers are in figure 3.

2. Morphology of Words Pre-test/ Post-test Assessment (Ogle and Correa, 2007). To learn new vocabulary, it is often helpful to chunk words into parts which sometimes can be used to figure out word meanings. Sample answers are from the text *Buzz* (Bingham, Morgan, and Robertson, 2007).

arthropods
word parts arthro pod s
part meaning joint foot more than one

Probably means: Things with a jointed foot.
Definition: An invertebrate with a segmented body, jointed legs, and an exoskeleton.
Quote from text: “Arthropods are the most successful animals on Earth” (Bingham, 2007, p. 13).
Related words: tripod- three feet, myriapod- many feet

antennae	exoskeleton	mantis	entomologist	arachnid	molting
thorax	cephalothorax	crayfish	abdomen	wasps	myriapod
entomology	scorpion	crustacean	migration	metamorphosis	invertebrate
beetles	insecta	pollination	centipedes	compound eye	

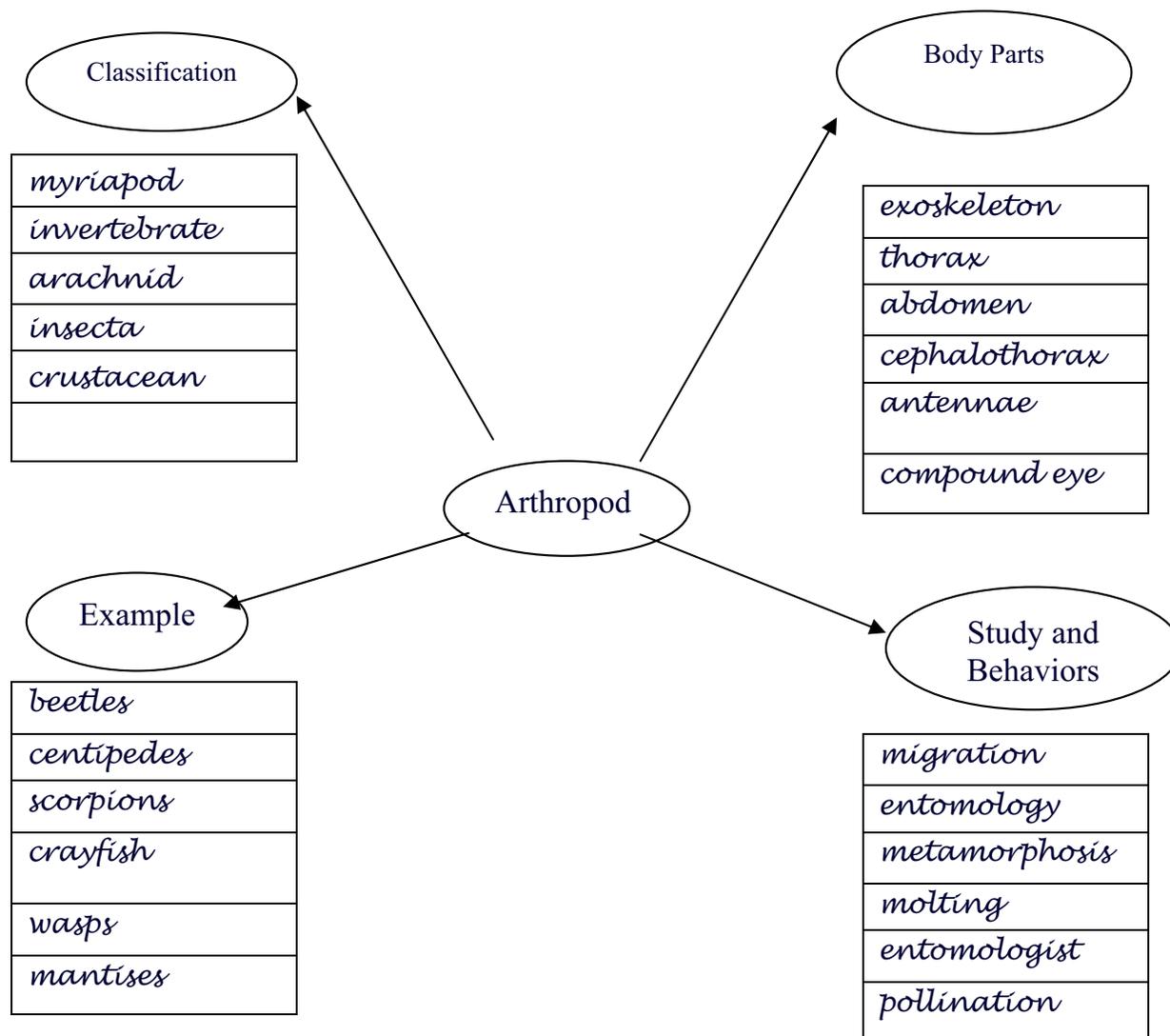


Figure 3. Word Categories and Concepts.

entomologist

word parts

entom	olog	ist
insect	study	person

part meaning

Probably means: A person who studies insects.

Definition: A scientist who studies insects. Some study the classification, life cycle, distribution, physiology, behavior, ecology, or population dynamics of insects (Dunn, 2007).

Quote from the text: “Forensic entomologists may be called to the scene of a crime to gather evidence, or may be sent samples by a police forensic scientist”(Bingham, 2007, p. 131).

Related words: entomology, the study of insects, biologist- a person who studies life.

exoskeleton

word parts exo skeleton

part meaning outside structure

Probably means: Something with a structure outside.

Definition: External hard supporting system of an arthropod.

Quote from text: “Most big animals have a skeleton on the inside. An arthropod’s is on the outside. Like a suit of armor, the external skeleton (or exoskeleton) is made of stiff plates linked together” (Bingham, 2007, p. 7).

Related words: external-outward or outside, exotic-from another country, expand-to spread out, vertebrate- animals with backbones.

metamorphosis

word part meta morpho sis

part meaning about itself form or shape process

Possibly means: Process about its form or shape.

Definition: The process by which an organism undergoes dramatic changes in body form in its life cycle.

Quote from text: “Most insects go through a dramatic transformation as they turn into adults. Often the change is so great that the adult looks totally different from the young insect. The changing process is called metamorphosis” (Bingham, 2007, p. 54).

Related words: morphology- The study of the form or shape of words or shape of animals. photosynthesis- A process in which plants use light to synthesize organic compounds from carbon dioxide and water.

Example: Animals

Classifying Arthropods:	Insect	Arachnid	Crustacean	Myriapoda	Not An Arthropod
Number of legs	6	8 spiders 6-12 scorpions	10 (woodlice have 14)	Numerous (30-750)	No Legs
Number of body parts	3 (head, thorax, abdomen)	spiders 2 parts (cephalothorax and abdomen); ticks (body not divided)	1-2	many, with legs on each segment	
Antennae	one pair	No (-)	two pairs	Yes (+)	some
Number of wings	2 pairs	No (-)	None (-)	None (-)	None (-)
Shape of body	oval	oval	oval	long, thin	long, thin
Where live	air, land and water	land	most in water, breath through gills	land	soil or water
Examples	flies, beetles, bugs	spiders, scorpions, ticks, and mites	crabs, lobsters, crayfish, and shrimp	centipede and millipede	slugs, snails, and worms

Figure 4. Animal Attributes Matrix.

3. Semantic Feature Analysis Matrix (Johnson and Pearson, 1984 in Walker, 2004):

Students can use various texts to complete this matrix (figure 4) in order to sort out the similarities and differences among classes of arthropods. Each animal is classified by the attribute, putting a brief description or + or – in each box indicating the presence of each feature.

Elaborate

Students will use previous information on arthropods to ask new questions, propose solutions, and draw conclusions in novel problems.

1. Scientists use the following categories to classify living things: kingdom, phylum, class, order, family, genus, and species. In order to remember the order students can use the following sentence as a mnemonic device: “**K**ids **P**refer **C**heese **O**ver **F**ried **G**reen **S**pinach.” Each student will select one order in the Phylum Arthropoda (figure 5) to study and present in a PowerPoint presentation.

2. Students can make an animal kingdom schematic word map (Tierney and Readence, 2000) including the phylum, class, and order for arthropods and the comparative branches for Primates to show how they are hierarchically related. For one species in that order, they will complete the schematic map using the chart below as well as make a schematic word map of the animal kingdom, showing the relation.

Evaluate

Students “answer open-ended questions by using observations, evidence, and previously accepted explanations; demonstrates an understanding of knowledge of the concept or skill; evaluates her own progress and knowledge; and

asks related questions that would encourage future investigations” (Trowbridge and Bybee, 1996, p. 218-219).

For each artifact and investigation conducted during the explore, explain, and elaborate phases, develop a scoring guide including each of the applicable science and language arts objectives. Figure 6 is a general example; however, you would want to include a more detailed scoring rubric for each investigation.

Through this integrated arthropod unit, students use their reading, writing, and communication skills to demonstrate their ability to plan, conduct, analyze, and synthesize inquiries, and comprehend many of the life sciences and science fields in personal and social perspectives. Not only that, it puts the excitement of buzz, crawl, and creep back into your science lessons.

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	Human	Honey bee	Student Selected
Species	<i>sapiens</i>	<i>mellifera</i>	
Genus	<i>Homo</i>	<i>Apis</i>	
Family	Hominidae	Apidae	
Order	Primates	Hymenoptera	
Class	Mammalia	Insecta	
Phylum	Chordata	Arthropoda	
Kingdom	Animalia	Animalia	

Figure 5. Student Selection Chart.

Arthropod Investigation Objectives	Score
Asked questions, made predictions, and formed hypotheses about arthropods and their environment	
Plan and conduct investigations, text investigations, and field investigations.	
Observed, collected, and documented arthropod characteristics and behaviors along with the interactions with their environment.	
Predicted, observed, and documented butterfly metamorphosis	
Found answers to self-questions using resources and observational notes.	
Identified, described, and classified arthropods by their class and order.	
Analyzed, synthesized, and reported findings orally and in writing to class and family in a manner that clearly communicated their learning about arthropods.	

Figure 6. General Scoring Rubric.

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Websites

www.pedagonet.com/other/lspins.html-63k

This website has a phenomenal amount of information for teachers. A wide variety of insect lesson plans for preschool through high school is present.

www.insectsafari.com

This student friendly site would make for a wonderful opportunity for students to continue their study on insects on their own or with a partner from kindergarten through sixth grade studies on classification activities for insects. Students will be able to find just about any information on an insect they can think of.

<http://www.enchantedlearning.com/subjects/arachnids/spider/>

<http://www.explorit.org/science/spider.html.html>>

http://kidshealth.org/kid/ill_injure/aches/brown_recluse.html>

<http://www.cdc.gov/ncidod/diseases/insects/diseases.htm> National Center for Infectious Diseases related to insects and other arthropods.

<http://www.kidport.com/RefLib/Science/Animals/Arachnids.htm>

Author Information

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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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Baseball in Motion: A Free Body Diagram Lesson about Force and Motion

Dianne J.E. Kraus
Northern Illinois University

Physics concepts
can be rather
boring if students
are kept inside in
their seats.

Introduction

As an educator of general level students, I have discovered that my students are not easily motivated and they need to be actively engaged in their learning. It is important to get our students out of their seats and out into the world in order to learn science. The more often that we can get students outside and experiencing science activities hands-on, the more relevant science will be to their lives. The goal of my activity is to have students experience the forces of motion and to identify them while playing a game of baseball. I have a few baseball players in my class and I wanted to relate physical science concepts to their interest in the sport. Physics concepts can be difficult to understand and rather boring if students are kept inside in their seats in a classroom, and I know that they would rather be in physical education class playing any form of sport. Science should be fun and students should be actively engaged in inquiry activities. By developing interesting, engaging lessons that take students outdoors we can build a strong rapport with our students and they will develop a desire to participate in science. As a result, I developed this activity in order to learn science while playing sports.

My greatest success comes when my students can apply what they have learned to new experiences that they have outside of school. When they can relate and explain how they understand something new because of what we have done in my class then I feel that I have accomplished my goals. When they tell me that they will register for science next year because of how much fun they have had in my class, then I know that I have been successful.

Lesson Objectives

- Students will prepare four free body diagrams after observing the motion of objects in the field.
- Students will calculate the magnitude and direction (in degrees) of the net force.
- Students will explain the displacement of the moving object.

State Goal/Standard/Benchmark: 12.d.4a/5a

Assessment Framework: 12.11.74 and 12.11.75

Preparation

1. Notify students (the night before) of plans to go outside the following day so that they can dress properly.
2. At the beginning of class set-up the anticipatory set – put the equipment, carts, and other materials on display at the front of the room so that the students can see it when they enter the room.
3. Write on the front board the name of the activity: “Baseball in Motion.”
4. List the objectives/purpose on the overhead and go over them with the students.
5. Review pertinent background information from previous lessons. See teacher notes.

6. Give out handout: Forces of motion data collection/post activity questions.
7. Discuss safety issues, which should include wearing safety equipment and no rough play.
8. Set up materials on a hard surface such as the surface at the track, a tennis court, empty section of the parking lot, or possibly the baseball field. The cart wheels operate best on a hard surface. The activity must be set-up so that the bases are equal distances apart and the students end up back at the starting point. The baseball diamond is a perfect location when the base lines are hard packed.
9. Set up the activity in the shape and size of a baseball diamond with plenty of room for the students to set the carts in motion.
 - a. Home plate is the rotating platform with the set of hand weights.
 - b. At second base place the blue cart tow rope.
 - c. At third base place a set of 2 cart ropes (balancing forces).
10. Give all groups a trundle wheel, two calculators, three compasses, three stopwatches, one set of safety helmet, and pads, and a cart.
11. Each group will need to assign the following responsibilities to a student. At each station they will require three timers, a recorder of data, a person to measure displacement with the trundle wheel, a student to sit on the cart or to run the bases, three students to find the direction with the orienteering compass, and students to apply the forces as required at each station. Encourage students to share responsibilities and to take turns.
12. Explain the activity. Prior to collecting data allow the students to play a short game of “baseball” without taking data. Have the students observe the forces of motion as they play the game and pull/push the players around the bases. Afterwards, divide the students into four groups and have each group start at a different base and then move around the diamond until all students have had an opportunity to complete the activity for each base. Data collection should be made and recorded into the appropriate table as provided in the handouts.

Materials

- 4 trundle wheels
- 3 jumbo carts (for students)
- 12 Stopwatches
- 2 1.8 kg hand weights
- 1 rotating platform
- 2 cart ropes of equal length
- 1 cart tow rope
- 4 safety helmets
- 4 sets of elbow and knee pads
- Set of calculators
- Set of orienteering compasses
- 1 baseball bat (optional)
- 1 baseball (optional)

Student Activity

1. Students will observe the motion of the object between each base and prepare a free body diagram showing all of the forces on the object. The diagram should be labeled with all of the forces to scale in black and the F_{net} vector should be colored blue. Label the net force. Under each diagram, label the displacement of the object in motion. All measurements should be reported in metric units. Each student shall complete the calculations and questions in the post-activity handout.
2. From home plate to first base: The object in motion is a student running.
3. From first base to second base: The object in motion is a jumbo cart with a student sitting on the cart and one student pushing the student/cart from behind, from first base to second base.
4. From second base to third base: The object in motion is a jumbo cart with a student sitting on the cart and the student/cart pulled from the front by another student towards the third base. The student pulling should hold the blue tow rope at one end and the other end should be held by the student on the cart. At the end of the activity the blue tow rope should be returned to second base for the next group of students.
5. From third base to home plate: The object in motion is a jumbo cart with a student sitting on the cart and the student/cart pulled from the sides by two students using the ropes for balancing

forces. The student on the cart should hold the two ropes in opposite hands and the students pulling will be in a slight V formation toward home plate. This should demonstrate vector addition and the movement of the cart should be in the forward motion. After completing this activity students should leave the balanced forces ropes at third base.

6. At home plate the object in motion is a student standing on the rotating platform. The student should hold the hand weights (one in each hand) with arms straight out from their sides (parallel to the ground). Another student will start the student rotating and release. The student on the platform should slowly bring their hands straight in to his/her chest and see what happens and then move his/her hands back out to the original position. Then have the students describe what they have observed.

Anticipatory Set for Next Lesson

Home plate (rotating platform): This station is difficult for the students and few if any will be able to draw a diagram for the forces that occur. This is the anticipatory set for our investigation on circular motion. Students should explore this phenomenon and try to come up an explanation of the forces occurring to explain what they observe.

Wrap-Up

After each group has completed each activity, all equipment should be picked up and returned to the classroom. Give students time in the classroom to complete the free body diagrams and calculations. Collect worksheet from each student for grading (or one per group).

On day 2, return the graded worksheets to students and have the students form the groups that they were in the previous day. Assign each group to explain and to defend one of the free-body diagrams they prepared from the previous day.

Discuss the displacement of the objects (player) moving around the bases and returning home. Have the students use a vector addition diagram to show how the applied force vectors produce the net force vector. How does a large F_{net} affect the velocity of the object?

Post Activity Questions

1. Based on your data calculate the velocity of the moving object: (average distance divided by average time) + direction
 - a) Home plate to first base _____
 - b) First base to second base _____
 - c) Second base to third base _____
 - d) Third base to home plate _____

2. What is the displacement of the moving object: (change of position or distance in meters) + direction
 - a) Home plate to first base _____
 - b) First base to second base _____
 - c) Second base to third base _____
 - d) Third base to home plate _____

3. Prepare four free body diagrams for the moving objects showing all of the forces acting on the object in motion. (Show the F_{net} as a blue vector (include magnitude and direction). Use an 8' 1/2" piece of white paper folded into half – draw one free body diagram in each square and use both sides of the paper. Label your drawings a, b, c, and d.
 - a) Home plate to first base
 - b) First base to second base
 - c) Second base to third base
 - d) Third base to home plate

4. If an object travels from home plate around the bases and returns to home plate, what is the displacement of the object? Explain your answer.

5. Calculate the average velocity of the object as it travels from home plate around the bases and returns to home plate. (Hint: average velocity = displacement divided by time).

6. Describe what you observed at home plate on the rotating platform. Analyze the forces that you observed. Predict and draw what the free body diagram might look like. Be prepared to explain and defend your answer during a class discussion.

FORCES OF MOTION DATA COLLECTION

DATA TABLE 1: Time

Name: _____

Intervals	Timer #1 Time (sec)	Timer #2 Time (sec)	Timer #3 Time (sec)	Time (sec) Average
Home base to first				
First to Second				
Second to Third				
Third to Home base				

*Average = (Add time 1 + time 2 + time 3) divide total by 3

DATA TABLE 2: Direction

Intervals	Direction Compass Bearing (degrees)	Direction Compass Bearing (degrees)	Direction Compass Bearing (degrees)	Direction (degrees) Average
Home base to first				
First to Second				
Second to Third				
Third to Home base				

Average + (Add compass bearing 1 + 2 + 3) divide total by 3

DATA TABLE 3: Distance

Intervals	GROUP 1 Distance (meters)	GROUP 2 Distance (meters)	GROUP 3 Distance (meters)	Distance (meters) Average
Home base to first				
First to Second				
Second to Third				
Third to Home base				

*Average = (Add distance 1 + distance 2 + distance 3) divide total by 3

7. During which sport(s) have you observed this kind of motion? Propose an investigation that we might do as a class to learn more about circular motion.

Teacher Notes

1. Jumbo carts should be used on a hard surface such as a track or sidewalk. The activity is best set up in the form of a baseball diamond with the students moving through the bases.
2. This lesson will take two to three days to complete, depending on the time available and the level of the students.
3. Background information is required prior to completing this lesson plan. Students are required to have covered measurement using the metric system and are required to have an introductory lesson to the use of an orienteering compass. Students should understand Newton's Laws of Motion. Examples of vector diagrams that should be previously discussed include displacement, acceleration, velocity, and force, including vector addition. Knowledge of the difference between vectors and scalars is assumed. Students should have a clear understanding of contact forces such as frictional (static and kinetic), tensional, normal, air resistance, and applied force.
4. Prior to this lesson, students must understand that changes in motion are due to the effects of forces and that unbalanced forces change the speed and/or direction of an object (SFAA, Chapter 4).
5. Collaboration between students should be encouraged and reinforced by group work during science activities (NSES Chapter 13).
6. According to Program Standard D of the National Science Education Standards, good science programs require access to the world beyond the classroom and collaborative inquiry activities (NSES, Chapter 7).

Student Assessments

Varied types, as well as both formative and summative assessments, provide a good means of evaluating student learning.

- Embedded informal evaluations during the activity by observing the students and asking questions in the field.
- Formative evaluations include checking to see if students are collecting data accurately and to see if they are able to identify the forces of motion.
- Formative evaluations include collection of free body diagrams and post-activity questions/calculations from each student.
- Class discussion and peer presentations following this activity, using higher-level questions to test for understanding.

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Science Parking Lot: A Catalyst for Student Engagement and Science Conversations

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Introduction

For a year Amy worked together with Phyllis in her sixth grade classroom at the National Teachers Academy on Chicago's Southside through the Scientists, Kids, and Teachers (SKIT) program. SKIT is a partnership between the University of Illinois at Chicago and the Chicago Public Schools that offers science, mathematics, and engineering graduate students an opportunity to get involved with K-12 classrooms and support science and mathematics learning and teaching. Phyllis is a national board certified elementary school teacher experienced in working with urban youth. Amy is a graduate student in Earth and Environmental Sciences working towards her masters in paleobiology. Our goal was to use language arts as a tool for enhancing science learning in Phyllis's class. A particular emphasis we had was to encourage students to participate in science conversations.

The *Science Parking Lot* was born of necessity and an unwillingness to ignore students' enthusiasm and curiosity. A *parking lot* is a common meeting facilitation technique in which ideas that stray from the main theme are listed and revisited when and if there is time. Amy's presence in the classroom averaged only ten hours a week, spread out over three days. Phyllis suggested that during her absence the students write questions onto post-it notes that we would collect. We were both reluctant to ignore student questions in class, but with limited time, we had to keep moving forward. Amy recalled the parking lot technique from a former job and discussed it with Phyllis. We decided to make it a permanent element in the classroom where students could post questions at any time. As the science class grew and evolved, so did the parking lot's role.

A parking lot is a common meeting facilitation technique in which ideas that stray from the main theme are listed and revisited when and if there is time.

The Science Parking Lot

The Science Parking Lot (figure 1) began as a tool for keeping track of student questions, but quickly grew into an important technique for encouraging inquiry-based learning, as well as higher-order thinking. The parking lot itself was something that was quickly put together over a lunch break, made out of construction paper which Phyllis had laminated. We hung it in the center of the science word wall (symbolically placing questions at the center of science) and simply introduced the parking lot as a place for students to put questions during Amy's absence or if we ran out of time during class. The parking lot included suggestions for the students like: "I was wondering _____," "I saw _____," "I didn't understand _____." Students were initially drawn to the novelty of post-it notes and the attention it garnered. Early postings were relegated to observations such as: "I saw a dead rat on the way to school." Many of the same students were posting repeatedly, signing their names as if in

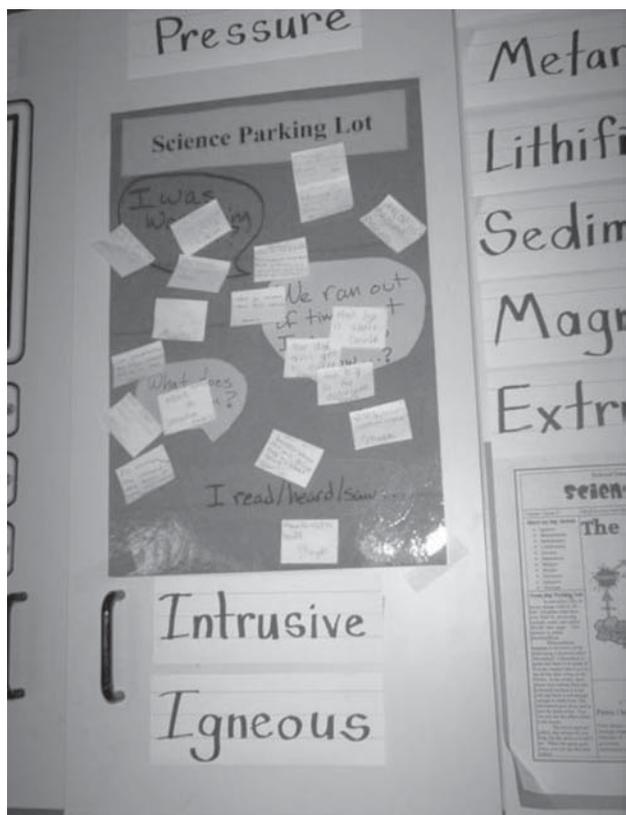


Figure 1. Science Parking Lot. The Science Parking Lot hanging on the word wall full of questions waiting to be answered.

competition with each other. But, as the class became comfortable with the parking lot, students made the lot into a learning tool for themselves. Over time, we noticed that names disappeared and students who were reluctant to participate in class were posting questions on a frequent basis. Questions evolved beyond simple observations into deeper content questions such as: “What would happen if the plates (tectonic) broke?” Students took great joy in the creativity of science as they began to see that anything and everything could be investigated and discussed.

Student questions generally fell into four categories: observations, vocabulary and science language, in depth questions or clarifications, and off-topic questions. The Science Parking Lot helped students see that their questions were not frivolous, or a waste of time, but that they were important points for discussion and investigation. Initially questions were addressed the following day, or in review sessions. On occasion, time was set aside for class discussion to further help the students see

themselves as legitimate members of a science community. Questions such as, “why do scientists use big stupid words?” bordered on the philosophical and went to the root of science. Many questions could no longer be quickly answered at the beginning of the next lesson, and a way needed to be found to address these questions completely, but without compromising our instructional goals. We had been toying with the idea of a newsletter for several weeks, and we soon realized that it would be an ideal format for addressing parking lot questions in greater detail.

Science 311—The Science Newsletter

The newsletter gave us an opportunity to give more emphasis to literacy, which is Phyllis’ area of interest, as well as the focus for the school. Language arts is a subject matter critical for science education as most professional scientific activity centers on researching and communicating. By blending language arts and science, students gain greater access to, and confidence in, the complex and often confusing scientific language, which, in turn, gives them greater access to concepts. Parking lot questions like: “How do you make the words go with the meaning?” showed us that the students were looking for meaning and understanding as they were trying to process the words they were encountering. So, we began teaching the students Latin and Greek word roots and the origins of words and broke down for them every word possible. This gave them confidence in their own reading as they learned to break down words for themselves, and were less likely to shy away from higher level reading because of intimidating big words. In addition, all students received a word journal which allowed them to write down words with which they were unfamiliar. The newsletter was an important tool to close the loop and follow up on parking lot questions. The parking lot also allowed us to immediately adjust our lesson plans to attend to misconceptions and adjust our teaching to the students’ strengths and needs. The parking lot and newsletter worked in concert with each other to give students ownership, as they had a hand in content, and had a powerful tool to strengthen their abilities in language arts and science.

Examples of Student Questions Posted on the Science Parking Lot			
Observations	Vocabulary and Scientific Language	In Depth Questions or Clarifications	Off-Topic Questions
I saw a rat on the way to school	What does accumulation mean?	How come you can't drill down to the middle of the Earth?	Why do leaves change color?
I found a neat rock	Why do scientists use big stupid words?	Can cementation dry like cement? Is it grey? Does it dry the way cement dries?	Do cockroaches have blood?
I saw lots of ants on a rock	How do you make words go with the meaning?	How big are the plates (tectonic)? How hot can it get? And what will happen when / if it brakes?	Are flowers in Montana the same as flowers in Chicago?
I saw on TV that there is a 13 th planet	What does compaction mean?	How does erosion break down sediment by chemical process?	How many dinosaurs were in the world?

Table 1. Questions. Examples of questions posted by students (presented here after correcting spelling and syntax mistakes). Names, when provided, have been removed.

Anatomy of a Newsletter

The primary intent of the newsletter was to respond to parking lot questions, as well as to review important points from instructional units. As more and more parking lot questions centered on language, we incorporated vocabulary builders and content words. As a scientist in the classroom with no education background, the greatest challenge for Amy was to gauge appropriate content level and language for the students. Through the parking lot and the newsletter, we were able to respond to those areas that were outside the students' reach. "Word on the Street" and "Science*ology" became parts in the newsletter and were articles dedicated to the language of science. "Science*ology" was an article that introduced an area of science and broke down words into roots. This article quickly became the class's favorite, as students realized the many flavors of professional science and gained word power. When reading together in class, students would quickly volunteer other words that contained the same root and infer meaning. The first time this happened it was quite magical, as several of the students spontaneously shouted out words and attempted to unpack their meanings. For example, when we broke down the word *Cephalopod*, head

foot, the students offered podiatrist, and even pedestrian, as having to do with feet.

Another important element of the newsletter that became quite popular and had surprisingly a positive impact was the "Science Fun" take-home experiments. Amy designed the experiments as quick little activities that were simple and done with materials that are easily and readily available in homes. These were entertaining activities (such as, bending water with static electricity) where everyone would get results. The intention was simply to reinforce the idea that science is everywhere. However, once again, with their newfound confidence, the students took it to the next level. The newsletter was given out on Fridays and we were surprised when students walked in the door on Monday morning discussing the results of their take home experiments. The discussions were wonderfully peppered with content words and further questions about why or why not a certain thing happened. Students compared procedures and results and were participating in a genuine scientific activity without knowing it. The parking lot was inevitably filled with questions about the underlying phenomena of the activities and why results varied.

The science activities also brought family and community into the learning experience, as students often included parents in the set up and performed the experiment for siblings and neighbors. Amy was very surprised one afternoon while waiting in the school lobby when a parent she had never met came up to her and inquired about the next edition of the newsletter. She stated how much she enjoyed reading it with her children and that everyone looked forward to the experiment. Parental involvement, such as this, is vital to the strengthening of science education in our schools.

Challenges

The parking lot and the newsletter are not without their challenges. They allowed us to balance staying on task and having healthy classroom discourse, but this could easily grow into a distraction for some classes. The parking lot was at its best when students were allowed to get up and post at anytime. Phyllis incorporated a number of science readings into her Language Arts class, and students were allowed

to get up and post to the science parking lot during that time. We both felt strongly that the students should be able to participate in science conversations at anytime, but some teachers may find this undesirable.

A question that comes to mind is: Do you need a scientist in the classroom to get full benefit from these techniques? It was useful to have Amy in the classroom as she knew the answers to a number of the questions off the top of her head, and she could quickly reference the appropriate Latin or Greek root. In general, it is helpful to have a content specialist available, and we cannot

National Teachers Academy
Science 311

Volume 1, Issue 9 Hot off the presses from the scientists of NTA room 311

From the Parking lot

- asked, "what do you call an animal that eats only fruit?" An animal that eats mostly or only fruit is called a frugivore. The suffix -vore comes from the Latin word vorare which means to devour. Vore is attached to nouns that describe what an animal eats. Some more fun words ending in vore:

Carnivore, eats meat
Herbivore, eats plants
Omnivore, eats everything
Folivore, eats leaves
Limnivore, eats mud
Insectivore, eats insects
Granivore, eats seeds
Piscivore, eats fish
Frugivore, eats fruit
Mycovore, eats fungus

Wow! Did you ever know that animals eat so many different things? What kind of vore are you?

A little more about Cockroaches

asked, "why do cockroaches have white blood?" Another way to think about this question is, why is human blood red? Our blood not only moves nutrients (food and energy), but also moves oxygen around our body. When you inhale air into your lungs, the oxygen in the air goes into our blood by special processes. Blood is made up of millions of cells. The oxygen attaches to a part of the cell called hemoglobin. Hemoglobin is red because it has iron in it. Remember from our mineral lab that rust is red iron and it is iron that gives human blood its red color.



different than humans so even though they have blood, their blood does different things than our blood. A cockroach has blood, but it does not circulate through veins and arteries the way our blood does. Blood sloshes around inside the insect and is moved by the heart. The main job for cockroach blood is to move nutrients around the body. Since cockroach blood does not move oxygen around, it does not need hemoglobin or iron, so it is not red! So, if blood does not move oxygen around a cockroach, how does a cockroach breathe?

All animals breathe through their mouths and noses, right? Not cockroaches, they don't even have lungs! Along the side of a cockroach's body are tiny holes called spiracles. Oxygen enters the cockroach through these holes and follows the tiny breathing tubes called tracheae to all of the cockroach's body parts.

For more cockroach answers, visit: www.bio.umass.edu/biology/kunkel/cockroach_faq.html

Cockroaches are very

Science * ology

If it is out there, there is a science that studies it!

Entomo / logy

Entomo means insect / logy means study of. Entomology is the study of insects. Insects are the largest group of animals and make up 3/4 of all living animals. There are over 900,000 different species of known insects (there are still some we haven't found). You may think that insects are gross, but they are very important because they help plants grow and break down waste.

Figure 2. Science 311. An example of a newsletter that addressed student parking lot questions and incorporated word roots.

emphasize enough the benefits of this relationship between higher education and elementary education, but there are a number of ways around this issue for classes that do not have access to a similar program. In fact, the parking lot and newsletter structures can be seen as a safety net for teachers. Not only do they make the class, the students, and the teacher responsible for finding an answer, but they also help students realize that science is a practice where everybody continuously learns, even the experts. Students gained a lot of respect for Amy when she admitted that she had no clue about a certain question and she posted it on the Parking Lot.

Science Fun

The Queen of Hearts Holds a Glass of Water

I challenge you to get the queen of hearts to make the water stay in a glass when the glass is turned over. Think you can do it?

Here's what you'll need for this experiment:

1. An ordinary drinking glass (the mouth has to be smaller than a playing card).
2. The Queen of Hearts from an ordinary deck of cards (actually any card from the deck will do.)

Now, you'll want to perform this experiment over a sink to ensure that we don't get the floor soaked.

Here's how you do it:

1. Fill the drinking glass half way with water.
2. Place the queen of hearts over the top of the drinking glass making sure that the card covers the entirety of the mouth of the glass.
3. While applying pressure on the card gently turn the glass over. Once the glass is completely turned over remove your hand from the card. ZALOOM! The card should now be held in place under the mouth of the glass without any assistance from you, without the water rushing out of the glass.

How did that happen?!

Well, it's a little thing I like to call air pressure. It goes a something like this: You know how when you go down to the bottom of a swimming pool you can feel all that water pushing in on you? Well, even though you can't see it, we live at the bottom of an ocean of air that's always pushing in on us. The air around the card actually pushes up against the card harder than the water pushes down on the card. In fact, you would need a glass of water almost 30 feet high before the water would weigh enough to push the card off the glass.

Looking for more fun home experiments? Surf over to, <http://www.geocities.com/TelevisionCity/Set/4567/ex.html>



Figure 3. Science Fun. A page from an edition of the science newsletter, with an example of a take home activity.

Students realize that it is ok not to know, but what is important is taking time to find out, which leads us to another challenge, time.

In many ways, the parking lot saved a great deal of time, as we were able to table random questions and stay on task. But, on the other hand, it took time to do the newsletter. Again, the SKIT program provided a unique support that allowed time for the newsletter to happen. Teachers working without such support can change the frequency of the newsletter or increase student involvement in the development and research, furthering the integration with language arts. It is the heavy blending of language arts and science that we find the most powerful aspects of the parking lot and newsletter structures.

Benefits

There are so many benefits that the science parking lot and newsletter structures offered the students that

we were thrilled by how they came alive. The parking lot's foremost success was supporting student confidence and risk taking. It allowed students to maintain dignity with off-the-wall questions and build confidence and comfort as they realized that science was about questions growing from observations about the world around them. In a neighborhood in the middle of a large city, a neighborhood that has been undergoing many changes and has been facing many challenges, students opened their eyes to the natural wonders of an urban setting. A couple of students wondered why there were bunnies on one side of the street and not on the other. They took their free computer time during the week and researched this question that grew from their own observations, with no prodding from us. Students took charge of their learning. Many students checked out science books for free read and discussed them among themselves. Science was now a real, tangible, and social activity for them. The legitimacy of the parking lot and the newsletter offered them the freedom to

explore any topic, and the support related to scientific language gave them greater access to science content.

The anonymity of the parking lot gave students, who were less likely to ask a question in class, an avenue to pose their wonderments. Dina, a wonderfully intelligent young girl would never actively participate in class in the beginning of the year. Her writing showed that she had ability, but it was the parking lot and newsletter that gave her an opportunity for safe participation. Towards the end of the year she blossomed into an active and vocal participant, often taking charge of her small group. Other popular students no longer worried about their image and could participate fully in science discussions, even if only through posting and reading the answers in the newsletter. Michael was quite confrontational and resistant in class, but he would frequently sneak a post-it note and ask very perceptive and deep questions that more than

once took the class into very interesting territory. We loved to watch as he would suddenly lean forward and intently listen to the conversation on something he had just discounted moments earlier, and then write something down in reflection.

A great benefit to us as teachers was that we had a tool for immediate evaluation of how students made sense of ideas in a lesson. It showed where the holes were in the lesson or activity and where we needed to review. The parking lot helped gauge the appropriate level as well as student interests. The newsletter allowed us to create our own curriculum geared toward the needs of our classroom and in keeping with the Illinois Learning Standards. Students also had a text they could take home with them at the end of the year that was directly connected to their experiences and their community.

Concluding Thoughts

Amy has moved on to another school, but Phyllis has continued to collaborate with the seventh grade science teacher. The seventh grade science teacher has noted that students that benefited from participation in the SKIT program brought a greater interest, attitude, and content engagement to her class. There has also been a marked increase in science fair involvement and many students still profess an interest in science as a career. Phyllis has also continued to include science readings in her literacy block.

For students, science class became a personal activity. The crowning example of this was their field trip to the Field Museum of Natural History at the end of the year. Students made it into a learning experience rather than just a day away from school. They read and discussed exhibits and stunned the tour guide as they were able to quickly answer questions and were not shy communicating with her. They were comfortable because they had been prepared for the experience through the language support, the confidence building throughout class discussions, and the freedom to be unafraid. They had a special opportunity to visit the research floor and see real scientists in action. It touched us deeply to watch the class march silently, for once, down the long hall together, peaking into labs and offices. They were not intimidated by the fossil preparator who had

graciously allowed them to visit her lab, because they were scientists too.

On the walls of the Geology Department hall, there are pictures of significant Field Museum geologists. At the end of the hall, Amy stopped the class to see if they noticed anything about all the people on that wall. One student shyly raised her hand and said that she noted that they were all men, and another student timidly offered that they were all white. Amy told the students that they were correct and that many often refer to it as the wall of the “dead old white men.” She related to the students that this was why she and Phyllis were working together and that is the goal of SKIT, to get their faces on that wall. We all looked at each other, in a moment of reflection, almost tearing up a bit.

As teachers of science we need to always remember that science can only seek answers of questions that scientists themselves pose and, so, *who* is practicing science is vital to the future of science. The Parking Lot was a tool that gave these young African American students the support they needed and the confidence to pursue science because they were able to access, achieve, and learn science at their own ability, engagement, and interest levels.

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Lessons on Teaching and Technology from *Roomba*!

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One of the authors noticed that his vacuum was losing its effectiveness and usefulness. In fact, there were times when there appeared to be more dust on the outside of the canister as inside it. That is an exaggeration, but the point is that it was probably time to make a change...so, being the adventuresome individual he was, he decided to try one of those robotic vacuums. Now, this is not an advertisement for the *Roomba*TM or an endorsement, but rather an attempt to share the lessons *Roomba* has brought to light about life and education.

Roomba, the name given to this flattened fourteen inch circular disc-shaped cordless robotic vacuum cleaner, is designed on the basis of the chaos theory, sometimes called the butterfly effect. This theory proposes a non-linear dynamical system. This vacuum travels forward monitoring and removing the dirt, debris, and even dog hair from the carpet and hardwood floors. When it comes to a concentrated area needing serious attention, it begins spinning slowly in circles a few rotations and then returns to its straight path. When it bumps into furniture or the wall, it turns a few degrees and continues to seek forward momentum. Since it is a flat disc, approximately two inches high, it goes everywhere, even under furniture, like seldom done with traditional vacuums. There was much skepticism about whether a vacuum the size of a large FrisbeeTM was going to be of any justifiable use. When it became apparent that there was truly nothing “space science” about *Roomba*’s pattern or process of conquering the dirt on the floor, disappointment followed. There were, however, lessons to be learned from this piece of twenty-first century technology.

As of late, the authors have been focused on changes in how we teach and how technology should affect the way we teach. This is a vital area in middle school education, as well as in all areas of schooling due to the fact that technological advancement has

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grown exponentially in the last ten years. Not only has technology mushroomed before our eyes, but educational budgets and cost-per-student factors have increased as well. Though not highly publicized, the Higher Education Price Index¹, an index used to judge the cost of education, has risen sixfold in the last forty years, and much faster than the Consumer Price Index (Guskin and Marcy, 2002). What has developed is that technology has so improved that it is now almost impossible to accomplish without technology what can be accomplished with it. That makes technology a required and vital component of education, but herein lies the problem.

We cannot continue to reinvent the wheel by duplicating the same practices and procedures with computers that have been accomplished without them...at least not without exponentially rising costs. We must, in the words of Twigg (2005), “use technology intelligently to make a real difference” (p. B12). With the traditional structure of educational delivery the cost of education has, actually, far outpaced the cost of living; as evidenced when comparing the Higher Education Price Index with the Consumer Price Index. Thus, at the present rate of increase your middle school students today will be unable to pay for a college education in the next four to six years, if this trend continues. State

and federal government aid programs are not going to offer more support than the cost of living. Twigg (2003, 2005a, 2005b), as well as Levine and Sun (2002), have all pointed out the lack of cost effectiveness, which is not only making a college education an impossible goal for most students in the future but, will adversely affect the entire system of higher education and the quality of those aiming for careers in education. In practice what has occurred in the last ten years in kindergarten to the undergraduate level is that we have kept the same traditional mode of instructional delivery while adding the new technology. In other words, the cost factor to educate a student in your school has risen exponentially due to the practice of continued delivery of education in the traditional mode by our utilizing technology to duplicate instructional delivery. Twigg (1996) warned of this “silver bullet” admonition, by stating: “As you design mediated programs, you will find that the more you replicated the traditional campus model, the more your operating costs will resemble or exceed traditional campus cost...you will save money only if you substitute one function for another function at less cost (p. 7).”

Guskin and Marcy (2002), likewise, noted that cost effectiveness will only occur when duplication is avoided, and this will occur only by redefining learning and instruction as has traditionally been restricted to mean that students can only learn in groups and at specific times of the day. In other words, the traditional restrictions placed on the present structures and processes of higher

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education institutions not only restrict reform, they will eventually undermine the two components which have assured past success in higher education: quality of faculty and student learning.

Here is a vital question we believe applies to our present education and our school classrooms and upon which teachers and administrators must begin focusing on if they have not already done so: *Is our use of technology benefiting my students, or is it just a “newer” way to do the same old tasks?*

With this focus question in mind, we return to the lessons which *Roomba* has taught one of the authors about education from the use of technology. These lessons focus on instruction, strategies, and short-cuts.

We must be able to
locate the problem
areas.

Like *Roomba*, as it utilizes a sensor which detects when dirt is concentrated and needs additional attention, there must be a means in our curriculum which permits us to determine where the “dirt” is located before we can expect to clean it up. We are sometimes cleaning clean floors and ignoring, or entirely missing, the areas that need it the most. We often duplicate duplications. We must require the system to change from summative to formative assessment, or at least make formative assessment the criteria for driving our curriculum and our instruction. According to Tuttle (2007), the classroom that is standards-based will have pre-assessments, embedded assessments, and post assessments. Although each of these assessments is important, the majority of assessments used within the classroom must be embedded assessments. Tuttle asserts that 80% of the assessments used within a standards-based classroom should be embedded. The purpose of embedded assessments is to monitor progress of students toward the preset standards. Even the traditional short quiz can be utilized as a proactive means for assessing student progress if the

purpose is diagnostic (Martin, 2007). When teachers use embedded assessments they have the tools to reflect, adjust, and develop teaching strategies to aid in the achievement of students. Basic technology can be used to modify embedded assessments throughout the unit to insure that students demonstrate the understanding of the standards but in a different way each time an assessment is given. We cannot, and will not, succeed in changing the system or our own classroom strategies until we are able to soundly identify the problem areas, and this is going to require actually monitoring and adjusting strategies.

Teaching strategies should always be driven by research. Along with the data-based strategies there should also be assessments that provide useful feedback to the teacher. This feedback would allow the teacher to monitor and adjust teaching strategies and methods to ensure mastery of concepts being taught. Most school districts, for instance, have a means for classroom teachers to evaluate student knowledge, but most teachers do not have the time to utilize that data in a manner that provides them with criteria for adjusting the curriculum or with providing each student with the needed intervention (Puko, 2007). This, therefore, is both a teacher-problem and a system-problem. Both need to be adjusted. Most educators have an idea of where significant changes need to occur in the system and in instructional strategies, but it is time that we put the rigor needed to substantiate our lists, and to then convert it into a plan for change.

We must provide
additional attention
to needy areas.

It is not enough to create our list of problem areas. We must take the next step. Roomba would not be very effective or efficient were it to just run around the room at the same pace at the same moment. When working with students we must realize that learning should be the constant and we need to try to avoid capitulating to a system that makes time the constant. We are often tied to a time

table rather than to insuring our students are learning and mastering the concepts given. Some students need additional time and help, and until we learn to accept and work the way they learn, we will continue to take the blame of failure for a system that was designed for a very different time and era.

Our system does not utilize the chaos theory though it certainly seems chaotic at times. Roomba moves along in forward motion until it encounters either an obstacle or an area where dirt is concentrated. Upon encountering the dirt, it stops, backs up slightly, and then proceeds to spin in a circular motion over the area of concern. After a few revolutions in the troubled area it is off again in a forward motion. If, however, it encounters an obstacle (and we have lots of these in our classrooms, schools, and districts), then it stops and makes slight adjustments, moving forward and veering slightly in its directions. If the obstacle continues to obstruct, then Roomba repeats the process until it is free to continue in a forward motion. If that obstacle proves to be a wall, Roomba seeks a new direction in order to complete the task.

For most of our educational units in our twenty-first century American educational system, we simply run into an obstacle or two and we stop. The system or the convention often becomes our wall of prevention impeding success. Fortunately, we already have many of the important components in place. For instance, we have a system of assessment, but we fail to capitalize on these due to system traditions and conventions. We do not, however, have a functional system in place that checks, monitors, and habitually informs teachers of the students' understanding, and namely because of a lack of time we often neglect the problem of intervention based on such data, or we conveniently sweep the problem (lack of achievement and motivation) under the proverbial rug (Goodnough, 2004).

The answer to this dilemma can possibly be found in the modern concept of mastery learning developed by Bloom (1968). According to Gentile (2004), "Assuming knowledge or skill is never as good as assuring it or at least assessing systematically to distinguish what has been adequately mastered and what has not" (p. 15). We

Traditional Learning Environment	New Learning Environment
Teacher-centered instruction	Student-centered instruction
Single-sense stimulation	Multisensory stimulation
Single-path progression	Multipath progression
Single media	Multimedia
Isolated work	Collaborative work
Information delivery	Information exchange
Passive learning	Active/exploratory/inquiry-based learning
Factual, knowledge-based learning	Critical thinking and informed decision making
Reactive response	Productive/planned action
Isolated, artificial context	Authentic, real-world context

Table 1. Comparison between traditional learning environments with what is proposed as the “new” learning environment needed to help students’ succeed. From Shelly et al., p. 2.

might, early in our career, have tried to adjust and move on in a progressive and forward fashion, but upon bumping into another obstacle we begin to wear thin until we conclude that we cannot change the system, or that the system is unchangeable, or worse still, we were convinced by others that all is copasetic and that the system is not in need of being fixed. But, if that is the case, then we have failed to remember that our students are not robots nor are they parts traveling down a conveyor belt. We are educating, not mass assembling gadgets on an assembly line, yet we continue to operate as though students are going through the factory. Even school board members are beginning to recognize that

We must realize that learning should be the constant and we need to try to avoid capitulating to a system that makes time the constant.

factory schools are not succeeding (Steiny, 2007). Our students, more so now than ever before, are non-linear learners, have various learning styles, and often require differentiated instructional strategies in order to truly benefit from the classroom experiences (Tomlinson, 1999) and accept the fact that one size does not fit all (Rose, Meyer, Strangman & Rappolt, 2002). Fischer and Rose (2001) illustrates this change with digital learners that: “The process of learning is better represented by a web than a ladder.”

We have, in the past, considered student learning styles in a perfunctory fashion, and apart from small infusions of minor accommodations involving multiple intelligences, our classrooms have not really changed or adapted to learning style concepts during the last twenty years. Some educators now, such as Shelly, Cashman, Gunter, and Gunter (2008), proposed that it is time we established a new learning environment in order to meet the educational needs of our present generation of students. Currently, NCLB holds that our students need more testing (Guilfoyle, 2006; Clapman, 2005; Pryzbyla, 2004). Cashman et al., however, proposed that such a change can only occur if we incorporate new strategies. Table 1 compares their concept of the traditional versus the new learning environments (p. 2).

The rationale for creating a new learning environment is that today’s students, the “digital generation,” have different learning characteristics

simply due to the *era in which they have grown up*. They have changed but the system remains the same and we wonder why we are losing ground. Again, Shelly et al., have provided a comparison of previous generations to today's digital students (p. 16). See Table 2.

One can see from a comparison of the two tables that the Cashman et al. proposal is to simply identify the needs, habits, and paradigms of the present digital generation and then to construct educational strategies which meet those very needs. For example, we are being told that students today learn best if relevant. This, however, is not new to us for Fischer stated, "Now that relevance has become the rallying of a younger generation, perhaps it will be properly investigated (p. 162)." This statement however was written in 1970! Presently, one-half of American dropouts report that they did so because school was not relevant or seemed important to their lives (Chen, Chung, & Johnson, 2007). By identifying the problem, like Roomba, we are able to concentrate our time, attention, efforts, and resources in changing the learning environment (Brucato, 2005).

We must realize
that there is no
easy solution.

The purchase of the Roomba led to excitement over the prospect of the vacuum doing all the work! The general public and many politicians, as well, think teaching is easy work. The logic appears to be that everyone has sat in a classroom at some time in their life, therefore, anyone can teach, and that teachers hardly work. Anyone who has been around the profession or is married to a teacher knows this is not the case. That was not to be the case with Roomba, either. This robotic vacuum did save time, but it required its own maintenance, namely, cleaning out the canister and cleaning all the internal brushes. If it took twenty minutes to vacuum a room, then it took approximately ten minutes to clean the machine and its numerous brushes. The canister was a cinch, the brushes, well that was another story. Granted, that still is not a bad tradeoff of time versus effort, but there was no easy way; no getting out of work. The fact is that there is nothing easy about teaching, being a teacher, or educating students. And yet we cannot allow this fallacy to be our excuse for not adapting to the changes that have occurred since the conception of the American system of education during the early industrial revolution.

Whatever results we do to produce it is going to be hard work, if we truly care about helping students to succeed. We either put forth the effort in pushing the manual vacuum hose around the dirty floor or we are going to put forth the effort in tediously cleaning the innovative systems of brushes.

Previous Generations	Today's Digital Generation
Passive communicators	Hypercommunicators
Single taskers	Multitaskers
Work oriented	Play oriented
Linear thinking	Random access
Nonrelevancy learning (relevancy was not critical to learning)	Learning has to be relevant and fun
Single sensory input	Multisensory input
Text-based first	Digital and graphics first
Reality-based	Fantasy-based learning
Conventional speed	Twitch speed

Table 2. Comparison between previous generational students with today's technological savvy generation. From Shelly et al., p. 16.

Either way, it is *work*. And, arguably so, to do nothing is also going to create more work, for someone will eventually have to pay for the clean-up of our strained economy, rising crime rates, and high unemployment rates as third world nations rise to take the mantle in the every-growing global economy. Is this being pessimistic? We contend that it is being realistic.

Therefore, let us just accept that there is no easy means of change, nor is there some magical silver bullet that will take care of our current issues in educating students or improving our system of education. Effective teachers work hard. We need to dispel the myth that teaching is not real work. An effective teacher is one who goes the extra mile to ensure learning is taking place. There is no quick fix to the problems we have in our science classrooms, our schools, or our districts, and these are numerous (Knowledge Works, 2006). The solution is for teachers to step up and do whatever it takes, and that may mean readjusting our course a little, our school, or our system, like Roomba, and continually moving forward until the task is completed. One of the most often repeated accusations against education is that we never stay with one strategy long enough to determine whether it significantly improves learning.

There are no short-cuts in education. Try as we may we are either going to have to physically push the hose or tediously clean the brushes. Johnny is not going to do well in your science course if he cannot read the textbook, and he surely will not do well if your method of teaching is to regurgitate a textbook that he does not consider worthy of his time and attention. Answer? Identify the problem. Monitor the progress. Make the changes needed to put learning as the constant variable in education and not time.

We admit that there are not any short-cuts, and we often falter when it comes to admitting that change requires funding. Though the No Child Left Behind act has several major flaws, the weakest link is in the shortfall of promised funding and the idea that all students will rise above average (Growing Chorus, 2006; Lecker, 2005). But that defies mathematics. States and school districts are well overdue in the revamping of their funding systems,

We can change and compete or we can become non-relevant and accept the results.

formulae, allocations, and subsidies. We will always get what we pay for, and when it comes to quality it would seem that our children should have the very best that is reasonably possible.

A great deal has been learned from observing Roomba at work. Technology, however, is not the answer. Technology is only a tool to help facilitate finding and implementing the answers to our problems. Technology is always changing. What is useful today may not be so in five or ten years from now. Our focus should not be on technology but on how to identify our problems, adjust our curriculum and our teaching strategies, and then use all the technological tools we can to facilitate student achievement.

No one today would want our soldiers to go to war with weapons designed and produced for World War I. No one would think it wise to structure our military corps as they were structured in the First World War. So, why do we expect educators to function as the system did in its formative years? As good as Roomba might be, it has its limitations. It is slow, takes time, has to be able to locate its battery pack, must be recharged after several hours, and the brushes must be tediously cleaned. In a few years Roomba will become obsolete. It would keep the house clean now if everything is picked up off the floor and the brushes kept clean. Did it solve all the cleaning problems? No. Did it do all that was hoped? No. Was it the silver bullet of housecleaning? No. In fact, a few months ago an order was placed for a Dyson™. The Roomba is still used occasionally to supplement a thorough cleaning. Remember, technology is only a tool! Tools change, but the job of cleaning the dirt does not...so we have to adjust in order to complete the tasks in the best way and in the most effective and efficient manner possible.

Having identified problem areas, like Roomba, we then concentrate our efforts and resources in changing the learning environment. We must realize that there are no short-cuts and that we will reap exactly what we sow, get exactly what we pay for, and we must accept the fact that a system does not have to be completely broken to need work, or that what has been successful with past generations is necessarily going to be successful in today's classrooms with today's students. However, our students are at risk...all of them. Hard work is needed to make changes for this generation. We can change and compete or we can become non-relevant and accept the results. In closing, one of us recently heard a statement made that seems appropriate to share here. The speaker explained how several decades ago Smith-Corona proudly announced that they had just created the perfect typewriter. This, however, quickly became moot, as computers quickly annihilated the Smith-Corona market which failed to adapt to the changes that were occurring in technology. Can we change? Yes, we can. Must we change? Yes, we must if we are going to do what is best for our students, stabilize our nation, and provide a future for our grandchildren, then we must. Roomba will, in a few years, be sitting in that proverbial closet with all the other gadgets that are no longer relevant to the owners. However, it is our desire that the lesson this technology has taught us for education will not only be put into play, but that our children excel and achieve as a result. A plan for intervention far surpasses a plan for remediation. Let us aim to restructure and redesign where restructure and redesign are needed. Our future truly is our children.

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Endnote

1 A version of the Higher Education Price Index is also available at: http://www.umass.edu/oapa/publications/factbooks/05-06/finances/FB_fi_03_bot_2005.pdf

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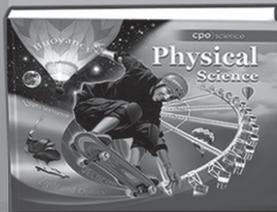
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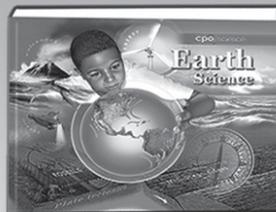
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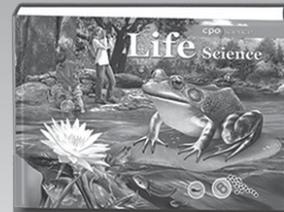
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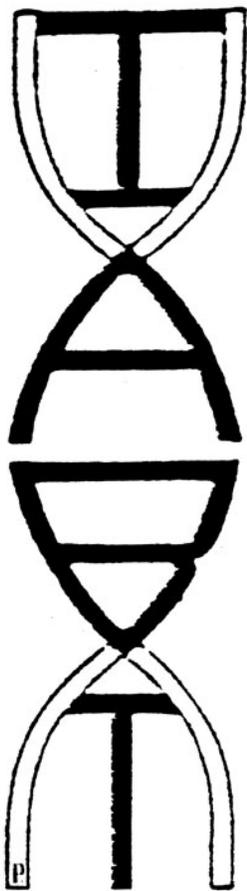
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