SPECTRUM

ISTA

Winter 2014, Vol. 39, No. 3

The Journal of the Illinois Science Teachers Association

In this Issue: Developing Transfer Skills in a Biochemistry Class
Prescription for Pedagogy: Curriculum, Clean Water, and Drug Disposal
Considering the Science of a Classic Toy
Making Science Matter: School/University Partnerships

Plan Ahead:
NSTA National Conference on Science Education - April 3 - 6, 2014 in Boston, Massachusetts
STEM Forum and Expo - May 14 - 17, 2014 in New Orleans, Louisiana
NSTA National Conference on Science Education - March 12 - 15, 2015 in Chicago, Illinois

Illinois
Science
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Association

Spectrum

The Journal of the Illinois Science Teachers Association
Volume 39, 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: Illinois Governor Pat Quinn, ISTA President Paul Ritter, and Illinois students pose after the signing of Illinois Bills 2056 and 2053 regarding prescription drug disposal; see pages 25 - 31. Photograph by Megan Bozarth.

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*.

SPECTRUM

The Journal of the Illinois Science Teachers Association

Winter 2014 Volume 39, Number 3

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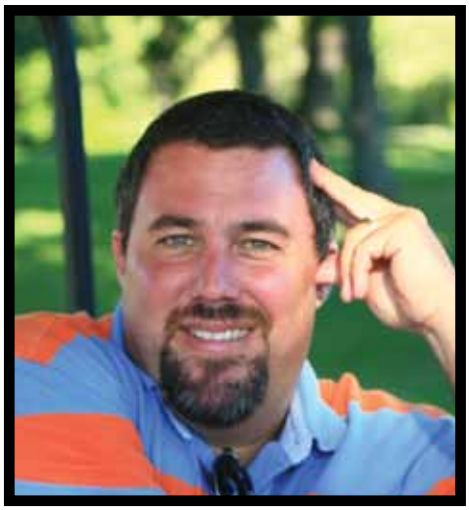

So many amazing things happened last year in ISTA, including the year's Illinois Science Education Conference (ISEC) which was held in Tinley Park, Illinois. It is tremendous to think that we had around 1050 participants in this year's conference. That amazing number includes three hundred plus administrators on Thursday, over seven hundred attendees on Friday, and a record setting two hundred people on Saturday. All I can say is "Wow!" I am so proud of the turnout. With that being said, I am very excited and looking to what the coming year has to offer. To start out the new year, on January 31st I was in Carbondale at the always exciting Science in the South conference. Each year educators from all across Illinois converge on Southern Illinois University at Carbondale to exchange ideas, Science in the South.

A great opportunity is the 2014 National Science Teachers Association Conference which is April 3rd through the 6th. This year's strands are Science and Literacy, Teaching Elementary Science with Confidence, Leading from the Classroom, and Engineering and Science. I just can't wait to be a part of this wonderful learning opportunity.

Speaking of NSTA… NSTA 2015 will be in Chicago. NSTA has asked if we would like to have the honor of having our members as ambassadors for different portions of their conference and we jumped at the chance. Please keep this in mind as we will be sending more information on this at a later date. I am so excited to have our national convention in our great state.

There are many opportunities out there and ISTA is working very hard to make sure that we meet your needs as we move forward with the roll out of the Next Generation Science Standards (NGSS). In regard to the NGSS, it is likely that the ISBE will adopt the standards sometime early in 2014, and ISTA will make sure we are actively providing opportunities for you.

It is my honor and privilege as president of our amazing association to wish you and your family a wonderful 2014. Thank you for all you do to positively change the lives of the children of Illinois and beyond.

Paul Ritter

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in Chicago at McCormick Place

March 12 - 15, 2015

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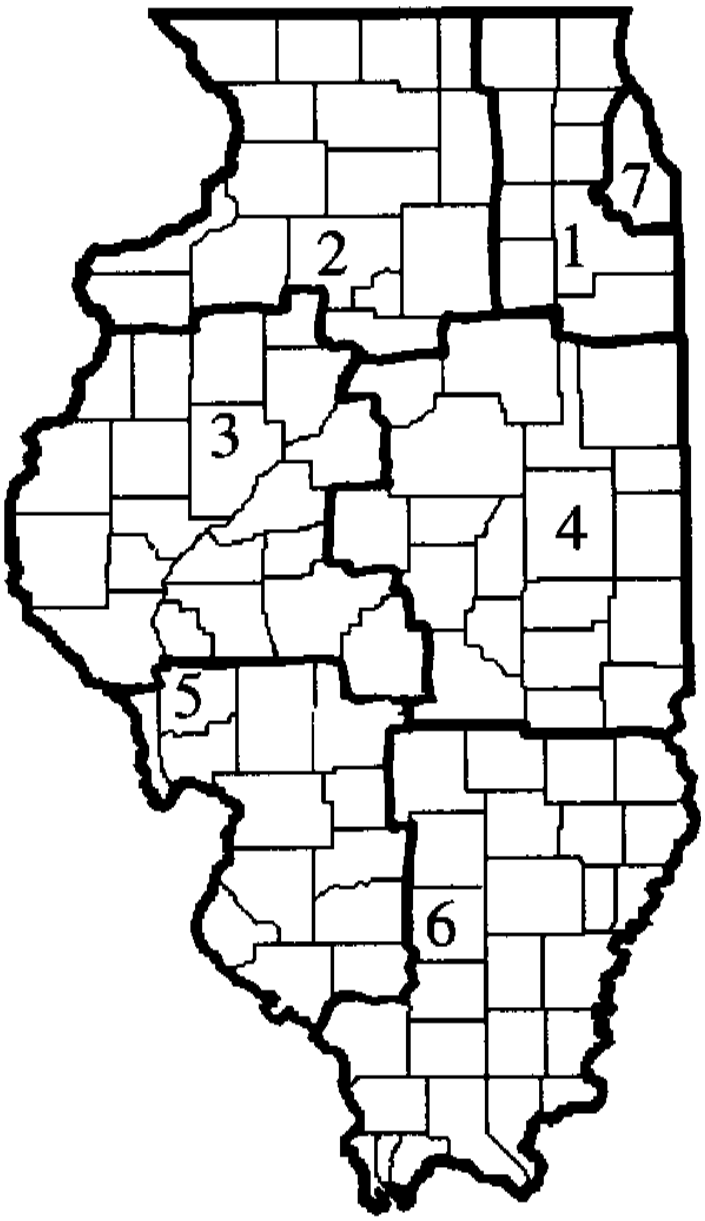

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According to ISTA bylaws, regional directors may serve only two consecutive terms. Directors noted with an "a" are in the first of a two-year term; those noted with a "b" are in the second consecutive two-year term.

ISTA membership options

Option 1: Full membership dues -- $35
Benefits:

- One-year subscription to SPECTRUM
- Reduced rates for conference registrations
- Voting privileges
- Opportunity to hold an ISTA elected position

Option 2: Two-year full membership -- $60
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Option 3: Five-year full membership -- $125
Full membership benefits for five years.

Option 4: Associate membership -- $15
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Option 6: Initial certificate option -- $20.
Full membership benefits for beginning teachers in first four years of service.

ISTA Regions

Additional membership options

Thanks to collaborative agreements with affiliated organizations, ISTA offers additional memberships for convenient shared benefits and mutual savings. Details are shown on the ISTA website (www.ista-il.org) and websites of our partners below. Select from the following one year additional memberships by circling your choice.

•FFSE--Fermilab Friends For Science Education
http://ed.fnal.gov/ffse (normally $10)---------- $4

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http://isaapt.org/
College faculty ---------- $20
K-12 faculty ---------- $10
Pre-service teachers or retirees---------- $00

•IACT--IL Association of Chemistry Teachers
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•C2ST—Chicago Council on Science and Technology
www.c2st.org (normally $25-35) ---------- $00

•EEAI--Environmental Education Association of IL
www.eeai.net
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Organizational (normally $75)---------- $65
Friend (normally $50) ---------- $40
Patron (normally $100) ---------- $90

•CESI--Council for Elementary Science International www.cesiscience.org
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Regular membership (normally $20) ---------- $14

TOTAL MEMBERSHIP DUES

ISTA Option #_____ ---------- $_____

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TOTAL----------$_____

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Illinois Science Teachers Association Membership Application

Complete the following form in its **entirety, printing legibly**. Your contact information will not be shared with anyone except for the organizations you choose to join via additional membership options. We take all reasonable precautions to protect your privacy. The *SPECTRUM*, other ISTA mailings, and email will be mailed to your home unless you indicate otherwise.

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☐ Other: _____

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Thank You IPRB!

NSTA National Conference on Science Education

Boston, Massachusetts

April 3 - 6, 2014

Future Science Education Conference Plans

(tentative)

2014 NSTA National Conference on Science Education in Boston, April 3 - 6, 2014
2014 STEM Forum and Expo in New Orleans, May 14 - 17, 2014
Fall 2014 Science Education Conference, Southern Illinois
2015 NSTA National Conference on Science Education in Chicago, March 12 - 15, 2015

Outstanding Teachers of Science

Gretchen Brinza

Gretchen M. Brinza, engineering specialist (K-fourth grades) at STEM Magnet Academy in Chicago, took a huge leap professionally when she left the comforts of teaching middle school math and science and walked into a completely new field - engineering - at Chicago Public Schools' first STEM-focused elementary school. Strengthening science literacy for all students has been her lifelong professional goal and she realized that developing herself professionally both inside and outside of the district would be pivotal in her success. She strengthened her science content knowledge by enrolling in the University of Chicago's SESAME program which led to a position teaching space science. Even when the toughest group of students walked into her room she reversed their "checked out" mentality by incorporating the SMART board into her teachings. This motivated her to apply and be accepted to the 2012 Mickelson ExxonMobil Teachers Academy to better engage her third and fourth grade students. She is always willing to try new learning activities to engage students from all parts of the academic spectrum, to execute a formative assessment strategy to guide instruction, or to reach out to someone with more expertise. According to Suzanne V. Mazenis-Luzzi, instructional support leader for CPS, "In her current role as the engineering specialist and a teacher at STEM Magnet Academy…, Ms. Brinza has taken extraordinary steps to work with the staff on finding the engineering connections in their teaching, both in literacy and math." In addition to her own learning, Gretchen has shared her pedagogical style and innovations with other teachers in her district. Barbara Dubielak-Wood, science specialist, CPS Department of Mathematics and Science affirmed, "(S)he has been an ongoing contributor in the Department of Mathematics and Science to the grades K-5 focus group engaged in the development of the CPS Science Planning Guides. These Planning Guides provide teachers with an outline of the standards, core ideas, practices, and crosscutting concepts to be incorporated into science learning." Last but not least, Gretchen has been selected as a state level science finalist for the Presidential Awards for Excellence in Mathematics and Science Teaching which solidified that the little accomplishments along the way - from grants, to scholarships, to the "thank yous" from parents - add up to an extraordinary job. We are lucky to have Gretchen as one of our award winners this year. Our best to Gretchen!

Elizabeth Slifer

Elizabeth G. Slifer, fourth grade teacher at Carrie Busey Elementary School in Savoy, has incorporated various technological tools to enhance her students' knowledge of current events in science. Elizabeth piloted the PBS LearningMedia which allowed her to use PBS videos and interactives to support her classroom science curriculum. According to Molly Delaney, educational outreach director, Illinois Public Media, "Through the PBS LearningMedia Elizabeth's students went on virtual field trips, studied animals, and investigated space. She even encouraged her students to take *brain breaks* throughout the day with a dance interactive from *Fizzy's Lunch Lab*. By doing this, Elizabeth helped her students establish healthy habits and understand

the relationship between movement and maximum brain function." Elizabeth is also creative with technology in her classroom. She records her classroom presentations, her students create iMovies, her students wrote shape poems on science themes then posted them on YouTube, and she had a videographer demonstrate lighting when they were studying a unit on electricity. Because of her use of digital learning in education, Elizabeth was selected by local television stations as a PBS Teacher Core member. She has developed an embryological curriculum that focused on the Common Core State Standards. The students observed baby chicks and once they emerged, they wrote two voice poems about being inside the egg and coming out. She has currently authored a Woodland/Forest Ecosystem unit for her school district that she presented at the ISTA conference this year. Kristin Camp, K-12 Science Curriculum Coordinator for Champaign School District Unit 4 shared, "She piloted the unit and the accompanying field trip to the woodland, and helped revise it as necessary to provide a quality learning experience for all teachers and students. Learning experiences in the unit include: acting out the roles of tree parts; creating an illustration of the various inhabitants of each woodland/forest layer; observing animal signs in the forest; acting out a food web; dissecting owl pellets; and investigating woodland/forest management strategies." Elizabeth has served nine years as the Science Building Leader at her school. In this capacity she has worked to distribute kits in an equitable fashion to all classrooms in the district; monitored assessments for each science unit; and kept the teachers in the building informed of district, state, and national science news. Needless to say Elizabeth exudes the excellence ideal for an outstanding teacher. Congratulations Elizabeth!

ISTA's Outstanding Teachers at ISEC 2013.

Outstanding New Teachers of Science

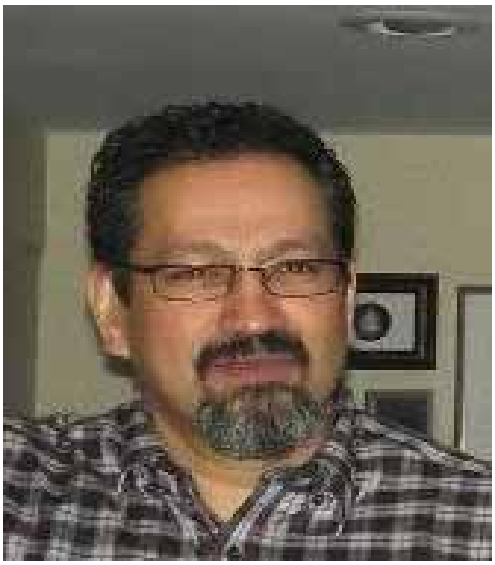
Liz Dabrowski

Liz Dabrowski, third grade teacher at Booker T. Washington (BTW) STEM Academy in Champaign, uses the STEM approach to help her students excel into well-rounded, scientifically literate individuals. Liz has demonstrated her excellence in STEM education by helping plan lessons for the state-of-the-art STEM laboratory at BTW; aligning curriculum with the national science standards and K-12 science ed framework; establishing best practices in inquiry teaching; and helping to prepare everyone in the department for NGSS. Her classroom is the epitome of inquiry and authentic learning, and numerous STEM volunteers from universities visit. She is also the master of collaboration and building partnerships. Liz and her grade level partner often co-teach throughout the day, which gives both teachers the support they need to further their students' experiences in STEM. Not only does she thrive in the classroom, but she coordinates social events like birthdays, showers, and engagement parties for her colleagues. During the past year she has completed the ISTA *Mentor Me* program and Dr. Sharlene Denos spoke very highly of her participation with her mentor. Tara Bell, STEM specialist and ISTA president-elect, said "(Y)ou can count on Liz to thoroughly accomplish the task with creativity, resourcefulness, and passion." It is easy to see why Liz has such a bright future as a STEM educator. Congratulations to Liz on being a winner!

Ashley Frantzen

Ashley Frantzen, seventh grade teacher at Castellanos Elementary School in Chicago, is in her third year of teaching. She has been selected to take on responsibilities that are usually reserved for veteran teachers. As science department chair in her school, Ashley has promoted collaboration within the department and has been leading the dissemination of integration of the Common Core with science and NGSS. Along with her chair position she has been selected to lead professional development for thirty middle schools on the engineering practices of the *Frameworks* and NGSS as well as CCSS for reading and writing, and she became a professional development leader to support high quality science instruction through the use of SEPUP material for a dozen eighth grade science teachers throughout the year. Ashley instructs them in best practices and pedagogy differentiation and critical thinking. If her leadership roles aren't enough, Ashley devotes numerous hours before and after school and during the summer to helping students with science literacy, homework help through Enlace Chicago, coaching softball, and implementing a robotics program for forty soon-to-be eighth graders. According to Hethyr Tregerman, director DePaul/CPS Math and Science Partnership, "[Ashley's] students take science concepts and content and apply them to real-world issues, such as analyzing the environmental impact of a product when selecting products to purchase, societal decisions, and personal health risks associated with poor water quality, how energy can be used more efficiently in a home, and how an understanding of motion can improve safety on the road." Obviously, Ashley is truly remarkable. We congratulate her on all her accomplishments and we can't wait to see what is next.

Sergio Hernandez



Sergio Hernandez, a sixth grade teacher at Madero Middle School in Chicago, shares a passion for learning with his students. Because of his knowledge, enthusiasm, and pedagogical skills, he was handpicked to become a SEPUP professional development leader (PDL), mentoring and coaching other teachers throughout Chicago Public Schools (CPS). He works diligently with other sixth grade PDLs throughout the year, planning, preparing, and delivering outstanding professional development sessions that walk other CPS teachers through the curriculum, allowing them to go back and implement it in their own classrooms. Hethyr Tregerman, science instructional coach, further elaborated, "In his role as a PDL, Sergio willingly mentors and coaches other teachers… bring(ing) out the best in his colleagues while leading these sessions and inspiring others to strive to his level of expertise. Leadership in his school is no exception. He represents science on the school's Instructional Leadership Team (ILT). Part of his ILT work included participating in voluntary yearlong training and meeting four times a year with other participating schools, called *early adopters*. This training focused on diving more deeply into the science reading (RST) standards of the CCSS for ELA; what they meant and what they looked like in practice; strengthening his ability as a teacher in the classroom, and sharing his knowledge with others through his leadership venues. Sergio's principal, Jose Luis Illanes emphasized, "The results have been that we have established a team that strongly contributes to improving student achievement, providing a better focus to the instructional delivery, and allowing for the movement of students to the next level academically." As his body of work with teachers continued to grow, he was specially selected to attend a Lab-Aids Leadership Institute in Colorado and to participate in a pilot web-based professional development program, NGSX, offered through Northwestern University. Sergio certainly has his plate full of science at its best. Congratulations and keep up your wonderful work!

Emily Mathews

Emily Mathews, sixth grade science teacher at Patrick Henry Elementary School in Chicago, enjoys watching her students grow as scientists through hands-on, engaging, and meaningful experiences. Her initial accomplishments as a new teacher were recognized in 2010 by NSTA when she was awarded the Maitland P. Simmons Memorial Award for New Teachers and she has continued to enhance her students' science knowledge by forming partnerships with the Lincoln Park Zoo and Purdue University. At the Lincoln Park Zoo she was part of the Young Researcher Collaborative Tier 1 (YRC). With this program, the students engaged in inquiry-based research comparing the ethology of an urban and zoo animal. Students developed original research questions; visited the zoo to gather animal behavior data; then collected animal behavior data in the schoolyard; and learned how to analyze and interpret their data, and present answers to their inquiry questions. Also at the zoo, students took on the role of researchers by using iPad technology to collect great ape data, then engaged in special presentations with the zoo staff. In 2012, she was one of only six teachers awarded YRC Tier 2 status and is the only educator on the zoo advisory board. She also partnered with Purdue University's Exploration Earth: Aquatic Adventures program where she received three freshwater aquariums. Her students organically cycled water to prepare the tanks for fish, and conducted chemical tests to measure and track pH, nitrate, nitrite, and ammonia levels. She then co-presented this project at the national NSTA conference in San Francisco in 2011. Emily is also part of a unique partnership with the arts. She coordinates the Chicago Arts Partnership

in Education in which a visual artist and she work together to create units where students can apply and contemplate the connections between art and science. Patricia Whitehouse, assistant principal at Stockton School said, "Her teaching style can be summed up as enthusiastic, and her students definitely become enthusiastic about science in her room. In a lesson about polymers, Emily had an entire class creating pink slime, dripping and oozing everywhere." Congratulations Emily! You are definitely an asset to your students and all the partnerships you have developed.

Brandon Rutherford

Brandon Rutherford, second grade teacher at Garden Hills Elementary School in Champaign, has been doing exciting and creative science for the past three years. Brandon received his masters certification from the University of Illinois at Urbana-Champaign (UIUC) and honed his skills for inquiry and a hands-on approach to science in those classes. During his first year, Brandon wrote a grant that funded his entire classroom with a set of Flip Cameras which were used by students as they developed projects about birds and insects. The videos the students made were then used to tie in literacy instruction into their portfolios. Presently Garden Hills is pursuing International Baccalaureate certification and Brandon has been the team leader in the development of the curriculum that includes inquiry and projects that integrate science in a significant way. In addition to all the work he is doing with the certification, he continues to enhance his classroom with fresh and saltwater aquariums that house a variety of creatures to inspire budding ichthyologists. According to Margery Osborne, associate professor in the department of curriculum and instruction at UIUC, "Brandon extends his own enthusiasm for science to children. I have witnessed how his enthusiasm for science is shared with his students and how they, in turn, share and internalize that same enthusiasm." It is clear that Brandon has a promising career in science education. Congratulations to Brandon. We look forward to seeing and hearing more about his enthusiasm for science.

Congratulations to ISTA's Outstanding Teachers of Science and Outstanding New Teachers of Science!

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Want to Volunteer?
Assistance is needed from reviewing session proposals to volunteering at the conference helping attendees, supervising field trips, stuffing conference bags, and more.

Local Contacts

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NSTA 2015

NSTA National Conference
Chicago, Illinois at McCormick Place
March 12 - 15, 2015

Chicago: Great Lakes/Great Ideas

Strand One: Natural Resources, Natural Partnerships
Sustaining natural resources requires collaborative partnerships among many stakeholders, and science is the key to making smart decisions about resources. Educators and students can engage with environmental groups, agencies, and businesses to build and support a sustainable future. This strand will help teachers identify possibilities and potential partnerships.
Goal: The workshops and presentations will focus on one or more of the following:
- Providing examples of successful partnerships and/or educational outreach efforts focused on natural resources
- Developing opportunities for new partnerships
- Demonstrating that environmental education can happen everywhere (e.g., in urban, suburban, or rural settings)
- Modeling evidence-based decision making to support a sustainable future, as described in the NRC *Framework* and the NGSS

Strand Two: Teaching Every Child by Embracing Diversity
All classrooms are diverse. Learners bring a variety of cultures, backgrounds, and experiences to the study of science. Educators must provide opportunities to meet the needs of all students, including English language learners, students with special needs, and those with diverse learning styles and abilities. Successful instructional approaches must address methods, materials, facilities, and partnerships. These sessions will confirm the belief that every student can excel in science.
Goal: The workshops and presentations will focus on one or more of the following:
- Sharing success stories in which educators and students have met unique challenges
- Providing research-based instructional practices for diverse learners
- Encouraging teachers to embrace and celebrate student diversity
- Providing examples of effective instructional methods for special needs, English language learners, and other diverse learners

Strand Three: The Science of Design: Structure and Function
Architecture and engineering provide the infrastructure for human-made systems. Designing for the future requires imagination and a commitment to sustainability. It also involves the crosscutting concepts of structure and function and the practices of science and engineering. Communities like Chicago provide examples of great design and great science.
Goal: The workshops and presentations will focus on one or more of the following:
- Describing how engineers and architects use the practices of science and engineering to improve our infrastructure
- Modeling how science, technology, engineering, and mathematics are used to create sustainable systems
- Integrating science and engineering with other disciplines, like visual arts and the social sciences to improve design, human welfare, and planet Earth.
- Demonstrating how to model engineering practices in authentic scenarios for learners of various ages
- Providing examples of STEM-related careers

Strand Four: Student Learning: How Do We Know What They Know?
The goal of every teacher is to maximize student learning. Monitoring learning is the responsibility of both the teacher and the student. To successfully monitor learning requires authentic assessment, including formative and summative strategies. The progressions embedded in the NGSS provide opportunities for students to engage in the practices of science and engineering; these should be assessed through a variety of modalities.
Goal: The workshops and presentations will focus on one or more of the following:
- Demonstrating the scaffolding of K–12 science learning using the NGSS progressions
- Modeling authentic formative assessment strategies
- Building on past assessment practices to align with the vision of the NRC *Framework*
- Aligning preK and post-secondary experiences with the NGSS learning progression
- Providing resources for authentically assessing the NGSS, both formatively and summatively

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Greatfully Acknowledge

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Articles

Developing Transfer Skills in a Biochemistry Class

Jeong V. Choe
Illinois Mathematics and Science Academy

Introduction

Students seem to struggle with transferring prior knowledge if the new problem they are given is in a different form from the way they learned the material. The process of transfer can be identified by four components: 1) recognizing the similarity between the old and new contexts; 2) identifying the potential of a certain skill or concept that has worked in the past, to give solutions to new problematic situations; 3) mental testing of the application of the potential solution; and 4) an attempt to apply the skill or concept to a new context (Georghiades 2000). These four components are important in preparing students to transfer knowledge learned during school to other situations as they enter the work force and are asked to solve real-world problems. However, the Committee on Science (2007) reports that the learning that occurs in high school classrooms does not prepare students well to solve real-world problems.

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The inability of students to develop transfer skills in the classroom raises a question of how we, as educators, can better prepare our students with transfer skills? During the fall of 2011, after years of asking students to transfer knowledge, I implemented two new strategies for practicing transfer. I chose two that aligned with the instructional design of my biochemistry class. The first is to have students make analogies between biochemistry topics and concepts that they have encountered in other classes; the second is to ask students to compare the contextual similarities and differences between various problems I designed for class (Fogarty, R., Perkins, D. N. & Barell, J., 1992). The course that I implemented these two methods in was Biochemistry which is an elective course at the Illinois Mathematics and Science Academy (IMSA). Students enrolled in Biochemistry are in eleventh and twelfth grade. IMSA is a public, residential school for tenth through twelfth graders who are academically talented in math and science. Biochemistry is a one semester elective only for juniors and seniors, and the course has a requirement that students must have successfully completed their sophomore level biology and chemistry courses.

Teaching Method

Part I: Guiding students to make connections between different concepts

Early in the semester, the Biochemistry course addresses four main concepts: osmosis, equilibrium, buffers, and amino acid titration. Students will have encountered titration, osmosis, and equilibrium in previous core science courses, but may not know about buffers or properties of amino acids. Figure 1 demonstrates an example of how familiar concepts are linked with the new ones.

The questions that were used to guide the students in making the connections between the four topics are as follows:

1. Connections between topics of amino acid titration, buffer, and equilibrium.

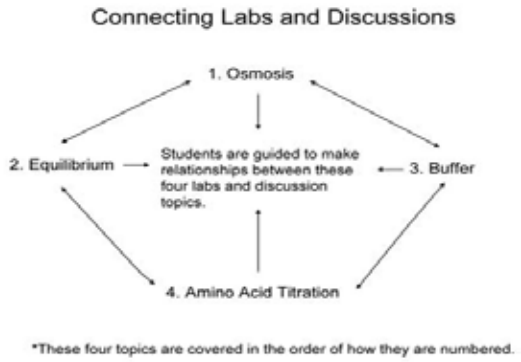

Figure 1. The connection between previously encountered topics and new topics. The encountered topics are titration, osmosis, and equilibrium. The new topics are buffer and properties of amino acids. These four topics are covered in the order of how they are numbered.

You are working in the biochemistry lab and you need to prepare 375 mL of a glycine-HCl ($HOOC–CH_2–NH_3^+Cl^-$) buffer at pH 3.00. A titration reveals equation 1.

$$HOOC–CH_2–NH_3^+ + OH^- \underset{pK_1 = 2.34}{\Leftrightarrow} {}^-OOC–CH_2–NH_3^+ + OH^- \underset{pK_2 = 9.60}{\Leftrightarrow} {}^-OOC–CH_2–NH_2$$

Equation 1. Titration of glycine

a) Explain the equilibrium process of H^+ being ionized in this buffer. Think about the weak acid and conjugate base that are involved in this process.

b) Can this equilibrium process be disturbed? If so, how?

c) Calculate the number of moles of acid and conjugate base form of glycine needed to prepare a 375 mL solution of 0.050 M glycine-HCl? Show your work.

d) Draw the predominant structure of glycine at pH 3.0.

e) Transfer what you have learned in the previous problems to answer the following question. Suppose you were designing a buffer system for synthetic blood, and you wanted the buffer to maintain the blood at the physiological pH of 7.40. Explain which buffer system would be preferable: H_2CO_3/HCO_3^- or $H_2PO_4^-/HPO_4^{2-}$ given that H_2CO_3 has a pK_a of 6.4 while $H_2PO_4^-$ has a pK_a of 7.2.

f) Pepsin is an enzyme used to digest proteins in the stomach. Activity of this enzyme requires deprotonation of a pair of aspartic acid residues in the active site. Given the low pH of the stomach at around 2, predict the activity of this enzyme.

2. Connections between topics of equilibrium and buffer.

a) Write the equilibrium constant expression, K_{eq}, for the dissociation of acetic acid, HAc.

b) Rearrange the dissociation equation of HAc (above) to solve for $[H^+]$.

c) The equilibrium constant, K_{eq}, for the dissociation of HAc is 1.8×10^{-5}. What is the pH of this solution when the concentrations of both HA and A- are equal to 0.5 M? What happens to the pH when both of these two concentrations are changed to 0.7 M? Based on the patterns you observe, can you find the relationship between pH and pKa when the concentration of the weak acid and the conjugate base are the same?

d) Rearrange the dissociaiton equation of HAc from the above problem, parts a through c, to derive the Henderson-Hasselbach equation. In other words, start from the K_{eq} expression to get to

$$pH = pKa + \log \frac{[Ac^-]}{[HAc]}$$

e) Let's now transfer your understanding of equilibrium and buffer to a different context. The active component of aspirin is acetylsalicylic acid, $HC_9H_7O_4$, which has a K_a of 3.0×10^{-4}. Calculate the pH of a solution made by dissolving 0.600 g (600 mg) of acetylsalicylic acid in water and diluting it to a final volume of 50.0 mL. The molar mass of acetylsalicylic acid = 180.16 g/mole. If you accidently spill a drop of 3.0 M NaOH, and you were able to identify that the spilled amount of NaOH has a volume of 0.05 mL, how would you use the Handerson-Hasselbach equation to calculate the new pH?

3. Connection between topics of osmosis and equilibrium.

What kind of salty food do you like? Draw a process of what a cell in your body might experience in order to maintain its volume and osmotic equilibrium with the surrounding environment as you intake this salty food. What would be the signs for the solute potential (Ψs), pressure potential (Ψp), and water potential (Ψw) when it reaches equilibrium? (In other words, fill in the blank with +, - , or 0). Use the word hypertonic and hypotonic in your explanation in addition to the drawing.

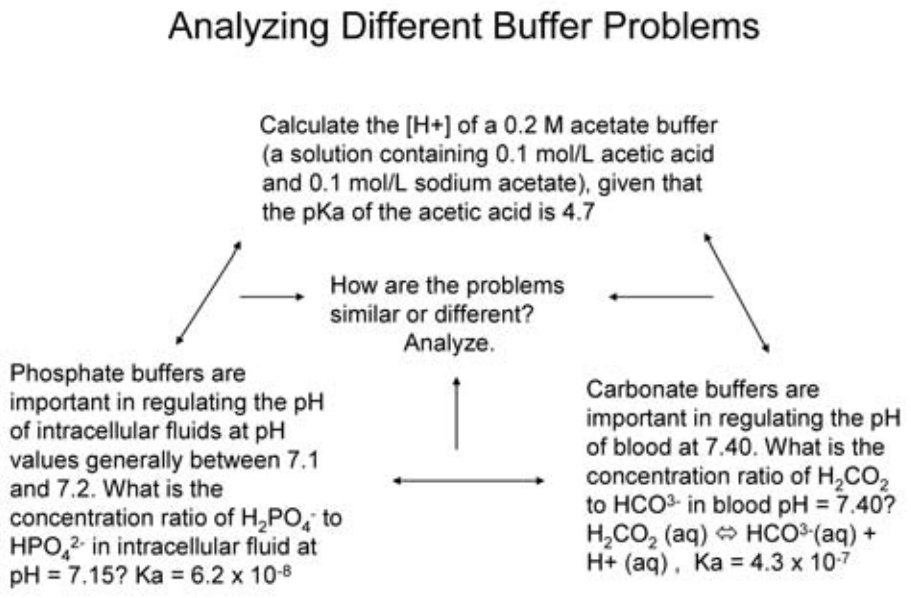

Figure 2. Buffer problems used to make connections. These listed buffer problems show use of acetate, phosphate, and carbonate buffer systems in a problem set to help students practice analyzing problems.

a) Drawing and explanation:

b) Signs for Ψs, Ψp, and Ψw at equilibrium:

Ψs_____, Ψp_____, Ψw____

Part II: Guiding students to find similarities and differences between problems

Students were guided towards making connections between the practice problems. They were asked to analyze how some problems were similar or different from each other; they were then asked if they noticed any patterns in the problems. Figure 2 demonstrates different types of buffer problems that the students analyzed for similarities and differences. They are typical buffer problems using acetate, phosphate, and carbonate buffer systems. Students had class discussions to describe the similarities and differences between the problems. As students generally find the buffer problems to be difficult, they struggled to determine where to begin. To help ease into the problems I guided students with the following questions; listed underneath each question are typical responses from the students.

Question: Identify or underline what the question is asking.
Typical student response:
- acetate buffer problem: Calculate H^+ concentration.
- phosphate buffer problem: Find concentration ratio of $H_2PO_4^-$ to HPO_4^{2-}.
- carbonate buffer problem: Find concentration ratio of H_2CO_3 to HCO_3^-.

Question: Do you see any similarities or differences in the three problems?
Typical student response:
- Both the phosphate buffer and the carbonate buffer problems ask for the concentration ratio between the weak acid and the conjugate base given Ka and pH values, whereas the acetate buffer problem gives you the ratio and pKa and we have to find the pH to find the H^+ concentration.

Question: How can we link all three problems?
Typical student response:
- They are linked through the Henderson-Hasselbach equation which is derived from the equilibrium constant expression of the weak acid as done in the lab.

Once students answered these three questions, they started to realize that these three problems were the same, except they were asked to find different variables based on the buffer system in the problem. Students were guided not only by these questions, but they were also given a table to fill out to organize their analysis of the questions. An example of this is shown in Table 1.

By discussing the problems in this way, not only do the students seem to solve all three problems more easily than before, but they also learn to break down the problems to analyze the pattern. Some of them find it useful to break down the problem in this way especially when a wordy or complex problem is given to them. Consistent practice such as this helps students to transfer their knowledge to different settings.

Results and Discussion

Students enrolled in the spring semester were asked the same buffer questions as the students who enrolled in the fall semester on their unit exam. The difference was that during the spring semester, students were not guided to practice

	Variables that describe buffer pH = pKa + log (base)/(acid)		
Problem	**pH**	**pKa**	**Ratio of acid and conjugate base**
a. Acetate	Question asked	Given	Given
b. Phosphate	Given	Given	Question asked
c. Carbonate	Given	Given	Question asked

Table 1. Table used to help students organize their analysis process. Students were given the table to organize their process as they analyzed the three buffer problems.

Semester	Full Credit (2pt)	Partial Credit (1pt)	No Credit (0pt)
Spring Semester (N=17)	3	14	0
Fall Semester (N=37)	30	7	0

Table 2. Semester comparison of the number of students receiving different credit for the buffer problem. The table compares the number of students who received full, partial, and no credit in the spring semester without students practicing transfer skills compared to the fall semester after practicing transfer skills.

transfer skills. However, during the fall semester, transfer skills were heavily emphasized by having students make connections between concepts and analyze different problems before they solved them.

The effect of student performance after having them practice transfer skills was analyzed through the following question on the unit exam.

Question: "Chemi" is widely used in biochemical research for the preparation of buffers. It offers low toxicity and it has a pKa of 8.08 making it convenient for the control of pH in clinical applications. This buffer is made by mixing 0.050 moles of chemi with 0.025 moles of NaOH in a volume of 2.00 L. What is the pH of this buffer?

More students in the fall semester received credit on the buffer problem than did students in the spring semester (Table 2). When students practiced recognizing patterns in the fall semester, 81.1 percent of the students received full credit. Only 17.6 percent received full credit on the same problem during the spring semester (Figure 3). Practicing transfer skills increased the number of biochemistry students who received the full credit on the buffer question by 63.5 percent, and decreased the number of students who received partial credit by the same percentage. None of the students received zero credit in either semester.

It has been widely demonstrated that it is valuable to teach students transfer skills so they can transfer their learning to other contexts and become better problem solvers. This study demonstrates a short term effect of having students practice transfer skills. If we continue to guide students to practice this skill in a more consistent way, students should be better prepared to transfer what they have learned during school to other contexts in the longer term.

The short term outcomes of this study were geared towards having students practice transfer skills in a more content specific way,

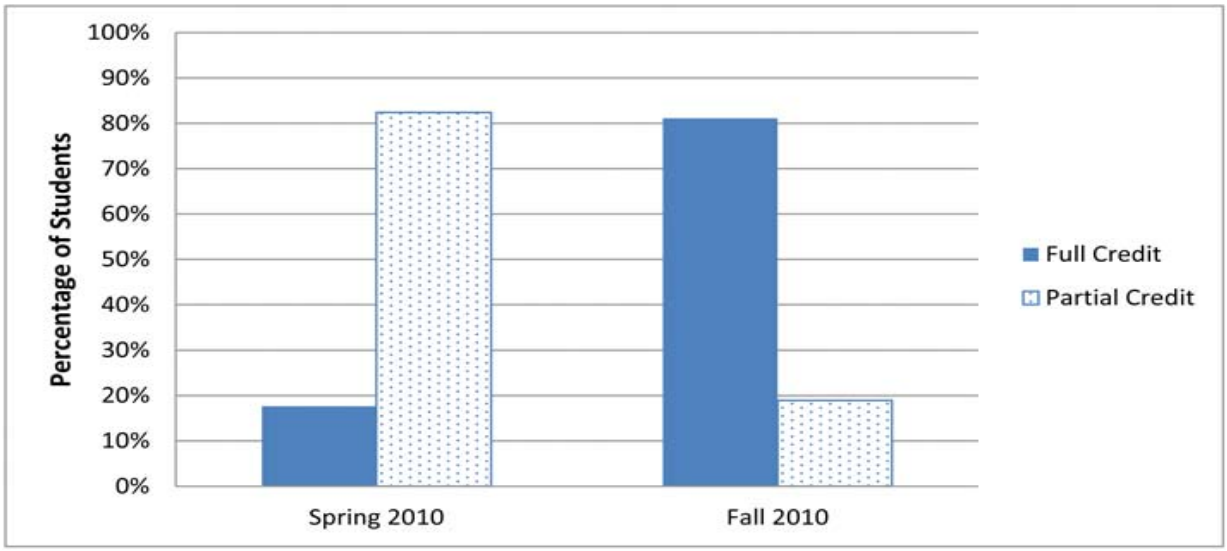

Figure 3. Semester comparison of student performance on the buffer problem. The graph shows percentages of students who received full and partial credit in the spring semester without practicing transfer skills compared to the fall semester after practicing transfer skills in the unit exam.

related to the Next Generation Science Standard (NGSS) HS-PS1-6: "Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium (NGSS, 2013)." The overall purpose of the NGSS is to emphasize the key knowledge and skills that all students need in order to engage fully as workers, consumers, and citizens in twenty-first century society (NGSS, 2013). This includes process skills as well as content skills. If we provide students with an environment where they can continue to consistently practice transfer skills, in the long run, they should be better prepared to apply their knowledge to real-world situations. These would include the ability to "design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering" (NGSS: HS-ETS1-2, 2013) or to "come up with a computer simulated model to propose solutions to a complex real-world problem by analyzing numerous criteria and making connections between interactions that are associated with the problem (NGSS: HS-ETS1-4, 2013)." It is important as an educator to consider both short term and long term outcomes and identify effective ways for students to practice the transfer skills which also align well with their instructional design.

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Do *You* Know an Exemplary Science Student?

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 pamela.spaniol@yahoo.com. The first medallion is free of charge; additional medallions may be obtained for $15 each.

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

Prescription for Pedagogy: Curriculum, Clean Water, and Drug Disposal

Michael Soares
Pontiac Township High School

Paul Ritter and Baylee Ritter hunched over the laptop computer, using both words and hand gestures to communicate across thousands of miles courtesy of Skype. Paul Ritter, president of the Illinois Science Teachers Association and a biology teacher at Pontiac Township High School (PTHS), and his daughter, PTHS junior Baylee, were speaking with officials in Istanbul, Turkey, the latest in a long list of parties across the globe who have decided to incorporate into the now international Prescription Pill and Drug Disposal Program (P2D2). In December of 2013, the program marked one million pounds of pharmaceuticals responsibly recycled, thanks to the student-driven program. Founded by Paul Ritter with the help of students and dedicated professionals both inside and outside of the classroom, the P2D2 program has touched the lives of hundreds of students, garnered the attention of government officials in far-reaching nations, and made a long-lasting impact on the environment, ensuring that the students who are the future of our world have a world in which to continue their work.

The remarkable story of P2D2 began in 2003 with the simple question of what should one do with expired and unused pharmaceuticals taking up space in medicine cabinets? Informal research quickly determined that most controlled substances outliving their usefulness simply

Lessons in conservation and recycling were reaching far past the high school to make postivie changes in the community and potentially the world.

were disposed of into drains or flushed down the toilet, eventually making their way into the water supply. Ritter challenged his students to take the research to the next level, to determine the effects of improperly disposed drugs on America's drinking water. It was not long before his students uncovered what Ritter describes as "startling information pertaining to the effect of pharmaceuticals on the quality of drinking water around the world." After reading and discussing "Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000: A National Reconnaissance." in *Environmental Science and Technology*, students found that "scientists with the United States Geological Society have detected drugs such as antibiotics, anti-depressants, birth control pills, seizure medication, cancer treatments, pain killers, tranquilizers, and cholesterol-lowering compounds in varied ground water sources." Furthermore, they uncovered that scientists were concerned "that, in humans, the chemicals

Pill Bottle Phil

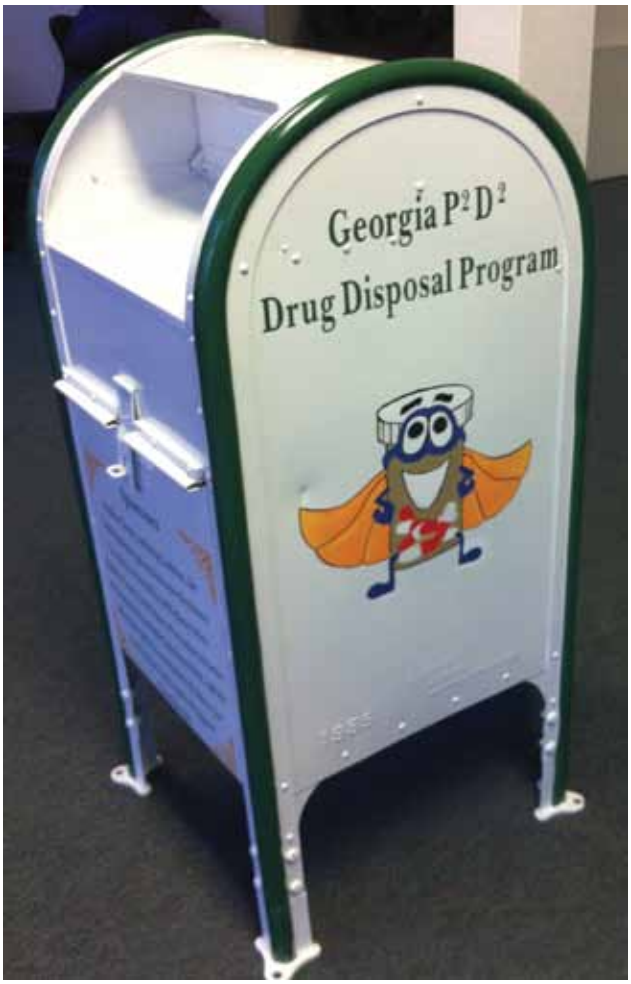
in our water supply could increase rates of breast, testicular, and prostate cancer, as well as lower sperm counts and disrupt hormones." Among the most disturbing discoveries was that waste water treatment methods were not only incapable of, but never intended to, removing such chemicals in local facilities. To complicate matters, pharmaceutical companies have been characterized as reluctant to take responsiblity for recycling their products, as described in Susan Sharon's 2010 article, "DEP Tests Show Prescription Drugs Leaching From Landfills." Documenting their findings on the P2D2 website, the information sank in and it became evident that the safe disposal of prescription drugs was not currently a viable option. Ritter became determined to change that and set about creating a program that would provide this service.

In an effort that became more and more like a crusade as it advanced, P2D2 began to make inroads not only at Pontiac Township High School, but in the surrounding community. Through the efforts of Ritter's students, local drug stores began to collaborate with town officials and law enforcement to begin providing safe places for medication to be deposited until they could be transported to a recycling plant in Indiana where they are incinerated to create electricity. Former US mailboxes were repainted and repurposed for the job, often placed inside the lobby of police stations. Many local drugstores began to accept medication as well, securing the unwanted prescriptions in a locked area until law enforcement officials could retrieve them. Within time, the program launched by Ritter and his students began to inspire others, including both students and teachers, and the outreach to other communities began in earnest. Principal Eric Bohm, at the time a history teacher in the building, initiated a letter writing campaign to elected officials ranging from local, to state, and to even federal levels in order to increase awareness of prescription drug disposal. Media became an important tool, and the students became savvy with contacting local radio stations in central Illinois to raise the profile of the fledgling program, boosting it into the consciousness of the general public and ultimately to the Illinois state capital. As the program gained steam, students at PTHS slowly began to move out of their comfort zones and began realizing that their efforts were paying off in high impact ways. Lessons in conservation and recycling were reaching far past the high school to make positive changes in the community and potentially the world. In short, Ritter's influence began to extend far beyond the classroom for these students, and his attempt to capture young hearts and inject into them his zeal for saving the Earth began to manifest itself in real-world applications both in Pontiac and statewide.

Baylee Ritter at the Volvo Adventure Awards, supported by UNEP. Photo by Paul Ritter

P2D2 students in Brazil.

Billing itself as "a collaborative effort between communities, local pharmacies, police departments, hospitals, city officials, students, and more," the P2D2 program,which once existed only in imagination, swiftly boiled over into reality. Pharmacies such as Walgreens, K-Mart, and local Sartoris Super Drugs in Pontiac agreed to allow customers to bring in unused prescription drugs for the purpose of safe disposal. However, neither Ritter nor his students were satisfied with only local success. Megan Bozarth, a social studies teacher (who now teaches at Bloomington High School), was enlisted to teach her honors students how to write to representatives and senators in support of bills concerning legislation funding P2D2 efforts, placing an additional $25 fee on illegal drug possession fines in Illinois. With these new funds, Illinois could ship all prescription drugs collected to incineration facilities at no cost to the taxpayer. The bills passed unanimously through the Illinois House in the spring of 2011 and eventually made their way to the governor's desk. On Wednesday, August 24, 2011, crowded into a small open space near Michigan Avenue next to the Chicago River and protected from curious Chicagoans by skyscrapers, a press conference took place. After speeches from various government officials, teachers, and students, Illinois Governor Pat Quinn finished



A mailbox repurposed for collecting outdated and/or unused prescription drugs. Photo by Paul Ritter

One of several billboards advertising the P2D2 program to the local community. Photo by Paul Ritter.

signing the documents in front of him and handed Bills 2056 and 2053 to Ritter, Bozarth, and the students who were intimately involved with the genesis of the bills. After years of development and thousands of hours of work, Ritter and his students had realized their dream of protecting the Illinois water supply. Yet the work was far from finished, and P2D2's victory in Illinois was the impetus it needed to gain the attention of activists in other states. Like the Chicago River, famously reversed long ago and ultimately reaching the Gulf of Mexico vicariously through other rivers, P2D2 was to make its way throughout the country by word of mouth, media exposure, and the sheer will of its creator and his students.

As important as the physical recycling may be, what are equally important are the pedagogical opportunities afforded by the program. From the beginning, students were able to witness the success of a grassroots approach to solving a real-world problem and to realize that starting off on the right foot required doing the research. At PTHS, Ritter and I combined our biology and English classes to conduct interdisciplinary research into the local water supply, the availability of drug recycling, and other information peripheral to the cause. Ultimately, the research yielded curriculum opportunities for students to write in multiple genres. Once the students documented the information and learned how to properly cite their sources, the next step was to educate partners, including but not limited to pharmacists, city officials, government agencies, legislators, researchers from local colleges and universities, and media outlets. Once students showed civic leaders how changes could improve the environment, it took very little additional convincing to get them on board. PTHS found particular success with the Street Superintendent and Public Works Director in paving the way for new policy, leading to the incorporation of recycling containers and even

This program was developed with the philosophies of 'think globally, act locally' and 'students are the agents of change.'

the stenciling of sewer drains to promote cleaner water. In other classrooms such as Art, a logo was created for the program. Originally conceived as a Superman-like icon for recycling drugs, *Pill Bottle Phil* was created, illustrated, and subsequently adopted by students as the mascot for P2D2. In another classroom, English teacher Brian Blair had his students write and illustrates a children's book for the character. Other examples of cross-curricular activities included a P2D2 theme song composed and recorded in Music Theory; T-Shirts and banners designed and produced in Graphic Arts; the writing of "Eco-ku's," haiku inspired by conservation activities, in Honors English. In addition to multiple P2D2 presentations at ISEC conferences, in 2012, Ritter, Bozarth and I presented "Water is Life: Developing Eco-Conscious Curriculum as an Avenue to Teacher/ Student Influence in the Classroom, the Capital, and the Environment" at the National Council of English Teachers conference in St. Louis. Amazingly, what began in a classroom eventually made its way outside of the school's walls as

P2D2 and Superman in Metropolis, Illinois.

Repurposed boxes for collection of drugs are colorful, attractive, and educational. Photo by Paul Ritter.

From the beginning, students were able to witness the success of a grassroots approach to solving a real-world problem, and to realize that starting off on the right foot required doing the research.

student engagement on a local level paved the way for eventual change on the state and national levels

As Pontiac's homegrown program advances, P2D2 continues to attract high profile media coverage. Ritter and five PTHS students, including his daughter Baylee, traveled to Sweden in early June 2012 to compete in the Volvo Adventure Awards. The competition, in conjunction with UNEP, invited twelve groups from among many nations to present their innovative and groundbreaking eco-conscious programs for a "greener future." The P2D2 team, already named first in the USA, returned home as third-place world champions. In 2013, Ritter and Baylee traveled to Nairobi, Kenya, to present P2D2 to the Tunza International Youth Conference.

As of the writing of this article, a version of P2D2 has been incorporated in communities representing more than two-thirds of the states of America, as well as several other countries including Brazil, Mexico, and soon the Middle East as talks progress with Bahrain and Turkey. According to Ritter, "This program was developed with the philosophies of 'think globally, act locally,' and 'students are the agents of change.' Knowing that the P2D2 program is a work in progress, I realize that it will change in response to our global needs. I do hope that people will look at

Illinois Governor Pat Quinn signs Bills 2056 and 2053 while PTHS students look on.

Student-designed informational materials promoting safe and environmentally friendly drug disposal.

it in years to come and see that we gave everything we could to be the catalyst for knowledge and change. This program has changed my life forever. I dedicate this material to our children. They are the future of our world."

Far from merely changing the way Illinois now disposes of unused and unwanted prescription medication and controlled substances, the program has forever changed the way many teachers in Pontiac and other cities approach innovative teaching, using the real life successes and applications of P2D2 to galvanize the potential of students, many of whom typically performed marginally, and animate them to levels of achievement demonstrated on the nightly news broadcasts. The scene in Chicago was far from the culmination of the program's success; as more teachers incorporate elements of the program into their classrooms, and as more communities adopt the program, the full potential for eco-conscious curriculum has yet to be realized. Please contact P2D2 leadership to discuss incorporating P2D2 into your community, state, or country.

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Considering the Science of a Classic Toy

Jean Mendoza
University of Illinois at Urbana-Champaign

Incorporating cardboard boxes into science time would be an inexpensive way to begin exploration of a number of questions and problems related to motion and stability; structure and properities of matter; and engineering design.

Famous Toys

When my sons were in grade school, they each spent time in and out of science class designing and creating a motorless model car from found objects. They and their classmates then competed to see whose car rolled the furthest and so on. I sometimes wonder about ways children might investigate the science and engineering of other types of toys. Any number of contemporary toys could be explored and experimented with in science class; Legos are an example of a well-known toy that is already a key component of some STEM curricula.

Legos are also among dozens of toys that have been inducted into the National Toy Hall of Fame, a project of the Strong National Museum of Play in Rochester, New York (http://www.museumofplay.org). The Hall of Fame recognizes *classic* playthings that have "inspired creative play and enjoyed popularity over a sustained period" such as the Etch-A-Sketch, the Viewmaster, the teddy bear, Star Wars action figures, and the game of Scrabble. In 2013, inductees were the game of chess and the rubber ducky.

If the Toy Hall of Fame decision-makers confined their honors to commercial toys and games, their mission might be less impressive. However, they also give attention to items that adults often forget to think of as toys, although generations of children have treated them as playthings. A 2011 honoree was the *blanket*. It was preceded by, among others, the *stick* (2008) and the topic of this article, the *cardboard box* (2005).

Science, Engineering, and the Cardboard Box

The cardboard box was an object of fascination for many generations of children prior to being recognized as Hall of Fame material. Many a family has a birthday story along the lines of "We got him a [insert name of a popular toy] but he only wants to play with the box." In her recent picture book *Not a Box*, Antoinette Portis uses minimalist prose and drawings to showcase the many uses to which a child's imagination can put a cardboard box. A box can be a nest, a tunnel, a castle, a robot costume, part of a ramp system for toy cars…. The list is probably endless.

Not all of those uses are in the realm of an elementary or middle school science teacher's direct concerns, but some certainly could be. Nothing in the Next Generation Science Standards precludes a role for that venerable toy, the cardboard box.

Incorporating cardboard boxes into science time would be an inexpensive way to begin exploration of a number of questions and problems related to motion and stability; structure and properties of matter; and engineering design.

The teacher might start by asking students to consider what makes cardboard boxes such appealing playthings, from a child's perspective. Possible conversation starters include these three videos: "Building with Boxes" (http://illinoisearlylearning.org/videos/boxes.htm), "Pretend Play with Big Boxes" (http://illinoisearlylearning.org/videos/boxespretend.htm), and "Toddlers and Boxes: 'Hi! Hi!'" (http://illinoisearlylearning.org/videos/boxestoddler.htm). As they think about the various ways they

and other children have used boxes as toys, the teacher can help them list scientific ideas that boxes might allow a person to "play with." More discussion and hands-on experience could follow.

Activities related to understandings of *motion* and *stability* could include:

- pushing or pulling a selection of boxes across a variety of surfaces (tile floor, carpet, wood, sand, sidewalk, snow, ice);
- moving a box (with or without a load) down or up an incline;
- using pieces of boxes to make ramps and pathways in different angles, where balls, wheels, and so forth can be observed in action;
- finding out what happens when pressure is applied to different parts of a box (side, corner).

Students might investigate *structure* and *properties of matter* with cardboard boxes by:

- comparing characteristics of various types of cardboard found in commonly used boxes (for example, corrugated cardboard, folding boxboard);
- creating challenges to cardboard's structural integrity (for example, what happens to cardboard when it gets wet, and when wet cardboard dries out again? What happens when a piece of cardboard is folded and creased once or multiple times?)
- observing what happens when some of the activities related to motion and force are performed with boxes that have been altered (for example, by cutting a door or window; by reinforcing with tape).

The students can investigate principles and practices of *engineering design* as they consider cardboard boxes as structures and as components of structures:

- thinking about boxes as structures (for example, What are key differences in materials and construction among different types of cardboard boxes? What are some unusual shapes for cardboard boxes? How much pressure can a particular box withstand, or a particular part of a box? How might we construct a cardboard box durable enough for a specific task - to ship a ten pound object, to carry a selection of chocolates, to be a playhouse for a four-year-old? What are some ways to reinforce the structure of a flimsy box?

- thinking about boxes as construction materials How high can we stack these boxes before they fall over? How can we position them so they make a stable wall? How might we alter a box to make a doll house, a racetrack, a costume? Can we make usable furniture from boxes?

Having investigated many properties and uses of cardboard boxes, students could discuss their ideas about what makes a box a good *science toy*; information that they can take with them as they make toy purchases, or perhaps, later on, as they make or invent toys.

The teacher and students might want to plan culminating class projects involving cardboard boxes. Perhaps several students could design and build a sturdy cardboard box playhouse or toy car raceway, suitable for use by a local Head Start or child care program. Or some students might create take-home kits for teaching science through play to younger siblings, which would include small boxes (shoe boxes) and other found objects, plus directions for replicating the experiments and activities learned in science class

As teachers seek to align their work with the NGSS, expense is sure to be an issue in schools around the state. The cardboard box is an award winning science toy that is both ubiquitous and versatile, that students can use for homework assignments without fear of breaking the budget should the "equipment" fail to return.

The *Spectrum* would like to hear from teachers who encourage students to learn science by exploring the affordances of cardboard boxes.

Making Science Matter:
School/University Partnerships for Successful Teacher Education

Meredith McAllister
Butler University

Abstract
The multi-faceted nature of school/university partnerships addresses teacher education reform from a *collaborative/tripartite* perspective. The collaborative work described in this paper includes the College of Education, the College of Liberal Arts and Sciences, and the Pike Township Schools, Indianapolis, Indiana. Pike Township Schools has partnered with Butler University over the last five years and created a sustainable professional learning community. This paper will discuss our implementation of professional development programs in science education. NSTA standards for teacher preparation are addressed by providing quality teacher professional development focused on content and best practices in science education, including the development of science content knowledge and the use of inquiry in the classroom.

Background
Located in Indianapolis, Indiana, Pike Township Schools is an urban school district made up of about 10,400 students in fourteen schools – nine elementary schools, three middle schools, a freshman center, and one large high school. Pike is an extremely diverse *minority-majority* school district, where 58% of students are African American and 23% are white. It has a growing Hispanic population of 10%, with 7% of Pike students receiving English as a New Language services, and 18% of Pike students have a special education label. About half of Pike students, 46%, receive free and/or reduced lunches.

The Making Science Matter Project is a partnership between nine high-need schools within Pike Township and Butler University (College of Liberal Arts and Sciences and College of Education); other collaborating organizations include Connecting Learning Assures Successful Students (C.L.A.S.S.), Central Indiana Educational Service Center (CIESC), the U.S. Department of the Interior - Geological Survey, the Institute of Electrical and Electronics Engineers (IEEE), and the National Inventors Hall of Fame Foundation - Camp Invention.

Making Science Matter is a comprehensive professional development program in science to equip teachers to deliver high-quality inquiry-based science instruction and to become teacher-leaders in science. Teachers participate in a summer science institute facilitated by Butler University and monthly follow-up workshops within the district. The teachers also become teacher-leaders in their schools by mentoring, coaching, and model teaching. These activities are designed to be sustained, intensive, classroom-focused, and aligned with standards and science curriculum.

Project Goals
Teachers of science (grades K-9) will increase their participation in content-based professional development activities.
2) Teachers of science (grades K-9) will increase their content knowledge of science.
3) Teachers of science (grades K-9) will make use of research-based instructional practice of inquiry-based learning.

Theoretical Perspective
The unique teacher education prototype envisioned by the partnership is characterized by: standards-guided, performance-assessed preparation (Darling-Hammond, 1997; NCATE, 2003; NCTAF, 1996); aligned national and state standards; integrated preparation; experiential learning opportunities (Partnership for 21st Century Skills, 2003; ISTE, 2002; Tom, 1997); compressed professional educational studies (Tom, 1991); and an expanded, shared governance structure (Goodlad, 1994; Patterson, Michelli & Pacheco, 1999). Renewal of high-need schools is

Making Science Matter Grant

- 3 year grant; focused on teacher professional development
- NSF funded; administered by the Indiana Department of Education
- 30 member teacher cohort each year
- Butler University is a grant partner

Making Science Matter grant objectives (partial listing):

- Teachers of science will increase their participation in content-based professional development activities.
- Teachers of science will increase their content knowledge of science.
- Teachers of science will increase their use of science integration in the classroom.
- To explore and implement specific strategies to enhance data-driven best practice teaching methods for Pike in-service teachers.

Over-arching grant goal - to improve student achievement in science

Figure 1: Summary of Making Science Matter Grant Initiative.

characterized by: standards-aligned curricular and instructional programs (Haycock, 2002; National Research Council, 2000); continuous school improvement programming (Elmore, 2002; Fullan, 1991; Glickman, 1993; Schlechty, 1997); induction program with mentor teachers; and enhanced, clinical field experience (Teitel, 2003).

Elementary Science Workshop

The summer 2008 K-12 summer institute workshops featured science methods for teachers. Faculty in the College of Education and master practitioners worked together to provide a workshop centered on active learning and hands-on science methods. Participants from local school districts learned how to incorporate projects into science classes, from kindergarten through eighth grade. The purpose of the science inquiry workshop for elementary teachers was threefold: 1) to collaborate with the Pike Township Schools Corporation by strengthening the link between Butler University and the local schools, 2) to refresh the elementary teachers' knowledge of science, and 3) to increase teachers' pedagogical knowledge.

The workshop was planned for participants to explore new and different teaching strategies to teach children through multiple hands-on activities that incorporated the Indiana Academic Standards (2000) in science. Inquiry can happen at all grade levels. With this in mind, the primary focus on inquiry activities related to science concepts within the grades represented by teachers who attended. Participants explored a variety of science concepts using inquiry.

While the main goal was to encourage and practice inquiry teaching, it was also important to build a sense of community with the learners in the workshop and by encouraging teachers to develop peer coaching as a means of post-workshop professional development. According to the literature in science education research, successful professional development of inquiry happens when the workshop addresses teachers' specific needs, includes follow-up opportunities, allows time for teacher reflection, and utilizes methods that model science and science pedagogy. A final consideration may be to remember that interventions take time to take effect in the classroom and that change is a personal experience.

	2007 - 2010 Grant	2010 - 2013 Grant
Target Grade Levels	3-8	3-8
Summer Professional Development Workshop Length	One week	One week
Summer Professional Development	- Variety of options, including participation in Butler Summer Institute - Choice of Butler session based on existing grade level offerings	- "Content Knowledge and Pedagogy: The Science of Teaching" at Butler - Custom course developed by Butler College of Education to meet grant requirements - AM - science faculty instruction - PM - correlated standards-based activities - All cohort teachers enrolled in the same session
Other Required Professional Development	-7 additional sessions *Held during after-school hours, 2 hours each *Many sessions sponsored by grant partners *Math and Science Community Fair participation included in the 7 sessions	- Two additional sessions 1) Celebrate Science Indiana *Fall, Saturday * State-wide science expo 2) Math and Science Community Fair * Spring, Thursday evening *Teachers and outside STEM presenters of hands-on math and science activities

Metropolitan School District of Pike Township, Indianapolis

Figure 2: Making Science Matter Grant Activities 2007-2013

Middle/High School Workshop

The Butler University College of Education is geared toward designing and implementing a preservice, clinically-based preparation program for teachers that is built on a solid foundation of understanding of the content to be taught coupled with 1) innovative, research-based, and best-practice instructional strategies appropriate to the needs of diverse children and youth; and 2) engaging in the simultaneous renewal of Pike Township School sites and the continued professional development of educators.

It is important to have high expectations of teachers' abilities to conduct their own inquiry in the classroom and to guide their students in conducting inquiry. Many lessons were learned during the summer 2008 inquiry-based science education workshops, such as that attention needs to be given to teachers' beliefs that interact with their view of practice, and that the workshop needs to offer the teachers time to redirect those beliefs. This often happens when teachers are given a chance to practice new science teaching strategies together as a group, followed by time to reflect, and then time to practice inquiry on their own.

When developing the workshop, it was felt that time was needed to help build awareness among teachers for a need for teaching reading in the science classroom. Teachers participated in a week-long workshop focused on the development of content area reading strategies in the science

Grant Year	Workshops
2007	- Inquiry in the Elementary Classroom - Successfully Constructing Inquiry-Centered Middle School Science Classrooms - Curriculum and Teaching Strategies for High School Sciences
2008	- Inquiry in the Elementary Classroom - Successfully Constructing Inquiry-Centered Middle School Science Classrooms - Criticial Reading Strategies for Science and Society
2009	- Exploring Inquiry-Based Science Resources Around our Community - Hands-on Science Instruction in the Middle Level Classroom - Collecting Data in the Field: No Child Left Inside
2010	- Content and Pedagogy: The Science of Teaching
2011	- Content and Pedagogy: The Science of Teaching
2012	- Content and Pedagogy: The Science of Teaching

Figure 3: MSM Grant Workshops

secondary classroom. It was also believed that the workshops would be more successful if there were a presentation of theory/concepts in order to give teachers the background on what it is they are to learn and why. Practice of the *project approach* under simulated conditions with feedback (such as micro teaching after fieldwork data was collected) aided in the construction of appropriate understanding of content area reading strategies.

Significance of the Partnership to Teaching and Teacher Education

The Pike/Butler University Partnership has, at its heart, the goal of ensuring that preservice teachers know the content and modes of inquiry that lead to deep understanding. Alignment of content standards from the learned societies and the state, and embedded throughout the content courses taken by candidates, will ensure that the knowledge base of all candidates is coupled with learner-centered, experiential, and inquiry-based pedagogical strategies and intensive field experiences within Pike Township Schools. By focusing on a community of learners among Butler University faculty and administrators, school-based faculty and administrators, and preservice teachers, this project affects the learning of all children and youth within the service area to build a shared institution capable of continuous renewal.

The Pike/Butler partnership addresses the question of how collaboration can assist in meeting the needs of each organization and further the accomplishment of our respective missions. More specifically, the partnership shares responsibility for goals such as implementing academic mentorship and leadership opportunities, enhancing data-driven best-practice teaching methods, expanding opportunities for high school students to take college courses, and implementing collaborative professional development.

In pursuit of these goals, all of the institutional collaborators - Pike faculty, staff, and administration; Butler faculty, staff, and administration; and Butler preservice teachers and graduate students - work together as a learning community. Each partner commits time and other resources as appropriate to the achievement of the partnership goals.

The development of the partnership is guided by the words of Nancy Zimpher (2001): "Good learning is a function of good teaching, and good teaching is a function of good teacher education; and good teacher education cannot be decoupled from the profound impact of ongoing school renewal; then all of this is a function of our seamless and interactive partnerships between schools and universities and increasingly, school communities."

Conclusion

The beliefs/values served as principles for the development of a connected concept for teacher education in which collaboration among all grant partners will become the continual norm. The role of classroom teachers is greatly expanded to include an equal voice in the early field experiences and student teaching of teacher education candidates. The university faculty roles are changing, as faculty begin to collaborate with teachers, principals, preservice teachers, and one another. Preservice teachers' roles change, too, as they take an active part in their own education, assuming greater responsibility for demonstration of skills learned, performances honed, and dispositions exhibited.

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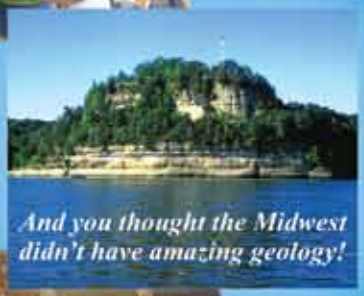

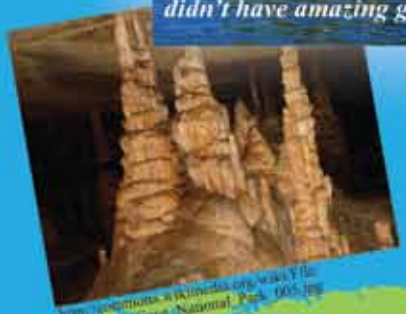

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