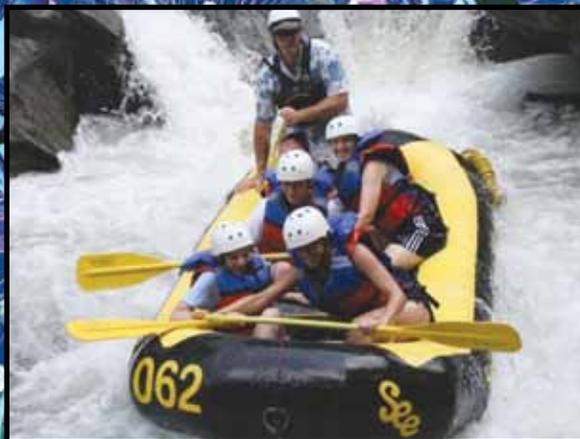


The Magazine for ACS Student Members
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Graduate School: Navigating the Challenges

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MIKE DIEBELSKI

Cover art: Dreamstime Stock Images. 3D rendered conceptualization of protein structure. Inset photo: Christopher Pollock and friends, courtesy of South Eastern Expeditions, Inc.

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COURTESY OF WILKES UNIVERSITY

LIQUID NITROGEN EXPLOSIONS, flaming pumpkins, exploding eggs and pickles, and thermite reactions delight and entertain our audiences when we perform chemical demonstrations. These demos are fun, easy to do, and dramatic. But please, before you blow up another pickle, stop and think about what you're trying to accomplish, and why.

If you're like many students I talk to, you will probably tell me something about having a mission to increase the public's interest in or knowledge of science. But do you really appreciate why this is so critically important?

For me, there are two outcomes that I seek when performing chemical demonstrations. First, I hope to nurture an interest in science among young students, so that they might someday pursue an



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Doing More with CHEM DEMOS

BY BRITTLAND DEKORVER

PART 1

education in a science field and become a scientist. In doing so, I'm trying to add to the "pipeline" of scientists.

Of course, not every student wants to have a career as a scientist, which is why I have a second goal: to increase science literacy among the masses in our society. Science literacy is important to our society because as new scientific advances are made, we as a people must deal with the legal and ethical implications that often come with these advances. To do this, we must be capable of making informed decisions built upon basic knowledge of scientific facts and the nature of science. Unfortunately, some students (and adults) are science-phobic and believe that they can't do science or that science doesn't affect them.

That's why it's vital that scientific **learning** occurs during outreach events. Learning is sometimes treated as an afterthought in science outreach. Too often, the primary objective is to entertain; if learning also occurs, it is seen as an addi-

Why Science Learning Is Critically Important to Our Future

tional benefit. Why do we, as informal science educators, tend to highlight the dramatic more than the educational? Because making chemistry flashy and exciting is easy: color changes, fog, glow-in-the-dark substances, and — the crowd favorite — explosions. Creating a learning experience, however, is more challenging. You've studied for years to obtain your chemistry knowledge. How do you convey it to an audience in just a few minutes' time?

Help the audience relate

Find a relatable context for the demonstration or activity. Show the audience how the knowledge can be applied in their everyday experiences. Food, alternative or renewable energy, electronics, and clothing are just a few examples of areas where you can find some relevant or timely topics to incorporate into your outreach.

Design a multisensory experience

Many times, we orally explain a particular demonstration in a few sentences after it's over. Generally, we use what we think are basic terms — but often, even these terms are new or unfamiliar to our audience. Consequently, our well-thought-out explanation will have little or no lasting impact on the audience.

Instead, consider using signs or posters to display key words so that the audience can read them. Use models for a particular reaction or process so that the audi-

ence can gain detailed knowledge. You can purchase the models from an educational supplier, or find images or video clips, or design and make something yourself. You may want to experiment with incorporating movement into your show by having the audience participate via gestures, clapping, standing, or sitting. For example, you can assign a meaning to a movement and have the audience repeat the movement at appropriate times throughout the show, or you can ask audience members to come up on stage and act out the functions of molecules you are describing.



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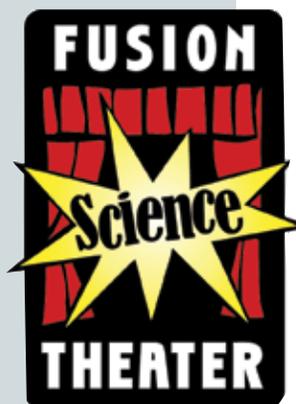
FUSION SCIENCE THEATER

Science learning can be fun, but creating that educational experience is far from easy! Fusion Science Theater (FST) is one approach to creating science demo shows that entertain and teach. FST is a nonprofit group of science educators, outreach professionals, and others collaborating to make science more engaging, educational, and inspiring. FST shows are designed to teach one central concept using the natural “story arc” of theater to model scientific investigation.

The show begins with a question, followed by observations, experiments (the demos), and data to provide the story development, and in the show’s climax, the question is answered. A genre and characters, such as a game show or three-ring circus, provide a familiar framework and humor to draw in the audience. Audience members take part in the show through call-and-response, answering questions, sing-a-longs, act-it-outs, and other activities in order to provide a life-size kinesthetic and visual model.

Another unconventional technique that FST uses is embedded assessment, in which performers give out ballots for audience members to vote on which hypothesis they believe is correct. It has been demonstrated that when this approach is used, the audience gains significantly greater understanding of the topic. Surveys have also shown that audiences find such shows exciting and enjoyable.

FST shows have been developed on a variety of topics, from electricity to phase changes to combustion. As scripts continue to be developed, FST is looking for student groups who want to perform FST shows. FST will provide the training, scripts, and other support. Interested groups can find more information at www.fusionsciencetheater.org or by checking out the FST Facebook page.



Strive to create demos that entertain AND increase science literacy.

Get the audience involved

Using movement is one way to get the audience involved in your demonstration. Another is to ask questions that provoke the audience and spark debate. “What do you think will happen if I (or you) do this?” is a good one. If you have a small group (less than 30), you may want to provide your audience members with name tags so that you can call on specific people by name for answers. Keep in mind, however, that soliciting predictions for the results of an experiment won’t work if you tell them what will happen beforehand!

Experiment with formalizing the investigative process by teaching one central concept with a series of related demonstrations.



Use the element of surprise

Surprising your audience will capture their attention. I have seen many demonstrations where the presenter says something akin to, "When the base is added to the indicator, it will turn pink!" That may be true, but by simply rephrasing the statement as, "Watch what will happen when I add this base!" you will engender more interest in the audience. If you are worried that the audience might miss subtle or fleeting effects, repeat the demonstration a second or third time.



COURTESY OF SOUTHERN ILLINOIS UNIVERSITY



Safety first! Kids and ACS student chapter members from Austin Peay State University (above) and Southern Illinois University (left) model appropriate eye-wear while performing chemical demonstrations.

COURTESY OF AUSTIN PEAY STATE UNIVERSITY

Model scientific investigation

Simply telling the audience what to expect is not how to model scientific investigation. The presenter and presentation should teach the *nature* of science, as well as scientific knowledge. Many of the recommendations above reinforce this goal. Allowing the audience to make observations rather than confirming what you describe will emphasize the importance of gathering data. In your model or explanation, you should use the evidence and refer back to the demonstrations. Allowing the audience to be surprised at a result or asking them to make predictions using prior knowledge also gives them insight into the practices of scientists.

Aim to teach one central concept

You might also try to formalize the investigation process by **teaching one central concept** with a series of related demonstrations. At the beginning of the show, you could ask the audience to observe a phenomenon and form a question. Each subsequent demonstration or model might give an essential piece of information that can be put together to arrive at a conclusion.

Always remember, safety first!

Finally, the most important concept, and one that you must always demonstrate, is safety. Don't hesitate to draw attention to the safety precautions you take, from wearing gloves and goggles to having a fire extinguisher handy. Make sure that you are taking all appropriate precautions in preparation, presentation, and cleanup. In addition to consulting

the original source of your demonstration for safety information, look for additional concerns or tips to make a demo safer by reading the work of other demonstrators. The online database of the *Journal of Chemical Education* (find it at <http://pubs.acs.org/loi/jceda8>) is a great place to begin your search. All presenters of your demonstrations should be familiar with the hazards and should know an explicit course of action to follow in the case of any mishaps for each demonstration they perform.

Of all my recommendations for engaging and educational shows, the only ones that are absolutely required are those involving the safety of the audience and presenters. However, including even one or two of the other minor changes could dramatically improve the quality of the learning experience for your audience. You may recognize that you already do incorporate some of these elements in your shows. If so, bravo! But even great shows can be improved by spending time to reflect on your outreach program, its goals, the content provided, and the needs of your audience. **ic**



LINDA WANG/GREEN

While performing a chemical demonstration, try to ask questions to provoke your audience to think and to spark debate.



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