Can Science Be Exciting for Teenagers
Session Title: Can Science Be Exciting for Teenagers?

Date: Monday, October 17, 2011
Time: 10:45 AM-12:00 PM
Location: Convention Center
Room: 317

Session Description:
Successful programs for teens will be presented hands on science labs connected to research; summer programs for high school students; the recreation of Franklin’s electrical experiments; a collaboration with the Navy and a program where girls get into contact with women who made a career in science.

Session Leader:
Patricia Verheyden • Experience director • Technopolis®, the Flemish Science Center • Belgium

Presenters:
Steven Madewell • Interpretive Exhibits Coordinator • Lemelson Center for the Study of Invention and Innovation National Museum of American History • Washington • District Of Columbia

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Bill Watson • Chief, Learning and Evaluation • Smithsonian’s National Museum of Natural History • Washington • District Of Columbia

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Diane Miller • Sr. Vice President, School and Community Partnerships • Saint Louis Science Center • Saint Louis • Missouri
Recreating Ben Franklin’s Electrical Experiments with Teens
Facilitator’s Overview

The Big Idea
This activity requires a trained facilitator. Working with the facilitator, visitors recreate the electrical experiments that led to Franklin’s invention of the Lightning rod. The experiment also highlights Franklin’s innovative contributions to science and government. Visitors will experience static electricity and may receive an exciting but harmless static electric shock.

Activity Supplies and Materials

- Clear acrylic tubes (27” to 36” in length)
- Craft fun swatches
- Cotton swatches
- Wrapped drinking straws
- Leather swatches
- Leyden jar (2)
- Cake of wax (or foam insulator pad)
- Leyden jar making supplies: aluminum Foil, plastic bottles, rubber bands, nails
- Reproduction of Franklin’s electrical machine (optional)
- “Counterfeit spider” apparatus (optional)
- Reproduction kite with brass key
Outcomes
By participating in this activity, visitors will:
1) engage in the invention process through a hands-on invention experiments
2) Use observation, problem solving and critical thinking skills to reach a set goal
3) understand that failure is often part of the invention process
4) Use tools to investigate and observe the world around them
5) gain an understanding of how science, engineering, and art can intersect in invention

Related Invention Process Steps

21st Century Skills
By participating in this activity, visitors will practice these 21st century skills:

LEARNING AND INNOVATION SKILLS
- Creativity & Innovation
  - Think creatively
  - Work creatively with others (if working with a partner or group)
  - Implement innovations
- Critical Thinking and Problem Solving
  - Use Systems Thinking
  - Solve Problems
- Communication & Collaboration (if working with a partner or group)
  - Communicate clearly
  - Collaborate with Others

LIFE AND CAREER SKILLS
- Initiative & Self-Direction (if working alone)
  - Work Independently
  - Be Self-directed Learners

Suggested Core Subject Links
- Science
- Geography
- History
Ben Franklin’s Electrical Experiments Implementation

Facilitation Ideas

- This activity is designed for use with large groups. Facilitating this activity requires a fair amount of training and requires the facilitator to become familiar with basic static electricity theory and practice safe handling techniques.
- Static Electricity can be a challenge to generate reliably using the equipment available in the 18th century (the equipment used in this activity). It takes some practice to develop techniques that will get reliable and predictable results. Practice. Practice. Practice.
- Make sure that every visitor is aware that participation in this activity involves modest static electric shocks, and allow an opportunity for visitors to opt out of the portions of the activity that involve shocks. Never surprise a visitor by shocking them.

Instructions for the Activity

- Facilitators should be trained and comfortable using the equipment, but do not need to be experts on electricity or on the history of Ben Franklin to lead this activity.
- Before beginning any of these experiments, make sure the equipment is clean and dry to ensure they work well. Dirt and moisture will result in poor performance.
- Begin the activity by generating a static electric charge on the plastic tube with a paper towel or strip of leather (this may take some practice to get the hang of it). You can detect the presence of a static charge by holding the tube over the heads of visitors (their hair will be attracted to the tube...stand up) or you can bring the back of your hand near the surface of the tube without touching it. The tingly sensation you feel is the static electric charge. Be sure to point out that Franklin did not invent electricity, but he did study it and applied what he learned to invent useful devices that are still in use....lightning rods.
- Once you have generated a sufficient charge on the plastic tube, slowly bring the end of the tube toward the container of paper bits. The paper bits should begin to “dance”; jumping up to the tube and then falling back down to the table.
  - Visitors can replicate this experiment with a wrapped drinking straw. See training video or the Franklin Background Manual for full details.
Next, show visitors the cake of wax (or foam insulation pad). Wax is a good insulator of electricity, just like plastic or wood. By setting an object on the cake of wax and transferring a static charge to it from the plastic tube, you can “electrify” the object...the static charge is not able to escape very well through the air or wax. To demonstrate this, ask a visitor to set the cake of wax on the ground and stand on it with both feet. Generate a charge on the plastic tube and transfer the charge to the visitors hand or even one of their ears. Transfer the charge from the tube several times to generate a sufficient change on the visitor. The electric charge may cause their hair to stick up. Ask a second visitor to stand next to the “electrified” visitor and touch his/her nose. This should result in a slight shock and a snapping sound. This is a fun game that Franklin used to play with his friends, but it also demonstrates that insulated (non-grounded) objects can cause shocks and sparks, whereas grounded objects can safely transfer the charge to the ground safely.

In 1752 a device was accidentally invented by an electrical experimenter in Holland; the Leyden Jar (named after the city where it was invented). The Leyden jar was the first device capable of storing strong static electrical charges for long periods of time. This was important because it allowed experimenters like Franklin to store and control electricity so that it could be studied more effectively. Franklin did not invent the Leyden jar, but he was the first person to correctly describe how it works and to improve upon the design; allowing for jars capable of storing enormous and dangerous charges. Franklin also experimented with connecting several jars together into electric circuits he called “batteries”; coining the term and providing a name for portable electrical storage devices.

The Leyden jar plays a key role in Franklin’s famous Kite experiment. Ask visitors if they know why Franklin flew the kite in a storm (demonstrating the replica kits). Franklin performed the kite experiment to prove that lightning is made of electricity. Through his experiments, he noticed that large electrical charges sometimes looked like miniature lightning bolts, sounded like lightning, and even smelled like the air after a lightning storm. This led him to believe that lightning was electrical. The kite experiment proved this idea. It is important to point out that Franklin’s kite was not hit by lightning, but did draw down a small electric charge from the sky that Franklin was able to store in a Leyden jar. He then compared the Leyden jar charged by the storm with a jar charged with the tube and he found the charges to be exactly alike.

Knowing that lightning was made of electricity, Franklin applied the lessons learned in his electrical experiments to invent the lightning rod, a metal rod that would attract and then safely conduct lightning down to the ground without harm to people, animals or buildings (pass around the replica lightning rod). One of the largest causes of fire during this time was fire caused by lightning strikes. Plus, there were no formal fire departments at this time....Franklin is credited with organizing the first volunteer fire
brigade in Philadelphia, PA. Franklin also invented bifocal glasses, the Franklin stove, and other useful inventions.

- While Franklin studied electricity very seriously, he also enjoyed its novel behavior and mystique. He developed many static electricity games to amuse his friends and to encourage them to assist him with his experiments. One of the most famous games was the Circle of Fire. Take a charged Leyden jar and ask the visitors (up to 60 at a time) to form a circle around you and hold hands with the people next to them. Once the circle is formed, ask one person to hold onto the bottom of the Leyden jar. Make sure everyone is holding hands and then ask the person next to the Leyden jar to touch the top of the jar. If performed correctly everyone in the circle should feel a mild shock. This game became very a very popular parlor game throughout Europe, and has been given many names. Franklin performed the Circle of Fire for the King of France during the American Revolution. Franklin was America’s Ambassador to France and was trying desperately to get more aid and military assistance from France. During his visit with the king, the king requested Franklin to perform an experiment for him. Franklin asked forty French soldiers to stand in a circle holding hands, then discharged a Leyden jar through them…causing them to jump in unison. The King found this quite entertaining.

- Congratulations...you've finished the experiment and shocked lots of happy visitors. Some of the visitors may want to be shocked again, which is fine. If visitors would like to construct their own Leyden jar at home, instructions can be found in the Franklin Background Manual.

Other Tips
- The equipment used in this activity work best when they are dry and clean. For best results, clean the acrylic tubes, electrical machine, and Leyden jars with glass cleaner and a soft cloth before time the equipment is used.

Safety and Maintenance
- While there are no known safety hazards with these materials, we recommend having a facilitator present whenever you are using any of these activities.
Youth Engagement through Science (YES!) Highlights

The Goal of YES! is to provide access to educational and career development opportunities in science to Latino youth in the Washington DC region.

During its inaugural year, YES! served 15 students, 10 of whom self-identified as Latino or Latina, with a 6-week Summer and 10-week Fall (Saturdays only) internship. According to the participants and their parents, the internship was the first experience that the students had that helped them to consider a career in science and/or scientific research. This excerpt from a letter written by the parent of one of the participants illustrates how this goal was met:

“The program has opened for my daughter a new view to choose a career. After the YES program she is considering and exploring new possibilities to choose her career and for that I thank the program as well. I hope these youth are given the opportunity to continue learning in connection with the program in some way. If after six weeks of internship they have accomplished so much can you imagine how much they can grow professionally if they are given the opportunity to do so?”

YES! engages Latino youth in authentic and meaningful scientific research to increase their critical thinking, communication, and other skills necessary to be competitive in a knowledge-based society.

Each student participated in a behind-the-scenes science internship that included 90 contact hours with Smithsonian researchers and science staff. Some examples of the research experiences in which the students participated are:

Amalia Gomez-Rexrode (Entomology)
Ant Lab: Arthropods of South America

Amalia helped to sort ants and other arthropods in leaf-litter samples collected in South America. Members of the Smithsonian AntLab have travelled to many locations in South America (Guyana, Argentina, Peru, Colombia, Brazil, Suriname, French Guiana) and collected ants. One of the main ways they collect is to use "Winkler eclectors" to extract ants from the leaf litter. The samples contain many new as well as rare or poorly known species. Amalia sorted the leaf-litter samples, sorting out the ants and other groups (aculeate Hymenoptera, mites, spiders, heteroptera, etc.). She was guided by Jeffrey Sosa-Calvo, who collected many of the samples and worked closely with Museum Specialist Eugenia Okonski.
Josephine Sanchez (Paleobiology)
Seed Fern Insect Damage

The objective of the research was to scan collections of the Pennsylvanian-age seed fern *Macroneuropteris scheuchzeri* for insect damage. Josephine was instructed in what to look for by Smithsonian researcher Bill DiMichele. All specimens potentially bearing damage were photographed for further evaluation by the curators. In such cases where preparation is warranted, Josephine prepared fossils in the NMNH FossiLab and photographed fossils in that facility.

Selam Amare & Malaika Simmons (Invertebrate Zoology/Encyclopedia of Life)
Nemertean Worm Project

Malaika and Selam digitized scientific literature and selected descriptive text to be published in an online database of Proboscis or Nemertean worms, along with illustrations and references. Tools included scanning and optical character recognition software, photo-editing software and an online publishing platform (LifeDesk and Scratchpad).

YES! supports the development of a view of careers in science and technology as viable career tracks for Latino youth to follow and provide college preparation assistance to assist enable the pursuit of those careers.

The internships in which students participated helped them to get to know scientists and to see first-hand what a career in science and technology entails. In addition, students participated in 30 hours of interactive college preparatory instruction and activities during the Fall portion of their internships. These activities were led by the Center for Minority Achievement in Science and Technology (CMAST). The mission of CMAST is to serve as a catalyst for establishing collaborative communities amongst science, engineering, and technology education stakeholders, in order to build the capacity and sustainability of programs that increase the academic achievement and global competitiveness of minority students. Student sessions were led by the principal of the organization, who has extensive experience in the Science, Technology, Engineering, and Mathematics education communities in and around Washington, DC, and a strong sense of what students need to succeed at the college level as the foundation for a career in science.

The topics included the College Entrance Process (choosing a college/university, deciding on a major, applying for college, preparing for admissions tests), Financial Aid Process (understanding the types of financial aid, navigating the financial aid process, completing the Free Application for Federal Student Aid, or FAFSA, form, finding scholarships and grants, the realities of student loan repayment), Practice PSAT and ACT Exams, and a field trip to visit with students and admissions officers at the Johns Hopkins University.
Students also developed their own Roadmap to College, including a personalized plan for college readiness, identifying a mentor, identifying potential career pathways, and considering potential pathways to graduate school.

The excerpt below, taken from a guest blog post that one of the YES! interns wrote for the Centennial Blog at NMNH, indicates how the program encouraged the pursuit of science and technology as a viable career:

“Working in the FossiLab Exhibit was an exciting experience because I’m in a room surrounded by glass where the public can watch me work, and see all kinds of cool objects. During my time there, I saw scientists work on a 5 million year old Whale Skull, the cast of a 36,000 year old Gray Whale Jaw, Mammoth leg bones, million year old camel bones, a brontothere jaw, prehistoric owl pellets and many more. I loved being able to work beside such kind and knowledgeable people whom I could ask questions to; I feel I learned a lot just from our conversations. I also learned about prehistoric ecosystems because that was what my project was; I was finding and measuring charcoal in 73 million year old fossil soils to get an estimate of the presence of wildfire, which can tell scientists a lot about what these prehistoric ecosystems were like. We were working on projects with actual scientists who wanted our assistance and were figuring out things on the way rather than already having an outcome in mind. With my scientist we went through many trials and errors; the vacuum wasn’t working as we thought, the rocks weren’t dissolving, some samples had huge chunks…but that’s what made it real, the fact that we had to put our heads together and actually figure out something that works better…This internship not only exposed me to different fields, but it solidified my interest in science. I would like to focus on environmental science to help solve many of the issues we have today and have a career that would take me to different places in the world like the scientists at the Smithsonian.”
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BROOKHAVEN NATIONAL LABORATORY ENGAGES TEENS THROUGH AUTHENTIC RESEARCH

What we do at BNL...
- School-based field trips connect classroom curriculum to BNL research & facilities
- Local teens participate in summer internship programs
- Open Space Stewardship Program connects schools, government agencies, and the public through environmental stewardship
- InSynC brings “Big Science” to the classrooms as teachers and their students gain access to a premier scientific facility to perform research

What can you do at your facility?
- Engage your local colleges and universities
- Utilize local businesses
- Facilitate citizen science projects
- Contact us for support

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