2006

PEER Perspectives

Broadening the Reach of University Resources by Advancing STEM



Lesson plans and novice teaching tips for middle schools; PEER research findings; graduate, undergraduate, and faculty testimonials



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Letter from the chief investigator:

My involvement in public schools started when I attended an open house at my son's middle school in 1994. His teacher asked for scientists to serve as guest speakers to promote science and careers. I began routinely presenting a talk on the "Health of the Respiratory System" using anatomical specimens from the Texas A&M University College of Veterinary Medicine and Biomedical Sciences and attending career days as a college professor and scientist. I was asked by the Center for Environmental and Rural Health (CERH) at Texas A&M to submit a grant proposal (CERH is funded by the National Institute of Environmental Health Sciences (NIEHS)), as part of an outreach effort to help translate environmental health science research findings from CERH scientists into a form that was usable by K-12 schools.

We assembled a team of scientists, veterinarians, educators, and staff to prepare the grant proposal. We received our first grant for a program directed at increasing interest in environmental health science in rural middle schools. Our approach was to produce an environmental health science curriculum, train teachers, and sponsor scientists' visits to rural middle schools. We dubbed ourselves the Partnership for Environmental Education and Rural Health (PEER). In our first year, NIEHS requested grant applications for a seven-year grant that integrated environmental health science with science, mathematics, English language arts, and social studies. We added new members to the PEER team, including faculty experienced in those areas. We obtained a second grant from NIEHS that allowed integrated curriculum development, teacher training, and scientists' visits to schools.

Since that time, PEER has produced three life science and environmental health/ toxicology online curriculum modules. We also created 14 additional modules that integrate environmental health science into middle school science, mathematics, English language arts, and social studies. A group of 804 teachers has been trained through our workshops and 1,522 teachers and 35,000 students have experienced PEER scientists' visits to their schools. The NSF GK-12 project was brought into PEER as a means of placing science, technology, engineering, and mathematics (STEM) role models and enhanced instruction in more rural K-12 schools. In our GK-12 program, 22 Graduate Fellows have served as STEM content resources for 56 teachers and 6,910 students in local rural schools; mentored University Honors Undergraduate Fellows; and produced 138 customized lesson plans that are available to all rural schools through our Teacher-Requested Resources. Broader impacts of PEER activities include broadening the reach of university resources to rural schools to advance discovery, enhance scientific and technological understanding, and provide STEM career knowledge and opportunity for all middle school students.

This monograph provides the "PEER Perspective" on institutions of higher education partnering with rural schools. PEER's mission is to provide resources and role models in the four STEM subject areas for schools with limited access to university-level science and mathematics inspiration. The goal of this publication is to document and share experiences and accomplishments of university faculty and students. We also present research findings and useful resources, including lesson plans and tips for new teachers. Here teachers can see a glimpse of what awaits them at http://peer.tamu.edu.

> Sincerely, Larry Johnson, Ph.D.

About Dr. Johnson:

Larry Johnson, professor in the Department of Veterinary Integrative Biosciences at Texas A&M University, has published over 110 original, peerreviewed, scientific journal articles; given invited scientific talks on four continents; won a national research award; served on a research panel for the United States Congress; served on NIH, NSF, USDA, and NIOSH grant review panels; received NIH and/or NSF funding for over 25 years; served on editorial boards of three scientific journals; and received both college-level and university teaching awards for his histology courses. He also coordinates a graduate course on scientific ethics and recently initiated a graduate course and veterinary school elective on the development of communication, organization, and mentoring skills through public school outreach training and experiences.



Dr. Larry Johnson displays two lung casts illustrating highly branched airways of lungs.

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About Virginia Traweek:

After beginning work as a GK-12 Undergraduate Fellow, Virginia Traweek is now a GK-12 Graduate Fellow involved in graphics and dissemination. Upon completion of her Bachelor of Environmental Science degree in architecture last August, she began studying for a Master of Science in Finance. She expects to graduate in May 2007.



Quick Definitions

PEER- the Partnership for Environmental Education and Rural Health; outreach component of CERH. Visit peer.tamu. edu for more information.

NSF- the National Science Foundation, which supplies part of PEER grant funding. Visit www.nsf.gov for more information.

NIEHS- the National Institute of Environmental Health Sciences, which supplies part of PEER grant funding. Visit www. niehs.nih.gov for more information.

CERH- the Center for Environmental and Rural Health, parent organization of PEER, with the goal of promoting rural health awareness. Visit cerh.tamu.edu for more information.

NSF GK-12 Graduate Fellow- A Texas A&M University science, technology, engineering, or mathematics graduate student who works in a local middle school classroom assisting math and science teachers. Known as a Resident Scientist/Mathematician.

NSF GK-12 Undergraduate Fellow- an undergraduate student at Texas A&M University who serves as support for a Resident Scientist/Mathematician and assists in developing activities for use in middle school classrooms.

Resident Scientist/Mathematician-NSF Graduate Fellow who acts as a content specialist in his or her middle school classroom. Teachers are asked to carefully distinguish student teachers from Resident Scientists and Mathematicians.

STEM- Science, technology, engineering, and mathematics, the areas of education where American children perform below the world average.

Lead Teacher- a teacher with whom the Graduate Fellow is assigned to work directly in his or her classroom.

TEKS-Texas Essential Knowledge and Skills, Texas educational standards for each grade level.

TAKS- Texas Assessment of Knowledge and Skills, Texas' benchmark test for academic proficiency.

PEER Overview

Goals and Roles of the PEER GK-12 Program Larry Johnson and Virginia Traweek

Goals of the PEER GK-12 program are to enhance interest in learning, to improve academic performance of K-12 students, and to enrich graduate education. The project hopes to inspire the next generation of researchers in academia, industry, and government to become aware of and sympathetic to the challenges and opportunities in K-12 education, and of how they can contribute and improve the science, technology, engineering, and mathematics (STEM) content and interest of K-12 students and teachers.

Objectives are to:

1. Enhance students' opportunities to learn STEM content by increasing access to inquiry-driven experiences in content areas from national and state educational standards;

2. Assist teachers in gaining more interest, knowledge, and confidence in teaching science and mathematics;

3. Provide middle school students with diverse STEM role models;

4. Improve student attitudes toward science and mathematics;

5. Help GK-12 Fellows improve pedagogical, communication, and teamwork skills, thus enhancing future career opportunities;

6. Provide resources to rural schools

throughout Texas via a distance learning community and worldwide resources through the PEER website;

7. Assess the shortterm and long-term impacts of the program on middle school students, their teachers, and GK-12 Resident Scientists;
8. Assess the educational materials produced and educational partnerships established;

9. Facilitate long-term interactions between teachers, teacher educators, and university scientists; and,

10. Facilitate a long-term, sustainable interface between Texas A&M and public schools.

Roles of participants in the GK-12 program:

The main players are the GK-12 Graduate Fellows (Resident Scientists/ Mathematicians) and Lead Teachers.

The GK-12 Graduate Fellow

provides STEM content expertise, demonstrations/presentations, materials and resources, and acts as a conduit to university faculty and resources. They serve as an example of scientific and mathematical thinking and as a role model of someone who enjoys and plans to make a career in STEM.

The Lead Teacher assists the GK-12 Fellows in meeting school needs, organizes and obtains resources, mentors the Fellows, and communicates to project managers how things are going in the school and what is missing. Lead Teachers mentor and provide teaching opportunities for the Graduate Fellows.



NSF GK-12 Graduate Fellow, Kevin Curley Jr., and GK-12 Undergraduate Fellow, Nathan Shepard, address a science class.

Project Products

Larry Johnson

Project products include human capital and teacher resources.

Human Capital:

Personal interface between Graduate Fellows, K-12 students and teachers has been found to have a positive influence on the Fellows, K-12 students, and teachers and has forged sustainable partnerships between participating schools and Texas A&M University.

Distance learning commu

nity extends the impact of the project into rural Texas and beyond by providing online lessons in a searchable database.

Southwest Regional NSF GK-

12 Meeting was an annual conference devoted to sharing of resources; hosted and organized by PEER and attended by 10 GK-12 groups in five states, as well as Dan Carpenter and Sonia Ortega of NSF.

NSF Fellows' presentations

are posters presented at the 2005 Southwest Regional NSF GK-12 Meeting by 13 of 15 Graduate Fellows and two Lead Teachers detailing specific activities, evaluation findings, and successful strategies of the GK-12 program.

To demonstrate cutting-edge scientific (STEM) research methods in the classrooms, 70% of our Fellows gave presentations on their specific research projects in their routine teaching presentations.

Introductory videos were produced at the beginning of each school year to help middle school students understand their Fellow's area of research.

These were presented before the Fellows attended class. As a result, the K-12 students saw their future Fellow in their scientific research role, talking about their daily activities including the specific research (cutting-edge STEM) of their graduate program, and enjoying hobbies. The Fellow's introductory video enhanced familiarity with the university and helped set up visits to the university

Other PEER K-12 Connections

- Middle school drawing and essay contest: PEER, in partnership with Sigma Xi and the Texas A&M University Distinguished Lecture Series, sponsors a yearly essay and drawing contest for middle school students. Topics change from year to year and are related to the spring lecture series topics.

- Science fair judging: PEER undergraduate and graduate students travel to local science fairs to assist with judging.

- Science Sleuths Summer Camp: PEER offers a two-week summer camp for middle school students that incorporates PEER integrated curriculum modules to solve a mystery.

- Virtual scientists' presentations: PEER's website offers online videos by Texas A&M University scientists. The videos cover topics related to anthrax, toxicology, the respiratory system, the scientific method, and scientists in the classroom.

by K-12 students of partner schools.

six to 12 per year.

Faculty and teacher presen-tations on the GK-12 outreach efforts were given by the teachers and faculty at state and national conferences at a rate of

Project evaluation mechanisms were developed for Fellows, Lead Teachers, and K-12 students so that PEER could measure progress. PEER also uses a career tracking system for previous Graduate Fellows.

Science and math courses

(VIBS 689 and MATH 689) were developed to train other interested graduate students who are not part of the GK-12 program. This helps STEM faculty in determining "Broader Impacts" of their own research grants or career development awards.

University funding for outreach includes three Undergraduate Fellows per year (about \$9,000) by the Texas A&M University Honors Program and over \$400,000 in cost-sharing contributed by the Office of the Vice President for Research.

Interface with the Sigma Xi Educational Outreach Committee helped institutionalize univer-

sity outreach in STEM.

Teacher Resources: Teacher-Requested Re-

sources (http://peer.tamu.edu/ DLC/NSF_Resources.asp) is the online interface through which teachers receive personal assistance with their math and science-related questions (see page 19).

These resources allow teachers in remote areas of the state to request websites, activities, and even customized lesson plans which our Undergraduate Fellows create with the assistance of their mentoring Graduate Fellow. Teachers are able to direct our activity to better meet their needs both in terms of subject area and lesson depth. Once a response has been produced, it is evaluated for content by STEM faculty, and for public school and age-appropriateness by middle school teachers.

Mini-modules (http://peer.tamu. edu/MiniMods.asp) are the PEER integrative (science, math, English, and social studies) curriculum divided into easy-to-use units, including downloadable packets of slides, activities, worksheets, teacher guides, and questions.

Southwest regional NSF GK-

12 website (http://southwestgk12. tamu.edu/) allows other groups (Southwest Region and nationwide) to upload lesson plans from their GK-12 program and search the hundreds of lesson plans.

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2006 PEER Perspectives

Lessons Learned

Larry Johnson and Bill Klemm

Our GK-12 experiences have taught us many lessons in the areas of training, management, the use of technology, communication, evaluation, sharing resources, and sustainability.

Selecting Effective Fellows

Selection of the right participants is crucial for effective K-12 learning. We select Graduate Fellows on the basis of grades, questionnaires, and interviews, and we look for evidence of interest and

experience in youth interaction and performance. Selection of teachers is not based on the principal's choosing alone. We use feedback from two classes of Fellows and have instituted a questionnaire and formal interview process to select teachers. University faculty are selected according to ability and willingness to serve as lesson plan evaluators and to promote university support for sustainability.

Correctly Training Fellows and Teachers

Training is essential for both Fellows and K-12 teachers. Fellows receive one week of pedagogical training, journaling instruction, general planning with the teachers, and visitation to classrooms. We also hold weekly Fellows meetings, run by the Fellows,

that allow them to share experiences and demonstrate successful activities and lessons. Teachers attended our summer Fellow training program to learn about their roles in the GK-12 program and to get acquainted with their Fellows. We discovered that monthly teacher meetings allow teachers from different school districts to interact and share how their Fellows had been effective in their schools.

Web-based Interaction

Project management requires weekly and sometimes daily attention, so effective web-based tracking of Fellows' activities and school demographic data is important. Fellows benefit from monthly evaluations. This information is used by the management team to help Fellows who might have difficulties and to reward those who are remarkably effective. Reward systems work well for both Fellows and Lead Teachers.

We patterned our online scheduling tracker, journaling, and data collection



An Iola ISD student practices her strategy for a game of math bingo.

system after that used in the University of Nebraska GK-12 program. This system collects data required by NSF for evaluation and progress reports. Online threaded discussions allow communication among members of the NSF GK-12 Southwest Region. Following the Regional Meeting, our group developed the Regional website (http://southwestgk12. tamu.edu), to house PowerPoint presentations of the 10 programs present at the Regional Meeting and GK-12 lesson plans, and to provide a threaded discussion. We have also uploaded the AAAS Regional GK-12 Meeting PowerPoint presentations to this site. In 2005, there were over 2,000 pages of our site viewed every day of the year.

Use of Technology

Use of technology has enhanced effectiveness at all levels (data collection, management, evaluation, and sharing resources). We use web-based technology to procure Fellows' applications and surveys to track Fellows' activities and schedules through weekly journaling. This web-based system allows for the creation and editing of lesson plans and

> extends our content resources to teachers in geographically-isolated locales through our Distance Learning Community and Teacher-Requested Resources. It also allows threaded discussions, online evaluation surveys, and sharing of lesson plans with other GK-12 programs and the world (http://peer.tamu.edu).

> Each of the 12 Lead Teachers were provided with a new laptop and projector for use in their classroom during the project.

Communication

Communication within and among GK-12 groups is key to evaluation and to keeping the project on track. It is also critical to expand the reach of the project through broader impacts to the world. Within our GK-12 group, we have optimized effectiveness of our Fellows through extensive online and in-person

communication between teachers, school administrators, and university faculty. In addition, we have conducted professional development workshops on our PEER curriculum.

Fellows' Videos

We discovered that it is important to communicate to K-12 students information about the Fellow as a person. We observed that students were motivated by relating to their Fellow as a person, and this was fostered by preparing an

(Continued on page 15)

PEER Curriculum

Experiences in Caldwell Middle School

Virginia Traweek

Teachers at Caldwell Middle School began using the PEER integrated curriculum following the spring TAKS testing. "It is already integrated, so students carry ideas from one classroom to the next," said Kelly Lazo, Caldwell science teacher.

The PEER curriculum involves adventure-based stories about middle school students who travel through time to solve mysteries. PowerPoint files and lesson plans cover topics in the modules, and include pre- and post-tests to measure comprehension. Last year, Caldwell used "Texas: 1867," a story about the yellow fever epidemic in Texas after the Civil War. This year, they will study "Dark Poison," a story about tenement housing, to explore the impact of cholera on the New York population.

"Last year, I don't think the kids even knew that those diseases existed. Then, when we talked about it, they realized people can still get smallpox in countries outside of the United States," said Lazo.

"We read the story in reading class; then



Middle school students learn biology of the respiratory system during a scientist visit. The students examine a horse's tongue with attached respiratory structures.

we wrote compositions and discussed symbolism, mood, and foreshadowing and then wrote a comparison essay. All of that covers TEKS," said Leda Long, Caldwell reading teacher.

PEER faces challenges as teachers attempt to reconcile its environmental health lessons with TEKS objectives. "We're using it in May because we like integration, but alignment to TEKS is not perfect, so it's hard to get in," said Lazo. To address this, PEER hired former teacher Shawn Martin to review all materials for TEKS compliance.

"The only other challenge I would say is that it's hard for teachers to have time to meet and coordinate the curriculum, because teachers have to stay after school to prepare. If someone else creates a curriculum and you just hand it to another teacher, it's hard to understand what's going on," said Long.

PEER's integrated curriculum is available online where it can be downloaded as a series of mini-modules. The entire curriculum can be ordered, free of charge from PEER. For more information about the curriculum and PEER activities, please visit http://peer.tamu.edu.



Danielle Lewis demonstrates her research to a middle school student visiting Texas A&M University.

TeacherSpeak

Most rewarding part of having a Fellow in the classroom:

• "time in preparation saves the teacher's time"

- "Fellows develop ideas to fruition"
- "rediscovering concepts in the classroom"
- "getting materials"
- "walking science encyclopedia"
- "more activities"
- "guest speakers"
- "she's [my Fellow is] a fresh face"

Areas where PEER has been especially useful:

- Kids get excited about the Resident Scientist/Mathematician (RS/RM) coming to class.
- The RS/RM makes math fun and exciting.
- The RS/RM is always coming up with something new.
- The RS/RM helps plan field trips and guest speakers.

• The RS/RM helps reduce the burden of creating and preparing activities.

FellowSpeak

Tips for interacting with your teacher:

- Be flexible.
- Don't be egotistical. The teacher already knows a lot.
- Create an initial bond. Ask about the teacher's life and interests.
- Plan your meeting time in advance.
- Treat the teacher like a colleague.

Golden Nuggets

Benefits to Graduate Students from Involvement in GK-12 Experiences Larry Johnson and Virginia Traweek

A "golden nugget" is a reflection that captures the spirit of the PEER GK-12 program. PEER collected comments from graduate students about their involvement in the program and presented the information at the national GK-12 meeting. What follows is a brief summary of the data and collection techniques.

PEER's main goal is to assist middle school teachers in creating a fun and inviting atmosphere in their science and mathematics classrooms, where NSF GK-12 Graduate Fellows serve as math and science content resources. Each June, a new group of graduate students at Texas A&M University is trained for interaction in the middle school classroom. These students become Resident Scientists and Mathematicians and spend their time working directly with students and teachers in local middle schools. In addition to studying the benefits received by middle school students, PEER hopes to catalog the experiences of its Graduate Fellows. Most Graduate Fellows

at PEER have never taught before or interacted with middle school students. By the time they have reached the end of their year as Resident Scientists/Mathematicians, many feel they have achieved a new level of understanding about their careers, their education, and their year in public school. PEER investigated the qualitative experiences of these graduate students and used mathematical analysis to help quantify their responses. Our goal was to understand how GK-12 experiences have enhanced graduate student skills, knowledge, and careers.

PEER"Golden Nuggets"

"I have done a few epidemiologicallybased activities with the middle school students. The kids had the chance to create their own outbreak scenario and have witnessed how fast a disease like yellow fever or malaria can spread in a population. The kids enjoy learning about reallife science."

"The GK-12 experience has enabled

me to practically apply the concepts in my degree program. I now have a much deeper understanding of the concepts underpinning my program and their practical applications."

"Any time you teach your discipline, it forces you to master the material. The program has not only strengthened my basics, but it has also caused me to look more at the real-world approach."

"Being in this program has changed my life and has given me new goals in my career path. I am so happy that I have found a profession where I can use my creativity while also helping improve mathematical education in this country."

"The students have taught me more about myself. The GK-12 program has also forced me to think about science in applied real-life situations."

"Physics is a mathematically-based (Continued on page 9)

Question	Percent
	Agreement
1. Has your work in the GK-12 program strengthened your career path? Do you feel you have more opportunities as a result of your involvement?	100
2. Do you feel that your experience in the GK-12 program has contributed to your knowledge or under- standing of your discipline? Has it widened your view of how your discipline fits with the scientific/ mathematic community?	90
3. Have you integrated your STEM knowledge into the K-12 classroom?	90
4. Have you presented any of your research or research techniques in your classrooms?	70
5. Has an advisor, professor or colleague noted that your presentation/teaching style has improved?	70
6. Have you learned a general strategy or general information that applied to your specific research problem?	40
7. Have you had a meaningful experience(s) in the public school classroom?	90
8. Has the GK-12 program made you a more complete scientist or mathematician or contributed to your personal development?	100
9. Did you have positive benefits or effects from participation in this GK-12 program?	100

"...the past nine months have been a series of continually rewarding experiences."

8

(Golden Nuggets, cont'd from page 8)

discipline that ties with engineering. The mathematics can be made fairly simple for a middle school student. I have integrated my STEM knowledge into the classroom where the students pretend to invest in the stock market and then spend the year tracking their stocks."

"I will definitely participate in outreach in my community. There are disadvantaged students everywhere. It is our responsibility to help them as we are able."

"When asked on a job interview 'What have I been doing for humanity other than going to class and being a graduate student?', my GK-12 involvement gave me something to say."



Middle school students examine a pig lung to demonstrate the effects of smoking during a scientist visit to their school. Students also learn about toxicology, anthrax, and a variety of other environmental health science topics.

"The program has opened my eyes to the diversity of our public schools."

Snook's Science Bowl Victory

How Two Graduate Fellows Helped a Small School Win Big Virginia Traweek

When asked about competing in the Science Bowl, Ricky Ramirez said, "It was something that was completely fun." Ramirez, along with eight other students from Snook Secondary, a school of about 150 students, competed in the Science Bowl and nearly won state.

The little team from Snook had tough competition. Snook had never been to a Science Bowl nor did they have experienced Science Bowl coaches. The students practiced twice a week after school, honing their math and science skills. PEER Graduate Fellows Erin Anitsakis (Oceanography) and Michael Karka (Biomechanical Engineering) hosted the practices and used their science and math expertise to guide the team.

"They test through 8th grade, and a lot of our Science Bowl kids were 6th grade. They were being exposed to higher level mathematics," said Laura Sebesta, Snook math teacher.

To prepare, the Fellows created a practice schedule that emphasized student responsibility. "[The students] took it upon themselves to make sure they were there all the time. Nobody had to be reminded," said Snook math teacher Laura Sebesta of the mandatory practices.

Students met with Anitsakis and Karka, who focused on math and science using hands-on activities to reinforce concepts. In one such activity, Karka led the class in a miniature competition. "We got fishing lures and used the weight to create an elevator," said Ramirez. The classroom elevator contest winners visited Texas A&M University, where Karka demonstrated laser experiments.

In the Science Bowl, Snook Secondary went 3-1 in the preliminary round and lost a tie-breaker in the playoffs. Students and teachers were amazed that the previously unknown Snook team was almost unstoppable. The tournament (Continued on page 10)



Graduate Fellows Erin Anitsakis of Oceanography and Michael Karka of Biomechanical Engineering pose with the Snook Science Bowl team at the competition. The students, who had never before competed in Science Bowl, made it to the semifinal round of competition.

(Science Bowl, cont'd from page 9) director told Karka that he was impressed with Snook making it so far in their first year of competition. "I overheard some kids asking their teacher where Snook was," said Karka. "They were shocked that our kids were so good."

Now that Science Bowl is over, Snook is already planning for next year's competition. "It felt good that all that hard work finally paid off. If we have it next year, I'll do it again," said Cullen Hairell, team captain.

As for the impact the competition has had in the lives of the students, Nicky Wiggins said, "It makes me want to go further into my career, not just get a bachelor's degree, but go on and get my master's and a doctorate."

Teacher Training

Undergraduate Fellows, staff, and faculty, in addition to the GK-12 Graduate Fellows, also interacted with teachers throughout the state via direct contact at teacher professional workshops or via distance learning connections. Rural teachers throughout the state reported a positive impact as a result of the PEER integrative curriculum and technology

training for themselves, their fellow teachers, and their students.

A group of 166 teachers from 9 workshops throughout Texas scored significantly higher on post-tests than pre-tests on content material for all four subject areas (math, science, social studies, English) and toxicology. These teachers shared the curricular materials with 423 teachers and 7,071 students. Additionally, 49% of teachers ranked themselves as having improved their PowerPoint skills following the workshops.



Dr. James Kracht addresses teachers at a PEER professional development workshop.

PEER and GK-12 Improve Middle School Teaching

Diana Mowen

After a full school year working with a GK-12 Graduate Fellow in their classrooms, teachers acknowledged experiencing many positive changes. One of the most successful objectives of the NSF GK-12 program was to increase Lead Teachers' content knowledge through interaction with the GK-12 Graduate Fellows.

Teachers reported increasing their use of technology in the classroom as a result of their interaction with Graduate Fellows. At the beginning of the school year, the GK-12 Graduate Fellows conducted activities with students using new technologies (PowerPoint presentations, computer research activities, and equipment commonly used in scientific research). As these types of technologies became more commonplace in the classrooms (the GK-12 program provided a laptop computer and digital projector to each Lead Teacher), teachers developed greater confidence using them and began incorporating them into class lessons even when the GK-12 Graduate Fellows were not present. Following teacher participation in the program, students will continue to benefit from the teachers' use of up-to-date technologies.

These changes have contributed to an increase in job satisfaction among participating teachers. Even though the Resident Scientists and Mathematicians will leave the classrooms to pursue STEM careers, the teachers will have a greater knowledge of their discipline, greater competence using and staying abreast of new technologies, and a renewed appreciation of how fulfilling teaching young people can be. These changes will continue to affect these teachers and their students for many years.

K-12 Student Interest in STEM:

Almost 10% of students in participating classrooms changed their attitude of STEM from negative to positive over the course of one year. The major reasons for changes included: NSF Graduate Fellows being present in the classroom, and K-12 students wanting to go to college, liking subject material, thinking they were smart enough, and having a positive self-image. This is a significant finding given that most research shows student interest in STEM has been shown decrease after the sixth grade.

Improved Impact by GK-12 Fellows:

Teachers evaluated the performance and impact of the Graduate GK-12 Fellows in their classrooms at both the middle and end of the 2004-2005 school year. As the year progressed, teachers saw improvement in the quality of activity preparation by the Resident Scientists/Mathematicians, as well as greater appropriateness of activity objectives.

The teachers reported increased effectiveness of their own relationships with other teachers and parents. The work of the GK-12 Graduate Fellows in the classroom also resulted in greater student involvement in class activities. Teachers expressed approval of the increased ability of GK-12 Graduate Fellows to develop the interest of students while planning and implementing activities in the classroom.

GK-12 Graduate Fellows improved their ability to conduct interesting and engaging activities, which resulted in class-room order being maintained. ■

A GK-12 Experience in Mathematics

G. Donald Allen

The GK-12 program seeks to involve public schools, graduate students majoring in STEM areas, and faculty in highquality universities. It is nothing less than a program with hundreds of variations and thousands of possibilities. This complexity is tremendously attractive to academics like me who have devoted a career to mathematics research.

What I do is listen and learn about the issues affecting schools. In my personal outreach to the schools, I interface with the teachers through various forms of professional development. What I have learned is that there is uncertainty among teachers about the conflicts between the content they are asked to teach, the pedagogy they are asked to apply, and the high-stakes testing that is used to measure their performance. Through my involvement in the GK-12 program, I find the pure goal of teaching children refreshing. It is remarkable that STEM graduate students are fully involved in the process of middle school student learning, since this is almost impossible in other environs. It is my great pleasure to help as we explore STEM teaching and learning.

This GK-12 program is one of my most rewarding professional endeavors. It has shown me numerous research problems in the field of mathematics education which need desperate attention to help resolve critical problems in STEM learning. The most important question of the day is: "Why do children get turned off to mathematics (and science) at such an early age?" Is it the students? Is it the teachers? Is it the subject? The answer is not clear. Middle schools are the proving ground, for this is where it happens. It has been very rewarding to see the fierce dedication of our teachers and to see and measure their successes. We need to determine how and why the confluence of graduate students with teachers contributes to such successes in the classroom. This remarkable symbiosis seems to be common among GK-12 programs nationally. Also, it is rewarding to serve

as a mathematics faculty reviewer of the Teacher-Requested Resources that broaden the reach of the university to rural schools.

Another reward is that I've met a number of professional academics, graduate students, and teachers all with the same goal of improving STEM education everywhere. This has led to my work on other STEMtype projects. Most of my work has been with teachers at the high school level and most have been from rural areas where the needs are most acute. Through this GK-12 program, I see a very committed core of professors, graduate students, and teachers trying to raise the bar of achievement of their students. Finally, I am involved in other STEM projects with teachers and students across the state, which may not have been possible without this GK-12 project. ■

Don Allen, professor in the Mathematics Department, has developed online mathematics courses and professional development workshops.



Dr. G. Donald Allen with a group of middle school math club students visiting Texas A&M University.

(Project Products, cont'd from page 5)

Regional threaded

discussion enables Fellows, teachers, administrators, and evaluators to select the specific type of communication in which they want to participate.

Online introductory video

streaming (http://peer.tamu.edu/ interviews.shtml) helps schools gain information about and access to graduate students in university math and science. One lesson learned by comparing the Fellows' streaming videos addressing roughly the same questions as asked of our faculty and answered in the virtual interviews (http://peer.tamu. edu/interviews.shtml) is that Fellows did not drive home an underlying faculty theme, namely that stamina and maintaining focus are important in preparing for and meeting academic goals. Perhaps the Fellows had not yet become hardened (matured) by years of seeing the wasted talent of many undergraduates or perhaps they were correct in using their time on stimulating comments.



Erin Anitsakis of Oceanography discusses her research in her pre-classroom introductory video.

The Death of "Drill and Kill"

School Administrators Speak Out about Facilitating Hands-On Learning Virginia Traweek

Though PEER graduate students have been active in approximately three dozen classrooms since the program began, the behind-the-scenes work has largely gone unnoticed. In addition to needing willing teachers, PEER Graduate Fellows have also needed the help of middle school administrative staff to approve projects and provide support as teachers integrate new teaching techniques into the classroom.

Robert Reyes, middle school principal for Snook ISD, has overseen three different PEER Fellows as they completed their year of classroom assistance. "I know [Ms. Donald] had a couple of students that were maybe a little more 'at-risk,' but when they were doing activities [with their Resident Scientist], they got along just like everybody else," said Reyes.

PEER's involvement in Snook schools began by word of mouth, first with a summer tutoring session and then with the placement of GK-12 Graduate Fellows in the classroom. Gerri Maxwell, Snook curriculum coordinator, noticed a difference in the students. "We were able to have pretty good attendance all summer, which tells me that it was effective at least on that measure," said Maxwell.

After the initial summer tutoring, PEER placed a graduate student in the middle school math class during the 2004-2005 school year. During the 2005-2006 school year, two new graduate students were placed in the middle school math and science classrooms.

"You can't have one hundred percent project-based instruction; you can't have one hundred percent drill and kill. Somewhere there's got to be a happy medium," said Maxwell. The happy medium, it seems, is combining the time and expertise of the PEER graduate students with the curriculum knowledge of the teachers.

Teacher Laura Sebesta spent a year with

Michael Karka, Texas A&M University biomechanical engineering major, in her classroom. "Michael has taken things that I've had in my head and never had a chance to do and seen how the kids responded to them. We're able to do a lot more with the kids," she said.

PEER involvement has gone beyond simply assisting teachers. It has sometimes been responsible for tremendous changes in classroom techniques. "I know in one case that there's a night and day difference in the way that one of our teachers does instruction because of having PEER

in her classroom, so I am happy about that," said Maxwell.

Most administrators felt that allowing the teacher freedom to change his or her teaching style was most important. "I don't really do much. I just let them run with whatever they need to do," said Reyes.

"If you really want to maximize the effectiveness of having Fellows in the school, I think you should have meetings with the Fellows, the administrators, with the teachers involved and with the people at the university," said Maxwell. One of the benefits of having a college student in the classroom is the connection students make between their education and their future. "When they see their Fellow, they are developing an interest in things they could do in college," said Reyes.

"When I have gone in and observed classes where students were doing handson activities, the students are always engaged. I think they enjoy that instruction," said Maxwell.



Danielle Lewis, NSF Graduate Fellow, helps demonstrate a science experiment at the Southwest Regional GK-12 Meeting.

TeacherSpeak

Having a GK-12 Graduate Fellow that we called "Resident Scientist" in my classroom for the past two years has been incredible. By far the best part was being able to bounce ideas off someone who was not a "teacher" in the traditional sense, but more of a "scientist." All too often, classroom teachers get bogged down with the real world and lose some of the excitement of real science. Having GK-12 Fellows for the last two years greatly improved my teaching. I learned so much (especially in the field of genetics!) and I found that by working with them, I was able to think outside the box and come up with new ways to teach things. They also reminded me of the power of scientific inquiry, something that I have always used but I now use much more often!

> Jan Fechhelm Cypress Grove Intermediate College Station, Texas

Dr. Bill, Memory Medic

Bill Klemm

Dr. Bill, "Memory Medic," is a PEER Co-PI who specializes in helping students remember their school lessons. When Dr. Bill was in the 7th grade, he finally got interested in making good grades. But, Bill had other interests too, so he had to find ways to be efficient at school work. That meant learning how to remember school lessons without hav-

ing to read them over and over. Besides, "drill and kill" was boring. Bill learned ways to get most of it right the first time, usually while he was still in class. Today, Dr. Bill's research has helped scientists understand how the brain works, specifically memory. He has developed these tips to improve learning efficiency:

Register the information in the first place. Most people find it hard to remember names because the names never registered in the first place. The key is to really pay attention when you are confronted with new information that you are supposed to remember. To do that, it helps to think

the information is very important (even if you don't believe that it is). People pay attention to things that they think are important and paying attention helps

Comments about Bill Klemm's "Thank You Brain"

I recommend this book for the student, the professional, and the senior citizen. This is a book that everyone wanting to look "smart," feel "smart," and be "smart" can read and enjoy. The book presents technical information ... and then rephrases it in easy to understand terms for the lay reader. Key ideas at the end of each chapter summarize the register the information, increasing the odds that it will be remembered.

Relate new information in ways that help give it meaning. For example, you can relate it to things you have already learned. Associate items to be remembered in groups, and in those groups include things you already know. The

> best associations are visual images. Invent weird mental pictures to represent what you are trying to remember, and include in the picture an image of things you already know. It even helps to have an animated video clip in your "mind's eye." For example, suppose you want to remember "chromosomes, genes, DNA, nucleotide bases," and the scientists who figured out how DNA was made: "Watson and Crick." Create in your mind a picture of a baseball field, seeing the bases (nucleotide bases). Ask yourself "What's on (Watson) first base?" See a car, with huge chrome

(chromosome) bumpers all around it. The driver of the car has a crick (Crick) in his neck that makes him lean out the window the whole time he is driving around the

salient points. The author has interpreted and reviewed, in plain language, the detailed tests and results of years of scientific experiments.

- reader review, posted on Amazon.com

Each chapter's theme in this scholarly work is supported through charts, graphs, research, lists of tips and citations, but not to worry, Dr. Klemm writes in laymen's terms and his conversational tone speaks directly to readers. Highly bases, and he stops briefly on each base.

Rehearse what you are trying to remember while it is still fresh in your mind. At this point, the information is on your mental "scratch pad," which is easily erased by new information. Don't let yourself be distracted until you have rehearsed your mental pictures several times. While rehearsing, think of all the details that go with what you are trying to remember. These details serve as clues that help you remember it in the first place and make it easier to retrieve later. Rehearse briefly several times during the first day and the next day. Doing this ensures you remember the information, therefore decreasing study time.

Retrieve as much of the information as you can. Remembering some parts will serve as clues for recalling the rest. If you are under pressure, as in a test, don't panic. Remind yourself that your brain has this information and that you can get it out if you just think of the clues that you remembered right away. Don't bang yourself on the head saying, "Think, think, think!" Relax, trust your brain to do its job, and chances of correct recall will improve. Be patient. Think about other things temporarily when you are stumped. ■

Bill Klemm is Co-PI of the PEER project and has spent most of his career researching memory. Visit thankyoubrain.com for memory tips and a blog on current topics in neuroscience, or read Dr. Bill's book, "Thank You Brain For All You Remember: What You Forgot Was My Fault."

recommended.

- Lavern Hall, editor, "A Glass Full of Tears: Dementia Day-by-Day"

[Whatever your memory problem,] Klemm (a.k.a. the "Memory Medic") has a solution for you. He has recorded his findings in this helpful book that includes more than 150 ways to improve memory for people of all ages and in all stages of life.

- "Auburn Alumni Magazine"



Dr. Bill Klemm in his memory medic jacket.

Scientists' Visits

Virginia Traweek

Thirty-five thousand middle school students and over 1,200 teachers in central Texas and throughout the United States can now say they feel differently about science following interactive presentations given by Texas A&M University professors. In addition to sending graduate students into classrooms for direct contact with middle school students, several professors travel to schools with specimens and activities to stimulate student interest in the sciences.

Dr. Larry Johnson, Principal Investigator for PEER, travels to middle schools across the country with a collection of plasticized animal lungs and torsos to explain the dangers of smoking. Students test their lung capacity and are shown human tissue samples of a smoker's and a non-smoker's lungs.

He starts by asking students, "What is the function of the respiratory system?" Students ultimately state that it functions in getting O_2 into the body and discharging CO_2 . Dr. Johnson explains this function called "gas exchange." Like plumbing in a school or house, the lungs have special structures that get air carrying O₂ into air sacs where it can be exchanged into the blood vessels in the walls of the sacs. The plumbing inside the body, Dr. Johnson continues, is called anatomy, and the respiratory tract has two portions to its anatomy. The conducting portion provides the conduit to the outside and cleans, warms, and humidifies air as it goes into the air sacs of the respiratory portion where gases $(O_2 \text{ and } CO_2)$ are exchanged. Carbon dioxide is discharged by exhaling. Students are amazed that the surface area of the air sacs is the size of a tennis court due to elaborate branching of the conducting portion. Students learn that inhalation (into the respiratory system) is one of four routes of exposure to environmental toxicants. The other three are ingestion (route by which poison killed Romeo), absorption (through the skin or eyes), and injection (like mosquitoes that transmit West Nile virus and agents causing malaria).

Students learn that most diseases are an over- or under-expression of a normal function. The constriction of bronchioles (airways of the conducting portion) in response to an inhaled stimulus is normal, but with asthma, the airway constricts air flow when it should not.

Students learn that the thickness of the barrier in the lung air sac between air and blood is much less than the thickness of a single red blood cell. Hence, environmental materials that enter by inhalation are very close to your blood. What you breathe influences

your health. Students learn that smoking damages ciliated cells of the conducting portion which move mucus out. It is the loss of these cells that gives smokers the "smoker's cough." Students see that smoking fills the garbage traps of the body (macrophages in the airway in this case) and turns the lungs black.

Students learn that smoking can cause emphysema (breakdown of the sac walls allowing too much air in the lungs and reduction in surface area of the respiratory portion). Other diseases discussed include pneumonia (swollen sac walls, edema, and increased thickness of the sac barrier through which oxygen and carbon dioxide must pass for gas exchange) and lung cancer. Students also learn about the excitement of discovery, scientific travel, opportunities, and satisfaction of careers in science.

Dr. Johnson's approach is to try to facilitate a knowledge base that leads to greater self-esteem and self-awareness when choosing careers. "I get to stimulate their curiosity," Johnson says, "and that is very gratifying."

"The students were able to view actual specimens, and Dr. Johnson elaborated on material that they had learned in class," said Kelly Lazo, science teacher at Caldwell Middle School. "Throughout the year, when we discuss similar topics, they bring up his visits and things they learned from him."

Another subject on which Dr. Johnson speaks is toxicology, the study of poisons. Most students are surprised to learn that almost any substance can be poisonous with the correct dose, even salt, sugar, and water.

The premise behind these and other scientists' visits is that most middle school students think science is boring or too difficult. PEER strives to spark interest among youth by encouraging inquirybased learning. "I start every visit with simple questions that the kids can answer easily. If they feel like they understand early in my lesson, they tend to be more involved later on. Then I try to challenge them a little. When I talk about toxicology, I ask them why one piece of candy is fine, but a full bag makes them sick.

(Continued on page 15)

(Scientists' Visits, cont'd from page 14) They all know that excess sugar consumption causes an upset stomach, but often do not realize that they are verbalizing a fundamental concept in toxicology, namely 'dose makes the poison' and not the sugar itself."

"Middle school students are in special need of guidance toward science careers," Johnson said. "This age group is sort of a forgotten group. The least amount of attention is placed on middle school, even though it is a prime developmental period. This is the time they establish interest in careers. We want to catch them before they decide that a science career is not important."

Ninety-three percent of students report learning something from the presentations. Seventy-nine percent plan to share what they have learned with others. "The most important piece of data," Johnson said, "is the fact that the students felt the same about the presentations regardless of where I went and to whom I spoke. This means that any scientist, anywhere, can do this and get the same results."

Students have written a variety of comments on the evaluations, ranging from, "I didn't like the dog because it was dead" (a reference to one of the plasticized specimens Dr. Johnson carries on his visits) to "I learned all about how the lungs worked, which I did not really understand before the presentation." Another student thought the most interesting part of the presentation was, "that the cause of hiccups is because your diaphragm is just having a contraction that you can't stop." One student even responded, "Texas A&M University is probably my future college, but all I thought of A&M was its sports. Now I see that their science program has advanced technology and is worth looking into."

Creating contacts with teachers is an important aspect of Johnson's involvement. "Every year, we send out about 4,000 letters asking teachers if they want a scientist to visit their classroom," Johnson said. "When I get invited, I try to speak to the students on their own level and try to be funny. They want to know what I do and where I have traveled, but they also want to have fun during the lecture."

"Although not all will go to college," said Johnson, "the goal is to make sure that all are aware of their own potential. We are reinforcing teachers as they encourage students to make informed decisions."



Pre-med GK-12 Undergraduate Fellow Varun Chowdhary illustrates organs and systems in a dog to middle school students during a summer camp.

StudentSpeak

Things you liked about having the Fellow in the room:

- "having fun but still learning"
- "Friday afternoon activities"
- "having someone other than the teacher in the room"
- "playing math games"
- "joking with my Fellow"

Things your Fellow taught you:

- adding and subtracting exponents
- FOIL method for binomial multiplication
- Pythagorean Theorem
- calculating surface area
- dividing fractions by whole numbers
- multiplying and dividing fractions
- how to use weights to create an elevator

(Lessons Learned, cont..d from page 6)

introductory video about each Fellow. Fellows also participated in relevant outof-class activities (such as science/math contests, science clubs, and field trips to the university and the Fellow's lab).

Evaluation/Sustainability

Evaluation has been useful for showing that the GK-12 program has had a significant impact on Fellows, teachers, and K-12 students. We have added a new committee, the Educational Outreach Institutionalization Committee, and an institutionalization objective to the proposed GK-12 continuation application. The PI and two of our Co-PIs (Klemm and Allen) have formed a university-wide K-12 Educational Outreach committee under the auspices of the local chapter of Sigma Xi. PEER will attempt to revise the university's graduate training infrastructure to include K-12 outreach as a routine part of graduate education for interested students. Institutionalization of the GK-12 concept will include the development of graduate science and math outreach courses, incorporation of projects of other faculty needing "broader impacts," and alteration of the graduate assistantship finances to include K-12 outreach.

Southwest Regional GK-12 Meeting, October 2005

Larry Johnson

The first Southwest Regional NSF GK-12 meeting was organized and hosted by PEER in the College of Veterinary Medicine and Biomedical Sciences at Texas A&M University. The expected outcomes of the conference were to:

- Establish collaborations through the immediate sharing of resources and subsequently through an online threaded discussion forum;
- 2) Share ideas to enhance effectiveness of the program, including impact on participants, establishment of links between higher education and public schools, and sustainability and institutionalization of GK-12 training of graduate students; and
- 3) Provide a framework for future collaboration opportunities among regional GK-12 groups.

Ten GK-12 groups from four states prepared a 12-minute presentation that covered their program successes.

Each GK-12 Fellow who attended the meeting was required to prepare a poster to present at a lunch-time poster session. Teachers and managers were also invited to present. Posters prepared by Fellows detailed findings regarding the overall effectiveness or impact of the program, as well as an involved activity or series of activities conducted in the Fellow's school, an unusual finding of PEER's involvement in public schools, or other aspects of PEER or interactions with K-12 students or teachers.

Each attending GK-12 group created a packet of five outstanding lesson plans that reflected original, polished activities that had been tested in the classroom. These were shared with other GK-12 groups during the "Birds of a Feather" session.

At the opening reception, Dr. Fuller Bazer, Executive Associate Vice President for Research at Texas A&M, discussed research enterprises of Texas A&M University, and Sonia Ortega provided comments for NSF about the value of regional NSF GK-12 meetings. The welcome was delivered by Evelyn Tiffany-Castiglioni, Associate Dean of Undergraduate Programs in the College of Veterinary Medicine. Karen Watson, Dean of Faculty at Texas A&M University, spoke on "Recruitment of Women and Minorities in STEM." During lunch, posters were displayed in the hallway for participants to view.

Special topics covered during the meeting were:

Developing Lasting Networks and Opportunities for Collaboration, Birds of a Feather Breakout Sessions (Math Fellows/Teachers: Science Fellows/ Teachers, PIs, Evaluators, and Managers), Sustainability, Birds of a Feather Reporting, hands-on activities (involving geology, GPS, and general experimentation), and closing remarks by Sonia Ortega.

Outcomes of the meeting:

It was noted at these sessions that a means for collaboration and sharing lesson plans was needed. As a result of the meeting, a Southwest Regional website was produced by our PEER GK-12 group (http://southwestgk12. tamu.edu). The site has details of the meeting, including session notes, a mechanism for uploading and sharing lesson plans among regional and national GK-12 groups, and a threaded discussion for various groups in the GK-12 programs (e.g., teachers, Fellows, PIs, and administrators). ■



Sonia Ortega, NSF GK-12 Program Director, gets the Southwest Regional GK-12 meeting off the ground!



Mechanical Engineering GK-12 Graduate Fellow Ryan Pedrigi displays his "Fun with Physics" poster.



Lead Teacher Pamela Donald shows off her class activities with the GK-12 Project.



Teacher Andrew Lyon demonstrates sediments to students and parents at the regional meeting.

The Making of a "Mathemagician"

Marta Kobiela

I remember distinctly the Christmas of 1992. I was eleven years old and dreaming of presents desired by every elevenyear-old girl: dresses, dolls, and the list goes on. At the Christmas tree, I found a different surprise. My dad handed me a package with an air of accomplishment, as if he had chosen the perfect gift. I opened it to find a book: "Mathemagics" by Arthur Benjamin and Michael Brant Shermer. I realized that perhaps I was not meant for the cool life of hip clothes and neat gadgets. I gave in and read a chapter, but only a chapter.

For many years the book stood on the shelf, a distant part of my life. It was not until I was in college, studying math, that I experienced a second encounter with "mathemagic." During a summer research program in California, one of my mentor professors, Joe Chavez, dazzled us with his mathemagic routine. This routine had been used for years at birthday parties, in classes, and for family and friends.

It was not until a year later that I became hooked. At a math conference, amid the equations and proofs, I saw the author of my book, Arthur Benjamin, give a "mathemagic" performance. It was mesmerizing, funny, quizzical, anything, and everything. From then on, I knew my future.

Being an amateur, I had to research to find good tricks. After reading books, searching the Internet, and modifying ideas, I came up with a small, but not too shabby, collection of acts. My most common act relies on the power of candy to entice audiences. Using simple candy algebra, participants disentangle "secret" number puzzles. Skittles represent ones and a Starburst represents a secret number. The participants can visualize the problem using the candy. I might ask the audience to do the following: Pick a secret number (represented by one Starburst). Add seven (Skittles) to the number. Multiply your answer by two (double Skittles and Starbust). Subtract

six (Skittles) from your new answer. Divide this by two (Take away half of the candies.). Subtract your secret number (the last Starburst).

Magically (or so it seems), each person always ends the series of steps with an answer of four, no matter what the secret number was. A regular magician would selfishly leave the audience to admire with awe, but as a "mathemagician," I feel the true beauty of the process is in understanding why it worked.

Another fun activity involves the amazing properties of dice. With my back

turned, I ask for a volunteer to stack three dice, one on top of another. I also ask the volunteer, with the help of the audience, to add together the bottom face of the lowest die to the four faces that are touching. After turning around and glancing at the top of the stack, I can tell the participant what his or her sum was.

Simply enough, the opposite sides of a die always add up to seven. By subtracting the value on top of the stack from twenty-one, I can always find the correct sum.

Being an amateur is not easy. My costume is poor, my salary is nonexistent, and I never get asked to perform at birthday parties or write books. But seeing the faces of the students makes it worthwhile. I know they are thinking, if even momentarily, that math is cool. That is the best reward ever. ■

Marta Kobiela served as a GK-12 Graduate Fellow for the 2004-2005 and 2005-2006 school years. She is now pursuing her doctorate at Vanderbilt University.



Value of Scientists in Public Schools

Scientists gain much benefit from interacting with teachers and students in secondary education. First, for a scientist to discuss their research with students in Grades 6-12, they must understand it! Knowledge of science in its most basic form is critical to having a meaningful interaction with young students. It is a beneficial experience for any scientist to gain such a detailed understanding of their work. In addition, breaking down science into a form that can be understood by young students may allow a researcher to identify needed improvements that previously were not obvious. Secondly, while we all want to think our research is important, igniting the lamp of interest in a young student may be our most important contribution to science. Certainly, our science and results contribute to a better understanding of our area of interest. However, how can one measure the contribution of the teacher who motivated Albert Einstein or Jonas Salk?

-K.C. Donnelly, Professor and Head of Environmental and Occupational Health Texas A&M University, Health Science Center

First-Year Classroom Improvement

Shannon Degenhart

Methodology

At the beginning of the school year, NSF Fellows were assigned to Lead Teachers whose classrooms were to be their primary focus. The Fellows were expected to spend at least 10 hours per week interacting in middle school classrooms, serving as content specialists, and promoting inquiry-based activities. Pre-surveys were administered to all students prior to Fellows' involvement. During the course of the school year, Fellows were expected to reach out to other classroom teachers in the school and interact in their classrooms as well. By the end of the school year, Fellows were expected to spend approximately 60% of their time in the Lead Teachers' classrooms and 40% in the classrooms of other teachers within the school system. At the end of the school year, post-NSF surveys were administered to students in both Lead and other teachers' classrooms.

Middle school student data (n = 1,145) were collected from 12 Lead Teachers and 12 other teachers representing 10 schools in a 40-mile radius of the university. Quantitative data were analyzed by univariate and multivariate analysis using the Statistical Package for the Social Sciences (SPSS). Classroom inquiry was measured using the criterion-referenced **Reformed Teaching Observation Protocol** (RTOP). RTOP quantitative scores are derived from five elements: 1) lesson design and implementation, 2) propositional knowledge, 3) procedural knowledge, 4) student/student relationships, and 5) student/teacher relationships. Each element consists of five items that are rated from 0 (never occurred) to 4 (very descriptive). Overall scores range from 0 to 100 (Sawada et al., 2002).

Members of the evaluation team observed each Fellow in the classroom multiple times. The evaluator only observed, scoring the classroom environment after the class period was completely finished. Cronbach's alpha coefficient was used to determine interrater reliability (.918) between evaluators. Independent sample t-tests were used to determine if significant differences existed between mean RTOP scores by semester or time of day. Analysis of Variance were performed in SPSS to determine if significant differences between mean RTOP scores were influenced by NSF Fellow, teacher, grade level, subject, observer, location, or announced observations.

Results



Pamela Donald meets with her NSF GK-12 Graduate Fellow, Laura Oehler, to discuss lesson plans.

Quantitative data were analyzed from the matched responses of 1,145 middle school students. Of the 1,145 students, 471(41.1%) were 6th graders, 290 (25.6%) were 7th graders, and 371 (32.8%) were 8th graders. In addition, 517 (45.2%) students were male, 560 (48.9%) were female, and 65 (5.7%) did not declare their gender. Other teachers' classrooms accounted for 418 (36.5%) students with 727 (63.5%) students in Lead Teachers' classrooms.

Multivariate analysis indicated that when the teacher and Fellow were present in the classroom, grade level and the Fellow had a significant effect (p < 0.05) on the rate at which middle school students' interests and beliefs in STEM subjects changed. The teacher did not have a significant effect (p < 0.05) on student beliefs and interests in the presence of these two factors. Analysis indicated that students in Lead Teachers' classrooms who interacted consistently with Fellows for one school year held significantly higher (p < 0.05) post-test beliefs and interests in STEM subjects than did students in other teachers' classrooms with occasional interaction with the NSF Fellow.

Analysis of responses to "Do you think you could become a [STEM specialist]? Why?" indicated that middle school students developed positive beliefs about their abilities and increased willingness to persevere toward STEM educational goals after their interaction with NSF Fellows. RTOP findings indicated that NSF Fellows, not teachers, significantly (p < 0.05) enhanced classroom inquiry levels. Analysis also indicated a significant (p < 0.05) increase in inquiry levels between the first and second semesters.

Conclusions

Putting GK-12 Graduate Fellows in the classroom may provide many benefits. Middle school students held more positive attitudes toward STEM areas in classrooms where Fellows were consistent factors. Fellows increased classroom inquiry levels and affected the rate at which middle school students' beliefs and interests in STEM subjects changed. Students in Lead Teacher classrooms also held higher STEM interests than students in other teachers' classrooms. This is promising as it indicates that the negative grade level effect (Morell & Ledermann, 1998, and Weinburgh, 2003) documented in the literature may be decelerated by Fellows in the classroom.

Analysis of the matched pre- and postopen-ended question "Do you think you could be a scientist/technologist/engineer/mathematician [like your resident scientist/technologist/engineer/mathematician]? Why?" indicates that Fellows may also increase middle school students' self-efficacy in those subjects. Self-efficacy is defined by Pajares and Miller (1994) as "a context-specific assessment of competence to perform a specific task, a judgment of one's capabilities to execute specific behaviors in specific situations" (p. 194). Bandura (1986) linked self-efficacy to a student's motivation and achievement in a particular subject. The potential of NSF Graduate Fellows to build positive STEMrelated self-efficacy is a particularly promising long-term benefit of the PEER program.

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The Making of Free Teacher-Requested Resources questions or a list of websites. The li-

Bill Klemm and Larry Johnson Middle school teachers need a singlesource electronic access point that allows them to search for instructional resources that are tagged by grade level and subject matter, designed by content specialists and refined by teachers.

Our program offers an Internet-based nationwide service to science and math teachers by providing them with quality demonstrations and activities. After submitting an online request, one of our honors Undergraduate Fellows selects the request, performs the initial work, and requests review and assistance from one of our GK-12 Graduate Fellows. After interacting to produce a draft response that includes state knowledge standards, the GK-12 Graduate Fellow submits the materials back to the requesting teacher and to our website library of resources (peer.tamu.edu/DLC/NSF_Resources. asp), whereupon an automated e-mail notification is sent to a professor specializing in that area. The professor suggests changes as needed, which are then incorporated and re-submitted to the professor. Once the response is deemed acceptable by the professor, an automated e-mail notification is sent to a middle school teacher specializing in that area. The teacher suggests changes as needed, which are incorporated and re-submitted back to the teacher. Upon teacher acceptance, it is approved and automatically goes to our live website as a "Teacher Requested Resource." All materials in the library are searchable by subject, content category (lesson plans, computer activities, teaching content, self-directed), and grade.

We created this resource system because we wanted our Fellows to have access to a variety of activities and demonstrations that would interest and engage the students. We knew that Fellows would want to generate their own lessons, because of their own academic experience and because lessons that are publicly available are either hard to find, inappropriate, or inadequate. The Principal Investigators of PEER insisted that Graduate Fellows document their lessons in a formal lesson plan, using the lesson plan format that had been developed by the NSF GK-12 group at Duke University. However, not all requests require a full lesson plan. Some of the materials are answers to

brary is searchable by subject, grade, and content category.

When teachers want to submit a request via the website, they see initial choice options to browse what is in the database or to submit a request. Teachers typically browse to see what is already available or search by category, subject matter, or by grade. Though the website houses mostly middle school lessons, many can be scaled up or down for other grades.

In the browse mode, teachers see the title and a brief description of the items in the database, which are hyperlinked to the lesson plan. ■



Diagram of the iterative process for developing responses for teacher requests.

Adventures of an Undergraduate Fellow

Virginia Traweek

I make a list so I don't forget to bring my cardboard models and a sheet so that the students can't see the models until I'm ready. I bring a few books about architects, a ladder, and a flashlight. I make a few printouts for props during

my lesson, and I bring a tape measure for the tower-building contest. Though my job is not going into schools, today is different. I have been invited to speak about architecture.

This is not the first time, but every time I go, the experience is different. I tell the students about architecture and how it relates to mathematics. We talk about different careers for people who get a degree in architecture. I show them pictures of famous logos, which help describe the way people view their world, an the deliver of the star have the all be the star have the star have

NSF GK-12 Undergraduate Fellow, Virginia Traweek, talks about classroom architecture with a group of Jane Long Middle School students.

important aspect of architecture. They raise their hands to answer my questions.

The best part of the whole event is when I open the ceiling. It works for buildings that have a suspended ceiling, with fluorescent lights and air conditioning

Undergraduate Comments

I have been assisting Michael Karka this semester with his work at Snook Middle School. The bulk of my assistance has come in the form of brainstorming with Michael and developing activities to be used in the classroom to reinforce the concepts the students are learning. On one occasion, I worked with Michael to carry out two outdoor activities that we had developed, a "math sack race," which allowed students to practice multiplication and division of positive and negative integers, and a "metric ducts spaced at intervals. I move one of the tiles and talk about what makes a building function. I point out wires and plumbing. The students are amazed that anyone would have the audacity to look into the ceiling. They ask ques-

> tions which sometimes delve into topics such as ethics and professional standards. Some students have parents who work in the construction field, but all of the students seem to be engaged.

> At the end, I show my models and talk about how long it took to build the tiny cardboard houses. Then I let the students build their own models out of toothpicks and gumdrops. They go to work, and soon we've got towers that are two or three feet tall.

Soon the teacher announces that class is almost over. Students begin

cleaning their desks and asking if they can eat their gumdrops. A few approach me to return the books I brought. They ask me questions about architecture, and I answer as honestly as I can. The teacher thanks me. "I'm so glad you came," she says. "It's good for them to see a

Olympics," which allowed them to practice measurement and conversion skills. The students responded very positively to these activities and it was great for me to get the chance to interact with the students and see the end result of the activities we developed.

- Ryan Newman

Every week, I brainstorm activities for my GK-12 Graduate Fellow and then prepare an activity for him to present to his seventh grade class. Last Friday, I went with him to Hearne Middle School and helped present an activity on scaling woman in a mathematics-related career." I tell her it was no problem. It really is no problem. Coordinating my schedule with a public school classroom is sometimes difficult, but for a person who has always wanted to work as an educator, it has been both the most frightening and exhilarating experience of my undergraduate (and now graduate) career.

I've learned that I do not possess the energy to teach seven classes in a row. I know that the challenges of having a new lesson prepared every day for students of different ages and grade levels can be overwhelming at times. However, the ability to share knowledge with another group of people is amazing. I try to present things that will be fun for the students, which means I have to remember what first amazed me about architecture. If I can communicate that, I've shared a piece of myself with a whole group of young minds (at least, younger than mine).

When I get home from my visit, I'm usually exhausted. Still, it's a rewarding experience. I'm getting an opportunity to give back, an experience few of my peers have had. It's not that I want architecture to be their future career, but I want to make sure they know it's an option.

Virginia Traweek served as an Undergraduate Fellow in 2004-2005. She is currently a Graduate Fellow.

in mathematics. We had the students make scale models of cars, people, and buildings in order to teach them scaling and proportion. The lesson was definitely a success! - Sarah Schott

I have gone to Snook and presented a physics lesson that I had written the day before! Through the PEER program, I have done TAKS tutoring for Snook ISD and volunteered for the TAMU math camp, which was a blast!

- Ross Shockley

Teaching Philosophy of a Scientist

Larry Johnson

Driven by curiosity and imagination, humanity distinguishes itself by the desire to learn. People want to elucidate mechanisms, predict outcomes, prevent undesirable situations or consequences, and plan for the future for themselves, their families, and for humanity. Young learners quickly realize the power of knowledge to establish and maintain self-esteem, to communicate with peers and others on interesting topics, to solve problems, and to overcome socioeconomic barriers.

A teacher's role is to facilitate students' desire to learn through helping them develop their knowledge base, their life-long learning skills, and their career choices. Teachers direct thinking behavior, motivate and encourage students, widen students' self-expectations and self-evaluation, and expand their opportunities and career choices.

Teachers can make a difference in the lives of their students. This includes immediate and life-long learning behavior, development of learning skills, and direction of careers. How many people in academia can cite the "third grade teacher" or "college professor" who would not accept mediocrity, who directed them to a certain life-changing book, who widened their opportunity, or who prevented a

FellowSpeak

Tips for a successful activity

• Make it shorter than the time you have. If class is 45 minutes, aim for a 20 minute activity.

- Try to involve the entire class.
- Limit the amount of lecturing time.
- Be able to adapt to the class' skill level.

• Make the activity as simple as possible. The higher-level students will ask good questions.

- Make the set-up easy for the teacher.
- Limit preparation and clean-up.
- Be enthusiastic.
- Rewards and competition always encourage participation.

• Always have a "Plan B."

wrong decision?

Teaching yields "immediate gratification" for one's efforts. The evidence of one's educational approach or point made is immediate in students' faces, behavior, or questions they can now ask. There are distinct behaviors that indicate students are learning. "Oh, so that's how it works," a student may say. When a research discovery is made, there is at least 95% effort on verification, and an expected delay in acceptance of one's discovery by the public. In teaching, the class is the public. Teaching allows scientists to try different ideas or approaches, to hold an investigation of what works with a given group, with students being the study subjects.

In summary, teaching represents a unique opportunity instructors have to mold and

Wings Across Texas November 2002 to May 2005 Jon F. Hunter, Professor



Dr. Johnson demonstrates lung capacity during a scientist visit.

direct academic lives of students and to facilitate the students' inherent desire to learn through stimulation of their curiosity and imagination. In return, instructors stay young in their thoughts, stay interested and stimulated in their subject, stay current, and enjoy immediate gratification for having affected a small part of humanity.

Wings Across Texas is an airborne mechanism for university scientists to reach rural public schools:

- 285 presentations to students attending 59 rural middle/junior high schools in 49 Texas counties
- Student contact: 9,832 hours

Demographics: 63.6% Hispanic, 33.2% White, 2.6% African American, 0.2% Native American, and 0.4% Asian; 62% of these students are on the free lunch program
Total distance traveled: 76,440 nautical air miles (equivalent to 97,264 statute highway miles)

128 scientists' visits: Tuesdays and Thursdays (November 2002 – May 2005)
Averages: 34 students per presentation and 597 nautical miles (equivalent to 760 highway miles) travel per trip

E-mail from Ms. Sandra Weaver (Hardin Middle School) - November 3, 2004

Dr. Hunter and Adam,

Thanks so very much for the *wonderful* visit yesterday. The other teachers were coming to me after school asking what I had going on because it was the talk of the school. It seems that the first group of students filled everyone in on the wonderful program. The winners were sporting their shirts and calculators today. We had testing all morning, so I didn't get to visit with all students today. I will have them fill out the evaluations tomorrow. I will send the evaluations and copies of the pictures to you. Thanks again so much, I don't think either one of you really know how much of a positive impact you have on these kids.

Presentations included: Water Quality; Air Quality; Enterobacteriaceae; The Jade Dragon; Texas: 1867; and Three Rivers, Three Nations

Calculating Surface Area

Under Pressure!

Ryan Pedrigi

Target grade level: 8

Time Required: One class period

TEKS objectives:

8th grade math: 8.1 B, 8.2 A,B,C,D, 8.8 C, 8.14 B,C,D, 8.15 A rational numbers, real-life problems, appropriate operations, volume and surface area, problem-solving strategies, communicating mathematical ideas

Materials:

"Calculating Surface Area Under Pressure" worksheet One 3-D object, such as a box, per group Two nails (for measuring/calculating the area of the tip versus head) per group Two tape measures per group Balloons (optional) Hammer and wood (optional)

Cost per group: Approximately \$1.00

Activity Summary:

The primary focus of this lesson is to introduce the basic qualitative concepts and associated mathematical formulations for pressure. The motivation is to introduce the students to a physical application involving the measurement and/or computation of surface area, which is treated as a secondary objective. This lesson begins with a short presentation that qualitatively defines pressure through examples. This gives students a tangible representation of concepts related to pressure and surface area. Once students understand the concept, they are given the mathematical formulation. There are then two quick examples, using the pressure formula, followed by two short activities requiring measurement and computation of surface area in order to calculate either force or pressure.

Activity Plan:

This activity introduces a creative way to practice measuring and calculating surface area. At the same time, it introduces pressure, a physical principle commonly used in science, technology, and everyday life. The activity begins with a presentation of qualitative examples of pressure. Students are asked to follow along with the provided worksheet (see "Calculating Surface Area Under Pressure" worksheet, page 24) in order to maintain their focus. To make the presentation more interactive, a student volunteer is asked to come to the front to demonstrate a push-up. The first is a normal push-up, where the student's palms are in full contact with the floor. The second is made harder by asking that the student do the push-up using only his or her fingertips. This type of push-up proves to be harder because the fingertips provide significantly less surface area over which the student can exert a force to produce the motion. This means there is more pressure on the fingertips. In this case, the force is the weight of the body, the area is the surface of the hand or fingertips, and the pressure is the level of difficulty

in completing the push-up.

Pressure Concepts:

Pressure is the application of a force (a push or pull) over a surface. Pressure is the ratio of force to surface area. Pressure is an important element in many parts of nature, such as in scuba diving or in keeping tires inflated and functional. For example, the pressure inside a balloon increases as air in the balloon increases. The balloon finally pops when the pressure is too much for the balloon to hold.

Applications of pressure include the heart pushing blood through the body, (blood pressure), divers worrying about the amount of air in their bodies and kids using a bike pump to inflate tires.

Provide the formula:

Pressure = Force / Area

Give a very simple example of its use: A force of five pounds acting over a surface of five inches square has a pressure of 1 psi (pounds per square inch).

Once students are comfortable with the use of this formula, they are given two problems that reinforce their mathematical understanding of pressure. These should be worked out individually, but with the teacher leading students to the solution.

Problem #1:

The deepest part of the ocean is about 32,000 feet deep, where the pressure is about 16,000 psi. What is the total force acting on a submarine that has a surface area of 8,000,000 square inches? Answer: Force = 16,000 pounds per square inch * 8,000,000 square inches = 128,000,000,000 pounds

Problem #2:

The rupture pressure in a balloon is 0.25 psi. If the radius of the spherical balloon right before rupture is six inches, what is the force acting on the inner wall of the balloon? (Surface area of a sphere = 4 * pi * radius squared) Answer: Force = 0.25 pounds per square inch * 4 * pi * 6 inches squared = 113 pounds

Finally, two brief activity questions are given to allow students to work a pressure computation that requires the measurement of surface area (using the tape measure provided):

Activity #1:

Why is it much easier to hammer the tip of a nail into wood versus the head? Assuming that the hammer exerts a force of 200 pounds on the nail, calculate the pressure exerted on the wood by the nail for (a) hammering the tip of the nail into the wood and (b) hammering the head of the nail into wood.

The teacher can demonstrate this phenomenon for the class by attempting to drive a nail into a block of wood (attempting each end separately). In order to show that the answer is related to the pressure exerted by each end of the nail on the block, students compute the pressure for both scenarios. They will need a nail and tape measure to measure the radius of both the tip and head of the nail in order to compute surface area. The calculations will demonstrate that the tip of the nail exerts a much larger pressure than the head because of its smaller surface area.

> Activity #2: Pretend that the 3-D object given to your group is a submarine.

Calculate the force acting over the entire surface area of your submarine if the dive depth is 1,000 feet, which corresponds to a water pressure of 445 psi.

The students should be given a box that they use as a make-believe submarine resting at a depth of 1,000 feet (corresponding to a pressure of 445 psi). The students will again need to measure the dimensions of the object and calculate surface area, and then calculate force using the pressure equation.

The lesson is finished when the final activity problem has been solved. The solutions to these activity problems (or the individual problems) can be discussed as a class or the teacher may choose to have students turn in their solutions for assessment.

Date:

Calculating Surface Area Under Pressure

- 1. What is force?
- 2. What is pressure?
- 3. What does "psi" stand for?
- 4. What is the formula used to find the area of a circle?
- 5. What is the formula used to find pressure?
- 6. What do the following letters represent? Remember to include units.
 - P =
 - $\mathbf{F} =$
 - A =
- 7. EXAMPLE PROBLEM 1: Submarine (show all work)
- 8. EXAMPLE PROBLEM 2: Balloon (show all work)
- 9. NAIL PROBLEM (with group)

10. SUBMARINE PROBLEM (with group)



Activity Summary:

This lab consists of a series of stations. Students will rotate through each station and answer the questions on the worksheet "Crank Up The

Target grade level: 8

Time Required: One to two class periods

TEKS objectives:

8th grade science: 8.1 A, 8.2 B-D, 8.4 A, 8.7 A, 8.9 D lab skills, scientific method, scientific tools, force and motion, physical and chemical properties

Materials:

1

5

Crank Up the Volume! worksheet Station 1 (per station): 250 ml or large beaker or cup - salt Pan (or tuning fork) Saran Wrap Wooden spoon Rubber band

Station 2 (per station): Five 16 oz glass bottles Spoon Graduated cylinder Access to a freezer

Station 3 (per station): Three tin can phones String of two different thicknesses, (Two cut to the length of the room, plus one cut longer than the others) Six tin cans Six buttons Electrical tape (to smooth the rough edges of the tin can)

Station 4 (per station): Sheet of paper for each person Tape

Cost per group: \$2.00

Demonstrating the Movement of Sound Danielle Lewis and Kelly Lazo

Volume." The class size may warrant duplicate stations. Depending on the level of the student, the teacher may need to read through the worksheet with the students. The set-up for this activity is described below in Materials List and Set-up. Students should already have been introduced to the concept of waves.

Vocabulary:

Wave: a disturbance that propagates and carries energy through matter or space.

Vibration: the back and forth movement of molecules.

Medium: any substance through which waves can travel.

Station 1: Time for the Salt Dance!

Cover the top of a cup or beaker with a piece of Saran Wrap. Use a rubber band to secure the Saran Wrap. Place a small amount of salt on the Saran Wrap. Students will use the wooden spoon and pan to discover that the sound waves produced by hitting the pan will cause the salt to jump!

Station 2: Sound Through Different Media

Part I – Characteristics of Sound (See worksheet, page 26.) Part II – How does the amount of water in the bottle affect the sound? (See worksheet.) Root beer or cream soda bottles work very well for this activity. Fill the bottles with 50 mL, 100 mL, 200 mL, and 300 mL of water. For the bottle that will contain frozen water, add 100-150 mL of water to it 24 hours

100-150 mL of water to it 24 hours prior to the activity. Do not leave the cap on or fill it too full, as the bottle may break. Students use a spoon to tap on the bottles and determine the difference in pitch.

Part III – Homemade Telephones Use a nail to punch a small hole in the bottom of each of six tin cans. Thread string of varying thicknesses and lengths through each can and knot the string or use a button to secure the string inside the can. There should be two cans per string for each phone. One student talks into the phone. The second student listens on the other end. Students determine which phone made it easiest to hear. Students should keep the string tight.

Part IV – Eh, What Did You Say? Students make a cone out of paper and tape it. They cut a small hole in the closed end of the cone and place it in their ear, amplifying sounds in the room.

Stations III and IV are listed on the worksheets. ■



Date:

Class period:

Crank Up the Volume!

Station 1: Time for the Salt Dance!

Materials per station:

250 mL or large beaker pan (or tuning fork) Saran Wrap wooden spoon

salt rubber band

Sound is produced by a back and forth motion called a vibration. Sound travels in waves from one place to another and it travels in all directions away from the source.

1. Sound travels as what kind of wave?

Answer: Sound travels as a longitudinal wave.

- 2. Place the Saran Wrap over the beaker and secure the Saran Wrap with a rubber band.
- 3. Place salt on top of the Saran Wrap.
- 4. Hold the pan over the beaker and salt and hit the pan with the wooden spoon.
- 5. Describe what happened to the salt.

Answer: The salt dances! It moves up and down as you hit the pan with the wooden spoon.

6. What caused the salt to act the way it did? Answer: Vibrations cause the salt to "dance."

Station 2: Sound Through Different Media Part I

In order for sound to travel, it must be transported in a medium.

1. Name two substances (mediums) that transport sound.

- 2. Place your ear on the side of the table.
- 3. Have your partner scratch lightly on the other side of the table.
- 4. What do you hear?

Answer: You hear a scratching noise.

5. Can sound travel through solid substances? Answer: **Yes.**

Part II – How does the amount of water in the bottle affect the sound?

For this exercise, you will use the four glass bottles filled with water on the table and ask your teacher for the 5th glass bottle in the freezer. The amount of water in each bottle is as follows:

1 = 50 mL 2 = 100 mL 3 = 200 mL 4 = 300 mL 5 = 50-100 mL frozen

Your mission is to determine if the volume of fluid in the bottles affects the pitch of the sound made when you tap a spoon against each bottle. Pitch is how high or how low a sound is perceived to be.

Answer: Water, air, and solid objects transport sound.

For this exercise, write a hypothesis stating whether you think the sound will change or will stay the same. 1. I believe that when I tap a spoon against the side of the bottles containing different amounts of water, the pitch

will

2. Now tap the spoon against the side of each bottle.

3. Record your results how it changed corn harder to hear, etc. 3. Record your results in the data table. If the sound doesn't change, write "no change." If the sound changed, write how it changed compared to the previous bottle - did the noise get softer, higher pitched, lower pitched, was it easier or

Bottle 1-50 mL	Bottle 2-100 mL	Bottle 3-200 mL	Bottle 4-300 mL	Bottle 5-frozen

Answer: The pitch decreases as the volume of water increases.

4. Was your hypothesis supported by the evidence? Explain your answer.

Answer: Students should examine their original hypothesis and decide whether they were correct or incorrect.

Part III - Homemade Telephones

I bet you always wondered if you could hear through a tin can telephone. Well today, you will find out.

1. In front of you are three "telephones." You and your partner should stretch the phones out.

2. Put your tin can next to your ear while your partner talks into the other can.

3. Change roles so that you both get a chance to listen.

4. Record your observations below. Be sure to include whether it was easier or harder to hear your partner when you Partnership used each of the three tin can phones.

Tin can with thin string

Tin can with thick string

Tin can with extra long string

Answer: The tin can that contained the thickest string should have the clearest sound. This is because the medium is more substantial.

for Environmental Education and Rural Health

5. Based on your observations, on which tin can phone was it easier to hear?

Answer: Students should review their data and observations and write down the tin can phone design that made it easiest to hear.

Part IV - Eh? What did you say?

Vibrations and air movement occur when an object moves. This movement results in sound. Your ear is specially designed to pick up on these vibrations and air currents.

- 1. Take the large sheet of paper at your desk and roll it into a cone shape.
- 2. Make one end as large as you can.
- 3. Use your scissors if necessary to make a hole as big as a dime or penny in the other end.
- 4. Use tape to secure the cone so that it stays together.
- 5. Hold the small end of the cone to your ear and listen.
- 6. Does the cone enhance your hearing? Answer:Yes.
- 7. Explain your answer. Why did you say yes or no to Question 6?

Answer: Students should describe what happened to the sound in the room when they placed the cone up to their ear.

8. Are there similarities between the shape of the cone and our ears? Explain your answer.

Answer: Yes, the ear also has a cone-shaped design to help pick up and amplify vibrations caused by sound waves.

Folding in Scientific Method

Paper Airplanes and Scientific Principles Melanie Ramon

Target grade level: 7

Time Required: One class period

TEKS objectives: 7th grade science: 7.1 A, 7.2 B-E, 7.6 A,B lab skills, scientific method, force and motion

Materials: paper, copies of graphs shown at bottom of page

Cost per group: None

It is sometimes difficult for students to understand how the scientific method is used in real-world situations. In this activity, students design paper airplanes and develop a hypothesis regarding which one will fly the farthest distance or at the fastest speed. Using stopwatches and metersticks, students test their models in several different trials. They fold a standard paper airplane, an airplane with a paper clip on the nose, an airplane with flaps on the wings, and an airplane of their own design. For each trial, students measure the distance traveled and calculate the speed for each plane and determine if their hypothesis was supported by data produced. Below is a graph on which students can record their speeds and distances. They calculate speed by dividing the distance flown by the number of seconds. An extension of this activity is graphing results to look for trends, then comparing them to fellow classmates' results.

Activity Plan: Day 1: Build Airplane Models Days 2 and 3: Test Fly the Airplanes Day 4: Graph the Data



A middle school student folds her airplane for the tests.

"The students really enjoyed being able to get out of the classroom and do a hands-on activity. The students who won the competition were so proud that they came up with an idea, took that idea and built it, and then put it into action. The students became very interested in airplane-building and some of the students were even motivated to do some research about airplanes on their own. We had a discussion about the costs of developing a new airplane design. The students learned that building several designs and testing them all would end up being quite expensive in the real world and that a great deal of math is involved in developing a new design." **Melanie Ramon, NSF GK-12 Graduate Fellow**

Model	Trial 1 Distance	Trial 2 Distance	Trial 3 Distance	Average Distance
Standard				
Paper clip				
Flaps				
Personal Design				

Model	Trial 1 Speed	Trial 2 Speed	Trial 3 Speed	Average Speed
Standard				
Paper clip				
Flaps				
Personal Design				

Rational Code Cracking

Bruce Ngo

Activity Summary:

In this lesson, the students calculate the answers to rational expressions in order to crack a "secret code." Answers are positive or negative rational numbers written either as fractions or as decimals. Expressions involve adding and subtracting positive and negative rational numbers. Each expression will be written on a notecard, with the associated letter on the back, and placed at several stations in the classroom. The activity uses a "rotation" approach through the stations to get students active and interested.

Activity Motivation:

Spies often use codes to communicate secret information. They are always on the move to keep from getting caught. Students will move from desk to desk, solving math problems to discover clues that will help them decipher their secret message.

Activity Plan:

1. Make notecards with the mathematical expressions listed in the table to the right. There are 15 different letters associated with the expressions. Students need to solve these expressions in order to match the letter to the value. Each notecard should have the expression written on the front and the associated letter written on the back.

2. Designate enough stations so that there will be one notecard at each station.

3. The "Rational Code Cracking" worksheet has the four expressions listed in code format. Tell the students that they must use the clues left by the mathematician spy in order to decode the secret message.

4. Students will have a limited amount of time at each station to

solve the expression. Make sure the students write down the expression and the associated letter even if they cannot solve the problem in time. 5. After the allotted time is up, the students must move to the next station. With 15 stations and a 45-minute class, students can have roughly 2 minutes to solve the problem and 1 minute to rotate. You may need to adjust these times depending on how confident the students are with solving the problems and how well they make the transition to the next station.

Activity Scaling:

The expressions can be altered in order to match the capability of the students. Time available for solving the problems could also be adjusted.

Target grade level: 7

Time Required: One class period

TEKS objectives:

7th grade math:7.1 B, 7.2 B,G, 7.14 A,B, 7.15 A,B converting, adding, subtracting and multiplying fractions, decimals and whole numbers, communicating mathematical ideas, logical reasoning

Materials:

Notecards "Rational Code Cracking" worksheet

Cost per group: None

Simpler messages with fewer letters would allow more time at the stations to solve the problems. ■

Station	Answer	Expression #1	Expression #2	Letter
1	-8.3	-5.6 + -2.7	-10 + 1.7	М
2	-4.4	-8.1 + 3.7	-2.1 - 2.3	А
3	5/6	1 1/2 + -2/3	-3 1/3 + 4 1/6	Т
4	34.6	23.411.2		Н
5	-59	-34.2 - 24.8	-12.4 + -46.6	Е
6	-1 3/4	-3 1/41 1/2	-2 5/87/8	Ι
7	78	45.232.8	87.5 + -9.5	С
8	1 1/4	2 3/4 - 1 1/2	-3/4 + 2	S
9	-23/9	-17/1 + -6.8	-13.1 - 10.8	Ν
10	-97.8	-73.7 + -24.1		F
11	-6.9	-15.38.4		U
12	41.6	45.1 + -3.5		R
13	-24.6	-10 - 14.6		L
14	4/5	-1 1/22 3/10		0
15	2 1/2	5 1/3 - 2 5/6		G

Message #	Coded Message	Order				
1	Science is fun.	8-7-6-5-9-7-5-6-8-10-11-9				
2	Mathematics	1-2-3-4-5-1-2-3-6-7-8				
3	Rationals	12-2-3-6-14-9-2-13-8				
4	Math is great.	1-2-3-4-6-8-15-12-5-2-3				

Worksheet

Rational Code Cracking

In order to crack the code, you need to solve the problems below. Copy the problem from the notecard onto your scratch paper and solve. Match your answer and fill in the letter on the card. Remember to show all of your work! You have been handed a top-secret, encrypted message from a mathematician spy.

Message #1

	• =										
1 1/4	78	-1 3/4	-59	-23.9	78	-59	-1 3/4	1 1/4	-97.8	-6.9	-23.9

Message #2

ι)									
-8.3	-4.4	5/6	34.6	-59	-8.3	-4.4	5/6	-1 3/4	78	1 1/4

Message #3

41.6	-4.4	5/6	-1 3/4	4/5	-23.9	-4.4	-24.6	1 1/4

Message #4

	2									
-8.3	-4.4	5/6	34.6	-1 3/4	1 1/4	2 1/2	41.6	-59	-4.4	5/6

Shoebox Apartments

Candace DiBiano

"You have just decided to move into an apartment with two roommates. You need to design the interior of each bedroom and buy the materials and furniture you will need."

Activity Summary:

In this activity, students explore area, perimeter, and volume by building miniature apartments in shoe boxes. They find the amount of wallpaper and carpeting they need, calculate the amount of space various decorations will use, and then calculate how much trim is needed to go around the different shapes.



Collect a shoebox for each student or group of students and cut out a rectangular door and several windows. Depending on grade level, the windows can be any shape from a simple triangle or square to more complex shapes like semi-circles, trapezoids, or combinations of shapes stuck together. Discuss how math can be used in fields like architecture and interior design. Ask how much math is required to be an interior designer.

Step 1: Measuring the Box Have students measure the dimenTarget grade level: 6 (modifiable to 5th-8th grades)

Time Required: Four to five class periods

TEKS objectives: 6.2 B, 6.2 D, 6.4 B, 6.6 C, 6.8 B, 6.6 C, 6.8 B, 6.12 A addition and subtraction, fractions and decimals, estimating, formulas, measuring, geometric relationships, communicating mathematical ideas

Materials:

Shoeboxes Magazines Construction paper Rulers Foam paper or felt Various craft materials

Cost per group: \$5.00

sions of their shoebox. From these dimensions, students will calculate the box's volume.

Step 2: Flooring

From the measured data, students will calculate how much carpet they need to cover the floor of the apartment, and will cut the carpet, and install it in their apartment. Brightly colored foam sheets can be used for this step.

Step 3: Wallpaper

Students use the dimensions of the box to measure the area of the four walls for wallpaper. They subtract the area of the windows and doors to get a total of how much wallpaper will be necessary. Students then cut and install the wallpaper. Wrapping paper with fun patterns can be used for this since actual wallpaper is too heavy.

Step 4: Wall Decorations

Students put objects shaped like rectangles, circles, triangles, and trapezoids on their walls. Students calculate how much wall space each object doors, wall decorations, and the top of their apartment. Before they add trim, they will need to calculate how much trim it will take to go around the various shapes. To do this, they will first calculate the perimeter of these shapes. Yarn, string, or ribbon work well for trim.

When the apartments are complete, students vote on their favorites and award prizes for top apartments.

Extension:

An extension for this activity is to use a scale, such as 1 cm = 0.5 m, for the apartment. Have students find the scaled dimensions of their box and calculate the amount of carpeting, wallpaper, and trim required. Give prices for carpet, wallpaper and trim per square meter. Have students calculate the cost to install each into their apartment. Another extension is to charge for furnishings or to have students create a budget and plan for certain purchases in their apartments. This gives students an idea of what it might be like to furnish an apartment in the "real world." Discussion should include occupations, like contractors and architects, that necessitate estimating. ■



An Iola ISD student shows her apartment, which has blue wallpaper and carpet.

"It was fun to be able to win prizes and get furniture for our apartments. I've been kind of interested in architecture." - Iola ISD Student

will need. Photos of the students cut into the different shapes or miniature mirrors can be used.

Step 5: Floor Furniture

Students add tables, chairs, and a bed and calculate how much floor space they require. Painted wooden or styrofoam blocks decorated with fabrics make good beds. Students will also be given a rectangular prism fish tank. They will find its volume, convert the calculation to milliliters, and then fill the fish tank from a graduated cylinder to check their work. Small clear plastic containers are available at any craft store.

Step 6: Trim

Students add trim around windows,

FellowSpeak

Tips for handling your first days in the classroom:

- Work one-on-one with students or in small groups.
- Learn the students' names, interests, and thoughts about math and science.
- Let students know that you're interested in their interests.
- Explain your role as a Resident Scientist/Mathematician.
- Try to be comfortable with the kids.
- Make a video or presentation showing your interests to give the students an idea of what your life is like outside of the classroom.
- Work with your teacher ahead of time to build a friendship.
- Look for opportunities like clubs and extracurricular activities to interact with the kids outside of class.

Tips for connecting with problem kids:

- Ask them a question.
- Use their name.
- Indicate that participation requires good behavior.
- Have a worksheet ready for nonparticipating students.
- Hold an outside conference with their teacher.

Walk This Way: Interpreting Motion Graphs

Jan Fechhelm, CSISD Teacher, and John Nelson

Activity Summary:

Developing and interpreting motion graphs can often be challenging for middle school students. This activity requires no involved technology and limited equipment, and teaches students to model the motion shown in time/distance graphs using their physical movements.

While they themselves may be in constant motion, getting middle school students to really understand the motion shown in time/distance graphs can often be a challenge – but it's a challenge that must be taken! In virtually every listing of national and state science standards for middle school students, the concept of graphically representing motion is included. In the National Science Standards for Middle School, Benchmark 3 states that middle school students should "Know that an object's motion can be described and represented graphically according to its position, direction of motion and speed." In past years, my sixth grade students have measured and graphed the movement of toy cars, made graphs describing a walk through a local shopping mall, and even walked, hopped, and stood still so they could then graph their motion. And while these were all "successful" activities, I could tell by the students' answers on assessments that they never really got it. Another option, if available, is to use graphing calculators and motion detectors. Yet, while that is a lot of fun for students and introduces them to technology they will undoubtedly be using in higher grades, this, likewise, left me feeling that my students still did not have a solid grasp of the concepts involved.

I found myself again racking my brain to find a lesson that would really get the students to understand the graphic representation of motion. My Graduate Fellow helped me develop a lesson where students try to move in such a way that their movement mirrors a given time/distance graph. And as any middle school teacher knows, a lesson that involves kinesthetic activities has a more lasting impression on students and leads to a deeper understanding of the material presented. In other words, any lesson that allows middle school students to get up out of their seats and move while they are learning is a good choice!

To begin the lesson, students are shown a variety of graphs which illustrate basic motion (see below). These graphs can be quickly and Target grade level: 8

Time Required: One class period

TEKS objectives: 8th grade science: 8.1 A, 8.2 B-E, 8.4 A, 8.7 A lab skills, scientific method, analyzing information, force and motion

Materials: Masking tape Copies of motion graphs Stopwatches

Cost per group: \$1.00

easily drawn on the board as each is discussed and then modeled by either a student in the room or the teacher. Then the challenge begins. (Depending on the length of the class period, this could be carried out the following day if necessary.) Students are randomly assigned to groups of



Figures illustrating basic motion: A) steady speed (a straight line with a positive slope); B) rapid steady speed (a straight line with a steeper slope); C) acceleration, D) deceleration (curved lines); E) no movement (a horizontal line); and F) starting away from the starting point and returning to it.

three or four. The class moves into the hallway, outside, or to any large open area. At the center of the area, a series of markings are made with masking tape at 1 meter intervals and marked from 0 meters to 15 meters. (With average class size of 32, I had four 0-15 meter sections marked off.)

Two groups are assigned to each set of markings, with one group on the right side and one on the left. Each group is given a basic motion graph and a stopwatch. I made a total of 15 different graphs. The students are told to work within their groups to see if they can model the movement shown in the graph, matching the distance traveled and the time intervals. Most groups start out unsure of what to do, but quickly figure it out. It is interesting that students who would have had a difficult time in the classroom constructing a graph of their own often seem to excel at figuring it out.

Groups are allowed to decide their own method of completing the challenge and the variations are many. Most groups divide the tasks, but it seems to work best when the students are allowed to work out "who does what" among themselves. For example, one scenario might be to have one person acting as the timer and using the stopwatch to count the seconds aloud. Another group member becomes the walker who, holding a copy of the graph, tries to match their movement to the graph according to the time called out by the timer. The other students in the group (also with copies of the graph) act as directors, giving the walker additional information such as, "Stay still for 2 seconds," or, "Get ready to turn around and head back."

Be prepared for noise as the students discuss how to model the graph and give encouragement and directions to the walkers. Most groups become very enthusiastic about the challenge, cheering their walkers to success. Once the group thinks they can model the motion shown on the graph, they raise their hands and wait for the teacher to come and observe. If the group manages to model the movement shown on the first graph, they are given a second, more complicated graph involving the movement of two people traveling in different directions (Fig. 3). Group members are told to change jobs and begin work.

As the groups become more proficient, they master the challenges faster and faster. After most of the groups have mastered three different graphs, the class returns to the classroom where the teacher shows the students a combination graph showing many of the possible movements the student had just modeled (Fig. 4). Allow the students, working in groups, a few minutes to describe the motion shown. Virtually all

groups are able to correctly interpret all parts of the graph. Even several weeks after completing the activity, the majority of students are still able to correctly interpret the motion shown on graphs.

This is a science teacher's dream: no special equipment, no extensive prep time, fun for the students, and no cost. Most importantly, the students learn



the concept because they are totally involved – mind and body! Even weeks after completing the activity, students continue to come to me with ideas on how they could have accomplished the challenges more efficiently or with suggestions on more involved graphs, saying "....you could use this one to really stump the students next year!"



Michael Karka

Target grade level: 7

Time Required: One class period

TEKS objectives: 7th grade math: 7.2 E-G, 7.4 C, 7.5 A,B simplifing expressions, appropriate operations, relationship between terms in a sequence, equations

Materials: Sequence Races worksheet

Cost per group: None

Activity Summary:

In this activity, students use pattern and sequence recognition skills to solve problems about sequences. The first students to make it through all of the problems win.

Activity Plan:

The teacher should print out the set of sequences, removing those which may not be appropriate for the level of the students, and attach them to the wall at different points (stations) around the room (or outside) so that the students have room to move. The teacher stays at one central point and all students start at the first station. The students race to solve the problem at the station, then line up by the teacher to have their answer checked. If their solution is correct, the teacher directs them to the next station. If it is incorrect, they have to go back to the station, solve the problem again, and get back in line to have their answer checked. The winner is the first student who makes it through all of the problems correctly or the one who solves the most problems correctly in

the time given. Each of the problems is a different type of sequence. There are arithmetic and geometric number sequences that should be familiar, as well as some more challenging ones. The problems should be set up in order from simplest to most challenging.

Assessment:

The answers are given below. Teachers should check the students' answers at each station before they move on to the next.

Vocabulary / Definitions:

An arithmetic sequence is a sequence of numbers for which the differences between successive terms is a constant. A geometric sequence is a sequence of numbers in which each term is given by a multiple (constant throughout the sequence) of the previous one.

Activity Extensions:

For students who finish early, or as an extra activity, the teacher could have the students come up with their own sequences for other students or the teacher to solve.

Troubleshooting Tips:

If the students seem to get stuck on a sequence, the teacher could give them a small hint based on the method used to generate the sequence.

Activity Scaling:

With 15 different sequences, the teacher can choose those which are appropriate for the class. ■

Answers and Reasoning:

- (1) 13; 3x+1 (arithmetic sequence)
- (2) 37; 6x+13 (arithmetic sequence)

(3) direction of lines rotates counterclockwise 45°, shapes: circle, square, triangle, repeat

- (4) 81; (3)x (geometric sequence)
- (5) -64; (-4)x (geometric sequence)
- (6) 21; 6+5+4+3+2+1
- (7) 8/27; (2/3)x (geometric sequence)

(8) 64 stars; on each ring there are twice as many (geometric sequence),

- shapes: circle, square, star, repeat
- (9) 64, 125; x3

(10) Dark box moves clockwise on corners, outlined box moves counterclockwise (corner, side, corner, etc.) and rotates 45° each time.

(11) 19, 39; x2+3

(12) 21, 34; Fibonacci: xn+2 = xn+1 + xn, x0 = x1 = 1 (each term is the sum of the previous two)

(13) (30,-1); (xn+1, yn+1) = (xnyn, xn-yn)

(14) 28; xn+3 = xn+2 + xn, x0 = 1, x1 = 2, x2 = 3 (each term is the sum of the previous term and the term 3 places back)

(15) 13112221; 1 is read as "one one" or 11, 11 is read as "two ones" or 21, 21 is read as "one two and one one" or 1211, 1211 is read as "one one, one two, and two ones" or 111221, 111221 is read as "three ones, two twos, one one" or 312211, 312211 is "one three, one one, two twos and two ones" or 13112221

Class period:

Sequence Races

Station 1

Х	0	1	2	3	4
Y	1	4	7	10	?

What is the next term in the sequence?

Station 2

Х	0	1	2	3	4
Y	13	19	25	31	?

What is the next term in the sequence?

Station 3



If these are the first 6 members of the sequence, draw the 9th member.

Station 4

Y 1 3 9 27 ?	Х	0	1	2	3	4
	Y	1	3	9	27	?

What is the next term in the sequence?

Station 5

Х	0	1	2	3	4
Y	1	-4	16	?	256

What is the missing term in the sequence?

Worksheet

Station 6



If these are the first three members of the sequence, how many bowling pins will the 6th member have?

Station 7

X	0	1	2	3	4
Y	1	2/3	4/9	?	16/81

What is the missing term in the sequence?

Station 8



What should be drawn on the outer ring?

Station 9

X	0	1	2	3	4	5
Y	0	1	8	27	?	?

What are the next two terms in the sequence?

Station 10









What should the next two boxes look like?

Station 11

Х	0	1	2	3	4	5	6
Y	4	7	12	?	28	28	?

What are the two missing terms in the sequence?

Station 12

1, 1, 2, 3, 5, 8, 13, ?, ?

What are the next two terms in the sequence?

Station 13



If these are the first four points in the sequence, what are the coordinates of the next point? (Hint: Write out the coordinates of the first four points, then try to find a pattern.)

Station 14

1, 2, 3, 4, 6, 9, 13, 19, ? What is the next term in the sequence?

Station 15

1, 11, 21, 1211, 1112211, 312211, ? What is the next term in the sequence? (Hint: Count the digits and read the digits out loud.)

Worksheet

How Low Can You Go?

Kevin Curley and Jan Fechhelm

Target grade level: 6

Time Required: One class period

TEKS objectives: 6th grade science: 6.1 A, 6.2 B,C,D,E, 6.4 A, 6.7 A, 6.8 A lab skills, scientific method, scientific tools, physical and chemical properties, energy and matter

Materials List: (per group) Two glass beakers (400 mL) Ice Water Thermometer Rock salt Stopwatch or clock Graph paper How Low Can You Go? worksheet

Cost per group: \$10.00

Safety Issues: Rock salt is not the same as table salt and is not edible.

Activity Summary:

This simple activity allows students to measure temperature changes of ice water over time. The addition of rock salt to water lowers the freezing point, yet continued melting of the ice results in plummeting water temperatures. This activity can be used for a variety of lessons, the simplest of which would be to have the students collect data that can be plotted with a line graph. However, this can also be utilized to introduce students to the concepts of endothermic and exothermic reactions, and the energy transfer that accompanies phase changes of water.

Activity Introduction:

In regions where freezing temperatures and snowfall accompany the winter months, it is a common practice to spread salt and sand over the roadways. The primary reason for this is not to melt the existing ice, but to prevent ice from forming on the roads. How does the salt prevent ice from forming in freezing temperatures?

Activity Plan:

Divide the class into groups of three to five students. Using the "How Low Can You Go?" worksheet, have the students conduct the experiment following the steps listed. After clean-up, demonstrate how to construct a line graph of the water temperature over time. Each student should



plot their group's data. Discuss why the addition of salt causes the water temperature to fall below 0 $^{\circ}$ C.

Assessment:

Here are a couple of questions that the students should be able to answer:Based on your graph, describe the relationship between time and temperature. Is it a direct relationship (X increases, Y increases) or an inverse relationship (X increases, Y decreases)?

• What effect did adding the salt have on the temperature of the ice water? Was your conclusion correct or incorrect?

• Why did the salt affect the temperature of the ice water mixture?

Background Concepts:

At 0 °C, the rate of melting and freezing is equal. This means that as the ice is melting, new ice is also forming. This process continues indefinitely until equilibrium is interrupted. Adding salt, which dissolves in the water, disrupts equilibrium by interfering with the freezing of water molecules. Salt does not inhibit melting. Ice melts, but refreezes at a lower temperature. The addition of salt or any other substance, like sugar, will also lower the freezing temperature.

References:

http://antoine.frostburg.edu/chem/senese/101/solutions/faq/why-salt-meltsice.shtml

How Low Can You Go?

OBJECTIVES:

- 1. Gather data to determine how salt affects the freezing temperature of water.
- 2. Create a line graph showing the data.

HYPOTHESIS:

If salt is added to ice water, then_

EXPERIMENT/PROCEDURE:

1. Carefully read the temperature of the thermometer. Record this on the data table as "Temperature at time 0."

- 2. Fill the beaker full of ice.
- 3. Add 50mL of water and IMMEDIATELY place the thermometer into the ice water mixture.

4. Every 10 seconds, read and record the temperature WITHOUT REMOVING THE BULB OF THE

THERMOMETER FROM THE MIXTURE! (You can lift the thermometer slightly, but do not take the bulb out of the ice water!)

5. Once the temperature does not change for 20 seconds (2 intervals), add one scoop of rock salt to the mixture and gently stir. DO NOT REMOVE THE THERMOMETER!

- 6. Continue to read/record the temperature every ten seconds for an additional 60 seconds.
- 7. On the data table below, be sure to indicate with an asterisk (*) the time at which you added the salt.

Time (seconds)	Temperature (°C)	Time (seconds)	Temperature (°C)
0			
10			
20			
30			
40			
50			
60			
70			
80			
90			
100			
110			
120			
130			
140			
ANALYSIS			

DATA:

Create a line graph to show your data. Line graphs are used to show how one thing changes in relation to another.

1. First, determine what data goes on the X axis (the independent variable) and what goes on the Y axis (the dependent variable).

- 2. Then look at the data and determine the minimum and maximum for each axis.
- 3. Label and number each axis.
- 4. Graph your data. For this data, you will connect the data points with a straight line.

(BE SURE TO WORK IN PENCIL and USE A RULER!)

CONCLUSION:

Please answer in complete sentences.

1. Based on your graph, describe the relationship between time and temperature. Is it a direct relationship (X increases, Y increases) or an inverse relationship (X increases, Y decreases)?

2. What effect did adding the salt have on the temperature of the ice water?

3. Was your hypothesis correct or incorrect?

EXTRA CREDIT: (3 points) Why did the salt affect the temperature of the ice water mixture?

Seasonal Mathematics

Candace DiBiano

"Holiday Shopping Activity"

Activity Summary:

In this fun seasonal activity, students review percents by going Christmas shopping for their friends and family. They will look through catalogs for gifts to give and cut out pictures of the gifts they choose. Students will have to calculate percent off to get the item's sale price and then add tax to the item's price for a final cost.

Activity Introduction:

Ask students where they see percents in the real world. Many will likely say they see them when shopping. Ask what kind of percents students see when shopping. Students should include both sales and tax. Tell the students that they will be using their knowledge of percents to shop for presents for their friends and family.

Activity Plan:

• To prepare for this activity, bring in catalogs or advertisements from the newspaper that include items students would want to give to friends and family for Christmas.

• Start with the Activity Introduction and then have each student pick a gift out of their catalogs. At this point, you may want to review with the students how to calculate a price for something that's on sale for a percent off and how to calculate the price of an item with tax.

• Have students tape their choices on a piece of paper and list who receives their gift and the original price. The teacher announces that each item is selling at a discount, but is also subject to state taxes. Students then calculate the price with the sale percent and tax percent as given on Item #1. • When the students complete the calculation for their first gift, tell them to raise their hands to have you check it. Bring a calculator with you if necessary. If the student's calculated price is correct, then have them pick a second gift and calculate taxes and discounts using the information for Item #2.

• Students should continue to work at their own pace through five gifts, or as many as they can correctly complete within the period. Allow the students to "exchange gifts" at the end of the period.

Activity Extension:

This activity would be more interesting and realistic if you gave the students a budget they had to follow for their five gifts. The budget you assign could be \$50, \$75, or \$100. Students could also make separate gift plans using different budgets.

Item Pricing:

Item #1 is on sale for 25% off. The item is from Alabama, so there is a 4% tax on it.

Target grade level: 7

Time Required: One class period

TEKS objectives:

7th grade math: 7.1 B, 7.2 B, 7.3 A, 7.13 A

converting fractions, whole numbers and percents, estimating using percentages, applying mathematics experiences

Materials List: Catalogs Giftbox handout

Cost per group: None

Item #2 is on sale for 15% off. The item is from Mississippi, so there is a 7% sales tax.

Item #3 is on sale for 40% off. The item is from West Virginia, so there is a 6% sales tax.

Item #4 is on sale for 75% off. The item is from Maryland, so there is a 5% sales tax.

Item #5 is on sale for 45% off. The item is from Kansas, so there is a 5.3% sales tax. ■



Candace DiBiano presenting her Seasonal Mathematics poster at the National GK-12 Conference in Washington, D.C.

The Great Easter Egg Hunt

Candace DiBiano

Activity Summary:

In this activity, the teacher turns the classroom into a gigantic coordinate plane and places plastic Easter eggs at points on the coordinate plane. Students in five teams go on an eggto-egg scavenger hunt, solving math TAKS problems found inside the Easter eggs in order to get the coordinates for their next point. After going through 10 points in this way, the hunt is over and a winner is declared.

Activity Introduction:

To introduce the students to the "rules of the hunt," pass out "The Great Easter Hunt" handout to each group and go over it with them. Answer any questions the students have about how the hunt will be run.

Activity Plan:

• Because this activity requires a lot of preparation, it is recommended that



An Iola ISD student makes her way through the Easter Egg Hunt, using each egg to find the next coordinate point.

you select students to assist you.

• Begin by purchasing plastic Easter eggs and enough sticky-back Velcro to attach a small piece to each egg. Next, copy a page of TAKS questions. The first question will be given to each team at the start of the activity. The rest of the questions are to be hidden inside the eggs. The answer to the first question should yield a point, which the students must find on the grid on the floor. The new egg should yield another point, which leads to another egg on the floor. Label each proceeding question with the point given from the previous one. For example:

First question:

X- The greatest common factor of 12, 18, and 24.

Y- The square root of 25.

Answer: (6, 5)

The second question should be inside an egg at point (6,5).

Use a separate color of paper for each team to minimize confusion when coordinate answers occupy the same spot.

• After you've copied your TAKS questions with their respective coordinate points, cut the questions into strips to separate the clues for each point. At this point, leave the answer to the previous question as part of your strip to help you as you place the eggs on the floor.

• Put the first question for each team in a separate plastic bag, as you will simply be handing this clue to them at the beginning of the hunt to start them out.

• Now stuff the remainder of the horizontal slips into plastic Easter eggs. Here is the procedure to use: Take the slip you are working with and a plastic Easter egg. Cut the strip vertically to separate the two questions on it from the point where the Target grade level: 6

Time Required: One class period

TEKS objectives: customizable

Materials List:

• 50-75 plastic, colored Easter eggs

• enough sticky-back Velcro to put a small piece on each Easter egg

• masking tape

• (Optional) Easter candy for inside eggs and/or for prizes

Cost per group: \$3.00-\$5.00

slip will be located. Put the part with the two questions inside the Easter egg, and tape the part with the location of the question on the outside of the Easter egg.

• When you set up your Easter egg coordinate plane, you will know where each egg is supposed to go.

• Many clues for the different team colors will have the same coordinate point as their location. Simply place them into the same egg that is labeled with that point.

• (Optional) Stuff candy inside some or all of the eggs.

• Place the sticky-back Velcro on the outside of each egg. The other side of the Velcro will be stuck to the floor where the coordinate plane grid is, to secure the egg to its specific point.

• The coordinate plane assumes only positive points, so you will just be making one quadrant. If the floor in your classroom has square tiles, you can just use the tiles as your coordinate plane grid. Otherwise, use masking tape and the assistance of students to make a coordinate plane grid on your floor. In either case, you must mark the X and Y axes with tape, and labeling every five units is also helpful. Your grid should be at least 21 units in the X direction, and 17 units in the Y direction.

• Once the grid has been built in the

classroom, start placing your eggs at the locations they noted on the questions, attaching them to the floor with the other side of the Velcro. Place the egg on its coordinate point.

• Once you've placed all the Easter eggs that will be part of the hunt, take the remainder of your plastic Easter eggs, and put slips of paper that say WRONG in them. Place these eggs at random positions on the coordinate plane. They will serve to confuse students so they can't just "guess" which egg will be next. When the students come across one of these WRONG eggs, they must report it to you. If they turn in five WRONG slips, they will not be able to win the Easter hunt.

• Now the hunt is ready for the students. Divide the class into five teams, and give each group "The Great Easter Egg Hunt" handout and their first clue. You can award an Easter prize to the first group that gets through all their points as a way of

encouraging participation.

Lesson Extensions:

This lesson can be extended to include the negative quadrants of the coordinate plane. A revision of the questions, to include answers with negative numbers, can be made to accomplish this.

The Great Easter Egg Hunt

Student Handout:

The classroom has been divided into a gigantic coordinate plane, with each floor tile being one space on the grid.

Your group will be given a starting point, and you will need to find that point on the grid and open the colored Easter egg that is there. Take out ONE slip of paper from the Easter egg, the one that has your group color on it. You may also take any candy you find. Replace the egg EXACTLY where it was.

This slip of paper will direct you to your next point. However, it should say "(Color) Team, Point 2" on it. If your team color is not listed, you've gone to the wrong point, and you need to replace the egg and try again. In order to win, you need to have all of your group's paper slips on your desk.

There will also be some eggs that just have a slip of paper with the word WRONG on it. If you find one of these, give the slip to your teacher and continue your hunt. If your group gets 5 of these slips of paper, you will not be able to win the egg hunt.



Valentine's Day Hearts

Candace DiBiano

Target grade level: 6

Time Required: One class period

TEKS objectives: 6th grade math: 6.3 B, 6.12 A representing fractions, communicating mathematical ideas

Materials List:

- three or four bags of candy "conversation hearts"
- small Ziploc bags

Cost per group: \$1.00-\$3.00

Activity Summary:

In this activity, students will use mixes of Valentine's Day candy "conversation hearts" to study fractions and percents. They will also formulate their own mixes of these candies from instructions given to them. Grade Level: Target Grade: 6 Time Required: 45 minutes

Activity Introduction:

Mention to students the upcoming holiday, Valentine's Day, and tell them they will be using candy hearts to study fractions and percents.

Preparation:

The teacher can make each group have the same Valentine's candy mix for simplicity, but this activity is designed so there are four different mixes a group can be given. Label each plastic bag with its corresponding mix number and fill each with the following:

Mix #1: 10 pink, 8 yellow, 20 orange, 6 purple, 6 white Mix #2: 10 pink, 12 yellow, 15 orange, 5 purple, 8 white

Mix #3: 16 pink, 4 yellow, 10 orange, 5 purple, 15 white

Mix #4: 10 pink, 4 yellow, 25 orange,

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5 purple, 6 white

The teacher should also print out two Valentine's task cards for each group that corresponds to their mix. They are designed to be printed out on 3" by 5" index cards, but can simply be printed on paper and cut into slips. Each group will be given cards that correspond to their mix number.

Activity Plan:

Divide the students into groups of two or three and give each group a plastic bag containing their mix. Tell students to begin Task 1, using a scratch piece of paper to record their work. As they complete each task, check their answers, and give them instructions for the next task. **Task 1:** You've been given a bag with various colors of Valentine's hearts in it, and it's now your task to find the fraction and percentage of each color of heart. Each bag contains 50 hearts.

Calculate and reduce the fraction of each of the following colors: pink, yellow, orange, purple, and white. Using the fractions, calculate the percentage of each color in the bag.

Task 2: Using the candy hearts you have, create a mix of 36 candy hearts with the ratios given to you on your task card.

Task 3: Using the candy hearts that you have, you will need to create a mix of 25 total candy hearts with the percentages given on your new task card. ■

TASK CARDS		
Mix #1 Task 2	Mix #2 Task 3	Mix #4 Task 2
Pink: 2/9	Pink: 28%	Pink: 1/4
Yellow: 1/18	Yellow: 40%	Yellow: 1/18
Orange: 5/9	Orange: 16%	Orange: 5/12
Purple: 1/12	Purple: 4%	Purple: 1/9
White: 1/12	White: 12%	White: 1/6
Total: 36 Candies	Total: 25 Candies	Total: 36 Candies
Mix #1 Task 3	Mix #3 Task 3	Mix #4 Task 3
Pink: 36%	Pink: 5/12	Pink: 32%
Yellow: 24%	Yellow: 1/18	Yellow: 12%
Orange: 16%	Orange: 1/36	Orange: 28%
Purple: 4%	Purple: 1/9	Purple: 4%
White: 20%	White: 7/18	White: 24%
Total: 25 Candies	Total: 36 Candies	Total: 25 Candies
Mix #2 Task 2:	Mix #3 Task 3	
Pink: 2/9	Pink: 40%	
Yellow: 5/18	Yellow: 12%	
Orange: 5/12	Orange: 20%	
Purple: 1/18	Purple: 4%	
White: 1/36	White: 24%	
Total: 36 Candies	Total: 25 Candies	V 🗸

Novice Teacher Corner

Shawn Martin, PEER Teacher

Novice, beginner, fledgling, rookie, apprentice. No matter how you say it, you are a new teacher. You are scared to death and don't know how to start, let alone teach a class full of students. So what do you do? Take a deep breath, breathe in, breathe out, and do what you know. Your students will come from a variety of backgrounds, economic situations, nationalities, etc. It is your job to create a safe, bright spot in their lives where they can relax, think and have their creativeness shine through.

1. Your room needs to be comfortable.

All of your students need to be comfortable in your classroom. That doesn't mean that you should go out and buy furniture for your room. Just arrange it so that students are the focus.

2. Your classroom needs to be a community.

Make sure that your classroom has rules and consequences. No community will work if antisocial behaviors are not addressed.

3. Your classroom is a learning environment.

Not everyone learns the same way. You must reinforce each student's learning by allowing multiple learning styles in your classroom. Let each student receive recognition for his or her own achievements.

Once you have developed your classroom home, the learning will take place. You will have a classroom full of learners who show respect for each other, who celebrate individualism, and who are open to thinking outside the box.

For novice teacher help: e-Mentoring and the GK-12 Program

One of the concerns of any teacher is where to get answers to sometimes difficult questions. PEER offers a variety of pedagogical resources through our website's e-Mentoring initiative, found at http://peer.tamu. edu/Mentoring.htm. Our goal is to provide a support system for all pre-service and novice teachers, as well as for those who have been teaching for a while.

Through this website we offer: a free service for requesting custom lesson plans, activities, and answers to content questions; free access to informational resources for new teachers, including articles, tip sheets, and links; free online interviews with scientists and educators to share with your students; free online web curricula; and the opportunity to request the free PEER curriculum, which integrates science, math, social studies and English content using adventure stories and PowerPoint presentations.

Last-Minute Tips

One of the hardest things about teaching is the first year. Whether it's your "first" first year or the first year in a new school, things will go wrong! I recently asked a group of veteran teachers, "If you could give novice teachers one piece of advice, what would it be?" After much laughing, crying, and story-telling, we compiled a list of the top 10 survival skills for the first-year teacher.

1. Remember to ask for help! You can't do it all, all by yourself.

2. Make sure you have a good discipline plan and follow it.

3. Be firm with students and parents.

- 4. Contact parents often.
- 5. Be flexible.

6. Don't sweat the small stuff; prioritize.

- 7. Surround yourself with friends!
- 8. Become a lifelong learner.
- 9. Don't take everything personally.

10. Don't try to save the world your first year!



Shawn Martin presents strategies for integrating curricula at a teacher workshop.

Visit peer.tamu.edu for free educational curricula.

- Mini-modules (one-class, self-contained lessons)
- Free CDs containing all of PEER's curricula
- Adventure-based health science story lessons that incorporate math, science, social studies, and language arts
- Online mentoring for novice teachers
- Professional sessions across Texas
- Distance Learning Community
- Web curricula on life science and environmental health



