crosslinks — Linking Science and Schools

SANDIA NATIONAL LABORATORIES • LOCKHEED MARTIN

Volunteer Handbook

Table of Contents

A special thank you
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CroSSlinks

The purpose of the program is to link the science community and the school community in an effort to improve science education for Albuquerque elementary school students. The CroSSlinks program continues Sandia's commitment to the effective utilization of inquiry-based science instruction. Volunteers partner with teachers to advance the teaching of hands-on science in support of district standards and required curriculum.

Goals:

- To partner with teachers by providing volunteers to assist with inquiry-based science instruction
- To support Sandians and science volunteers who want to promote science in elementary school classrooms
- To provide technical role models to Albuquerque youth

Features

- Volunteers choose their school

- Voluntary participation for both teachers and volunteers

- Time commitment is negotiated between school and volunteer

- Physical science focus

- Volunteer Support
  - Volunteer training
  - Resources:
    - Albuquerque Public School physical science kits
    - Family Science Night
    - Additional hands-on science activity ideas and materials
    - Sandia display materials/giveaways

- Periodic evaluation and program improvement

- A CroSSlinks Sandia Coordinator to facilitate school-volunteer interactions

SCIAD and CroSSlinks

The Science Advisors (SCIAD) Program was Sandia's major K-8 science education enhancement initiative from 1990 through 1995. The objectives of this program were to encourage hands-on science learning and to promote systemic change in science education by applying the unique resources of the laboratory. After 1995, the transition plan focused on encouraging local districts to spend their science instructional materials funds on high-quality, hands-on, inquiry-based instructional materials and to have processes in place that ensure that these materials can be used with high levels of effectiveness. We are pleased that the Albuquerque Public School district has chosen hands-on instructional materials to be implemented in the 1999-2000 school year. The CroSSlinks Program continues Sandia's commitment to the effective utilization of inquiry-based science instruction. There are some fundamental differences between these two programs:

SCIAD	**CroSSlinks**
8 hrs/week	Time commitment negotiated between volunteer and school- less time expected
Paid employee	Volunteer supplemented by A280
Materials from SNL Resource Center	APS-supplied kits with some additional materials available
Encourage inquiry-based instruction	Encourage inquiry-based instruction aligned with state standards
2-day training	Minimum training
Teacher professional development provided by Sandia	Not planned at this time
DOE Funded $3M/year	Lockheed Martin $3K/year
K-8	K-5
Statewide	Albuquerque

A CroSSlinks Volunteer

… a technical professional who partners with teachers in a collaborative effort to encourage the effective utilization of inquiry-based science instruction

Evaluating your interests

Enthusiastic and interested in working with teachers and students
Strong personal interest in science or engineering
Ability to work with a variety of diverse personalities

Preparing Yourself

Review the Volunteer Handbook
Review and becomes familiar with the physical science kits

Partnering with teachers

Determine their needs
Determine how a volunteer can help
Understand that you are not the teacher

Serving as a science resource

Provide science knowledge for curriculum support
Provide background in science content and the scientific method

Being a role model for children

Personalize what a scientist or engineer is and does
Connect courses in school to the knowledge and skills necessary for future employment and citizenship

Managing your time commitment

Negotiate with the school what you are able to provide
Encourage weekly communication via phone calls or e-mail

Understanding your liability

Sandia does not cover volunteer participation
Volunteers are currently covered by APS workers' compensation insurance

Using Sandia Equipment

Equipment must remain in your possession
Obtain manager's written approval

School Models

The volunteers' role and resources will vary determined on which type of school they are assisting. Within APS, some of the schools have elected to participate in a district-wide distribution model while others are using a school or cluster model. The primary focus of CroSSlinks is to assist APS teachers transition to hands-on science; however, volunteers may choose to partner with a private school.

- APS District Model – schools will receive specified kits from the district according to a schedule. Sandia will have the physical science kits available for review. The district will be responsible for kit maintenance. Volunteer is responsible for supporting district curriculum/kits.

- APS School Model – schools are ordering the kits themselves and will be responsible for kit maintenance. Volunteer is responsible for determining what kits will be utilized.

- APS ANSC Model – schools are joining together and setting up their own resource center that will order and maintain kits. Kits will be available for schools to checkout. Volunteer is responsible for determining what kits will be utilized.

- Private – Volunteer is responsible for determining schools inquiry-based science policy and resources.

Working with Teachers

Understand the school environment

- Time constraints – little planning time
- Multiple priorities – science isn't tops
- Most elementary school teachers are required to take little science
- Choose to work with teachers who welcome volunteers

Define your role

- Determine their greatest needs
- Be a science resource
    - Answering teacher questions on kit content
    - Generating interest for a new topic
    - Providing real world applications
    - Providing depth of understanding
    - Serving as a reward/incentive when students have mastered a subject

Respect the teacher's expertise

- Utilize their experience as educational professionals
- Review planned activities with the teacher
- Ask for feedback on how you're doing

Working with Students

I hear, and I forget
I see, and I remember
I do, and I understand
Chinese Proverb

Know the children

- Use concrete examples for these concrete thinkers (comprehend what they detect with their physical senses)
- Reverse the science interest decline that occurs about third grade
- Target the average student
- Avoid gender, ethnic or socio-economic references
- Call the students by name
- Give lots of positive feedback

Have a Plan

- Do activities that are age-appropriate
- Don’t try to cover too much
- Invest time in preparation – try out new activities
- Be safe (safety supplies, follow school regulations, avoid hazards)
- Arrange logistics (how many materials are needed, who will supply)
- Include a strong closing that allows kids to prove to themselves that they’ve learned something
- Turn incorrect answers into learning opportunities

Classroom Management Tips

- Make eye contact
- Use student volunteers to help you distribute materials
- Call on different students
- Give specific directions in small segments
- Use a prearranged signal to get students’ attention during activities
- Stop and wait for students to let you continue speaking if they get noisy
- Smile and give positive feedback

Great Learning Experiences

Here are a few common elements to create a great learning experience. All of the examples are real-life experiences from Dr. Ken Eckelmeyer (retired), Sandia National Laboratories.

Fun and exciting to get their attention

In a middle and high school program on chemical bonding we examine the effects of temperature on properties of rubber tubing. After demonstrating its normally flexible behavior, we cool it in liquid nitrogen and then challenge the students to bend it. At first they conclude that it is very strong, but when they exert sufficient force it shatters dramatically into thousands of tiny pieces, which fly all over the room (safety glasses are a must). This typically creates great interest, and soon students are selecting other things that they want to test and are hypothesizing about how various materials will behave at very low temperatures. This provides a great lead-in discussion of the molecular structure of polymers, and how materials scientists engineer materials with different properties by varying chemical bonding and atomic arrangements.

Discovery-based activities that combine science process with science content

As a follow-up to the rubber-hose-in-liquid-nitrogen activity, let's look at how rapidly foods freeze and thaw out. My students used a sample of apples, oranges, bananas, marshmallows, and dinner rolls to investigate a wide range of cooling rates. I asked "I wonder what made some things get cold quickly and others take a long time?" When they got around to the idea that not all the samples were the same size, I asked, "Is there a better way we could have done the experiment?" After discussing this a bit, they decided to repeat the experiment using samples of equal mass. (Fortunately, I had a balance handy!). This time they found the three fruits cooled at the same rate, while the marshmallow and dinner roll took much longer. When they recognized this grouping, I asked, "I wonder what it is that apples, oranges, and bananas have in common that's different from marshmallows and dinner rolls?" After some discussion, they hit on the idea that the three fruits contained a lot of water while the other two items were very dry. "When a scientist has an idea like that it's called a hypothesis," I commented. "Then she or he tries to think up an additional experiment to test their hypothesis – to see if it is correct." After thinking for a while, the students decided to put an equal mass of water in a vegetable bag, place this in the liquid nitrogen, and measure its cooling rate. The results confirmed their hypothesis. They discovered for themselves the concepts of controlling variables, grouping data, constructing hypotheses, and designing critical experiments to test hypotheses.

Application comes first, theory follows

One good applications-oriented math exercise asks each group of students to figure out how high the school (or something else) is using a cardboard tube from a roll of toilet paper or paper towels. Each group "calibrates" its tube by standing back various distances from a meter scale on the wall and determines how the vertical field of view seen through the tube changes as a function of distance. The students then go outside and see how far they have to get back from the school to just get it in the field of view. From this information, each group computes the height of the school. It can be a proportion problem, a graphing problem, or a trigonometry problem, depending on what is being covered in class. The beauty of the exercise is that it develops subject matter in the context of an application that is real to the students, rather than just as a rote manipulation or abstraction.

Integrate new ideas with past applications

When I work with seventh grade physical science classes it's amazing how many opportunities I find to connect new material with activities we have done in the past. Activities early in the semester involve Newton's Law (force and acceleration) and buoyancy (floating and sinking in liquids and gases). Later in the semester when we are doing activities involving states of matter we cool balloons full of various gases in liquid nitrogen. With just a little leading the students are able to go back to Newton's Law and both predict and explain why the balloon shrinks when the temperature is lowered and molecules slow down.

Success is defined as learning, not knowing

One of the most important things you can do is to help students redefine success in science – as learning something rather than knowing the correct answer at the outset. When I am working with students I frequently ask them to make hypotheses about an experiment we are about to do. Some of them construct a correct hypothesis, others incorrect. I then give them an opportunity to explain and discuss their hypotheses with one another. In this process, some of the students frequently see flaws in their reasoning and switch camps. Then we do the experiment and discover which hypothesis was correct and discuss why. Then I congratulate and make a big fuss over the students whose initial hypotheses were *wrong!* I tell them that they participated as *real* scientists because that's what good scientists do – they make a hypotheses based on their best current understanding, do an experiment to test their hypothesis, and *change their minds* when the results of the experiment indicate that their hypothesis was wrong. Then I share that many of my hypotheses at work turn out to be wrong, but that my employer continues to pay me because out of the incorrect hypotheses comes increased understanding, which eventually leads to some correct hypotheses and the development of improved engineering materials.

Appeal to all learning styles – auditory, print-oriented, visual, kinesthetic, group interactive

A common component of middle school study of solids, liquids, and gases covers how atoms and molecules are arranged and bonded in each of these states of matter. A conventional way of teaching this might be to have students read about it and explain it to them orally (auditory and print-oriented). In a more complete and balanced educational program, this could be supplemented by visual and kinesthetic experiences where the students see and handle ping-pong models – balls glued together for the solid, unglued but contained in vegetable bag for the liquid, unglued and not contained for the gas. Another kinesthetic experience would involve students pretending that they are each atoms. To behave as if they were a solid, everyone would hold hands. To be a liquid, everyone holds hands, but continually changes partners, in sort of a disorganized square dance. To be a gas, everyone lets go of one another and moves in straight lines around the room until they run into and bounce off of something or someone. A group interactive activity could involve teams of students trying to estimate how many bonds in a liquid are broken at any one time based on the heats of fusion and vaporization.

Putting it all together

When I do a program on force and acceleration, I start by wrapping up a student volunteer skateboarder in many layers of bubblewrap packaging material, giving him a bike helmet, putting him onto a skateboard, and running him into the wall (carefully, of course). After that everyone is paying attention! Then I take off the bubblewrap off and feint doing the "experiment" over. This leads into an interactive discussion of how the force applied to the student's body and the suddenness of change in speed vary with the number of layers of bubblewrap. Out of this the students develop an appreciation for the principle that force scales with the suddenness of change in speed. Only after this "intuitive" understanding has been developed do I present and begin discussions regarding the application of Newton's Law, F = ma. Then I move onto a more quantitative activity where we interactively estimate the forces applied to humans in accident scenarios that are part of the student' real world, such as a skier running into a tree or an outfielder running into the wall. After that I progress to a description of how engineers did very similar calculations to determine what damage would occur to a transportation system during a severe accident. I then show a 5-minute videotape of destructive testing of a few transportation systems. Finally, I explain that we used the few destructive tests to verify our calculations. Once we knew that our calculations were correct we were able to do most of the "testing" by computer rather than having to perform a large number of very expensive "real" crashes.

Getting Started

- Contact the teacher at your school
- Schedule an initial planning visit to clarify roles/expectations and to understand curriculum and school policies
- Report to the school office when visiting the school and observe all visitor policies (wear a badge, sign in and out)
- Determine classroom needs
- Determine the amount of time you can devote
- Formalize your agreement
- Setup communication vehicles – email, phone numbers, etc.
- Become familiar with the environment and dynamics of the school
- Observe teachers and classrooms before interacting with students
- Be familiar with emergency evacuation procedure (posted in classroom)
- Seek out additional activities as appropriate (webpage, CroSSlinks Resource Center located at 10510 Research Rd SE)

CroSSlinks Teacher

- Utilize the CroSSlinks Volunteer as a science resource:
  Answering teacher questions on kit content
  Generating interest for a new topic
  Providing real world applications
  Providing depth of understanding
  Serving as a reward/incentive when students have mastered a subject

- Provide background information about class (ages, attention span, what works best, number of kids, special needs, etc.)

- Prepare your students and classroom for presentations

- Be present in the classroom when a CroSSlinks Volunteer is working with the students to provide consistency, guidance and classroom management/discipline

- Provide feedback to the volunteer

CroSSlinks Sandia Coordinator

- Develop, evaluate and improve the program
- Coordinate volunteer involvement with APS
- Recruit technical professionals to serve as CroSSlinks Volunteers
- Volunteer management and recognition
- Develop and maintain a CroSSlinks website
- Provide volunteer training
- Coordinate additional resources
- Assist CroSSlinks volunteers as needed
- Promote the program (within Sandia Labs, outside media)

Resources

- Display Board (table top)
- Sandia Banner
- Pencils for student prizes/giveaways
- APS Physical Science Kits
- Additional Hands-On Activity Ideas/Materials
- Family Science Night
- Family Math Night
- Put a Little Science in Your Future video
- Environmental Education Outreach