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## **ScienceWorks: a University-Based Science Outreach Group**

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### Abstract

ScienceWorks is a science and engineering outreach group at the University of Nebraska-Lincoln, comprised of faculty, graduate students, undergraduates and community volunteers. We are brought together by one goal - to make science fun and accessible for everyone. ScienceWorks has developed over 30 modules that emphasize a range of scientific and engineering topics and guide the participants in discovery-based learning. Modules cover a wide variety of topics, including pressure, materials, electromagnetism, archaeology, DNA, optics and fracture. Most ScienceWorks modules involve hands-on activities. In Electromagnetism for example, students are asked to use a length of wire and a nail to design an electromagnet that will pick up as many paperclips as possible. Other ScienceWorks modules are scripted, multimedia presentations designed for larger audiences. In the Pressure Presentation for example, the audience learns about the basic principles behind pressure through a series of demonstrations and explanations using a Socratic dialog. Students involved in ScienceWorks have the opportunity to develop their own modules, strengthen their speaking skills, and learn how to effectively communicate with the public.

### Introduction

It is increasingly important for the general American population to be scientifically literate so that the United States can remain economically competitive. According to the National Science Board's yearly review of science trends, *Science and Engineering Indicators: 1998*, "Scientific and technological literacy are important. Science and technology skills are increasingly required in many jobs. There is an increased emphasis on accountability and the importance of public understanding and awareness of science and technology. The public should be able to understand the scientific process and be knowledgeable about science and technology discoveries in order to participate more adequately in policy discussions."<sup>1</sup>

A critical component in developing public science literacy is teaching scientists to communicate with and educate the public. NSF Director Rita Colwell recently said, "...we cannot expect the task of science and math education to be the sole responsibility of K through 12 teachers while scientists and graduate students live only in their universities and laboratories. There is no group of people who should feel more responsible for science and math education in this nation than our scientists and scientists-to-be."<sup>2</sup> "...We need to...reach out with clarity, explain what we do to the public, talk to the media, try new approaches to achieve a more inclusive workforce.

We at NSF need your help on all these fronts to get the message out about the importance of federal investments in research and education, and the extraordinarily rich returns they reap."<sup>3</sup>

ScienceWorks is a science and engineering outreach group at the UNL established to address the concerns of public scientific literacy and the university scientist's role in the public's education. Our goals are to improve scientific literacy in both children and non-scientist adults by making science fun and interesting through a series of hands-on activities and multimedia presentations and to encourage communication between university scientists and the community. We believe that interacting with and educating the public on a variety of scientific topics is directly beneficial to everyone involved: the university, the public and the individuals participating in the outreach.

ScienceWorks has been in existence since August 1995 and is comprised of UNL faculty, undergraduate students, graduate students, teachers, secondary students, administrators and parents. ScienceWorks travels to schools, scouting and other youth group events, science fairs and even shopping malls throughout Nebraska to teach scientific concepts to our audiences through a variety of activities.

During the three years of ScienceWorks' existence, many of the graduate students involved in the project have developed modules relating their area of research to adult non-scientists and children. These students have developed the important skill of relating their research to the general public, a skill that they will carry with them throughout their careers. ScienceWorks now has over 30 hands-on modules and multimedia presentations describing a variety of basic and applied scientific principles, from biology and chemistry to engineering.

#### Format

ScienceWorks activities take two forms: hands-on modules and multimedia presentations. For groups of 2-15 participants, we have several hands-on activities, including modules on polymers, seatbelts and airbags, failure and fracture, DNA and the human heart. These activities allow participants to discover science concepts through their own activity and have the advantage of one-on-one interaction between participant and presenter. Two of our most popular hands-on activities are Angular Momentum and Buoyancy. In Angular Momentum, participants sit on a low friction turntable and experiment with changing their speed using their arms, weights and a bicycle wheel. ScienceWorks volunteers explain that simply changing the position of the arms varies the speed of rotation. This is easily confirmed by the participant who can feel the change in speed that comes with a change of arm position. Volunteers relate this back to ice skaters that many have seen on television. In this activity, ScienceWorks demonstrates that Physics is useful in everyday life and that physical principles can be understood.

In Buoyancy, participants mold boats out of polymer clay in an effort to design a boat that can hold the most marbles before sinking. Participants in Buoyancy get the opportunity to redesign their boats and learn the valuable process of evaluation and redesign. ScienceWorks volunteers explain that the process of evaluation and redesign is a significant part of the scientific process. In this activity, participants learn the value of the scientific process and how scientists use this process everyday.

To accommodate very large audiences, ScienceWorks has scripted, multimedia presentations that develop a single concept (such as temperature or pressure) and relate that concept to everyday occurrences. In Pressure for example, there are a series of demonstrations showing the strength of air pressure. In one such demonstration, audience members learn that air pressure can keep two hemispheres (a Madgeburg sphere) together. After allowing students to try to pull the hemispheres apart, ScienceWorks volunteers explain that not even 30 horses could pull apart the original Madgeburg sphere in 1654 when Otto von Guericke first built it. Another pressure demonstration is the bed of nails. Audience members have most likely seen this demonstration many times before when they were encouraged to believe that the person lying on the bed of nails possessed a great skill. ScienceWorks volunteers attempt to remove the mystique surrounding this demonstration by telling the audience that it is all a matter of pressure; if there are enough nails, each nail supports only a very small force and the person lying on the bed is unharmed. These presentations take the form of a Socratic dialog between two ScienceWorks volunteers. Although the conversation takes place primarily between the two volunteers, they encourage audience participation through humor and animation and occasionally ask for volunteers to help with the demonstrations. All demonstrations are explained simply and clearly, reinforcing the idea that everything can be explained and understood by everyone. Other multimedia shows include Electrostatics, Color and Kitchen Chemistry.

Each module has written documentation with background information and a complete description of the module's experiments, including safety considerations, cleanup and where to get replacement materials. All module documentation is written so that a person with no technical expertise in the particular area may understand the module and explain it to others. ScienceWorks volunteers often present modules in areas completely unrelated to their area of expertise. This has the additional benefit of broadening the group's scientific knowledge and building inter-departmental bridges.

A typical ScienceWorks visit usually begins with one of the multimedia presentations given to a large assembly of students (100 or so). Following the presentation, the large group is divided into several smaller groups that rotate through several hands-on activities. The community response for ScienceWorks has been so overwhelming, that ScienceWorks cannot fulfill all requests for appearances. Through informal polling, we have found that adults and children walk away with a positive impression of science and scientists. They see scientists from all walks of life that are ordinary and friendly people, they see science concepts that affect their everyday lives and they learn that scientific concepts are not impossible to understand.

## Major Events

ScienceWorks organizes two major community events each year: Science Day at the Mall and Bright Lights. Science Day at the Mall occurs on a Saturday in February from about 10 a.m. to 6 p.m. at a local mall. In addition to ScienceWorks volunteers, other student and community groups host their own tables. ScienceWorks gives one of its multimedia presentations on a stage in a central area of the mall throughout the day. Tables are placed throughout the mall for hands-on activities. There are usually 10-15 student and community groups serving over 1500 people during the day. The event is well received by the mall and the community and attracts local

media coverage. Science Day at the Mall is an extremely valuable outreach activity, as we are able to reach many people who would not ordinarily make an effort to come to science events.

Our second major event is participating in Bright Lights, a summer enrichment program for Lincoln area K-12 students. Bright Lights is a non-profit organization that organizes three weeklong sessions throughout the summer on a variety of topics, although there is an emphasis on math, science and computer activities. ScienceWorks has offered a five-day long course on materials science for 4-6<sup>th</sup> graders for the past three summers. The students learn about atoms and molecules by building their own molecules with gumdrops and toothpicks. Later, we discuss material properties such as strength and brittleness, electromagnets, magnetism and thermal conductivity. Students learn by making their own polymers, breaking steel wires and making their own electromagnets. The highlight of the week is always the tour of the laboratories at the University of Nebraska. Students get to see working laboratories and talk with professors and researchers. Parents of



Figure 1. At Science Day at the Mall, a girl learns about angular momentum

our Bright Lights students have commented that these tours excited the students and started them thinking seriously about careers in science. Informal polling of the students has shown an improved positive impression of scientific professions and scientists in general. In many cases, students did not have a clear idea of how a scientist spends his days before going on the university lab tour.



Figure 2. During our participation in Bright Lights, students learn the best design for clay boats so that they hold as many marbles as possible before sinking.

## Conclusions

Science outreach is an extremely important and rewarding activity for the community, the school and the individuals who participate. UNL's science outreach group, ScienceWorks, has been active for over 3 years and has developed a repertoire of 30 hands-on and multimedia presentation modules. Students who participate in ScienceWorks gain the critical job skill of communication, giving them a distinct advantage in looking for a job. We find that there is a desperate need for these types of activities in the community, particularly in rural and urban areas.

Further information on ScienceWorks, including module documentation, is available at <http://www.engr.unl.edu/~sciworks/>. We are also planning to publish a book of age-oriented science exploration activities in the near future.

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