Lights, Camera, Action--It's Science!

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How does one get to Broadway? Perform, perform, perform! How does one learn science? Engage, engage, engage! Now, you can engage your students in learning and teaching science by having them become actors and actresses in the science classroom. The following theatrical approach will help you in implementing dramatic science characterizations in your science classroom.

Your students will not only gain a greater understanding of many science topics, they will also fine-tune their acting ability as they personify science characters who share their experiences as authorities on a specific scientific subject. For example, Adam Atom explains to students what life is like as one of the many extremely small particles that serve as the building blocks for most matter; he also illustrates the laws of physics that he abides by in his world of Teenyville. Kinetic Carla, Adam's friend, describes what happens when she and Adam play together. If they play with zest, expending lots of energy, Adam moves and dances all over the playground. If they take a break and rest, Adam slows down and essentially sits in one place, waiting for Carla to re-energize their recreation. Because Carla represents the energy of motion, the harder the two play together, the more Adam dances.

Using dramatic characterizations in the classroom enables students to research a particular scientific concept that interests them and then present their findings to their classmates in an exciting and invigorating manner. (Note: Review the presentations with your students before they present their characterizations, to prevent the dissemination of misleading, confusing, or incorrect content.) Rather than lecture them or require oral reports, which often cause students to become nervous, you can encourage your students to use their creativity.

You can easily weave the National Science Education Standards into the activities. For example, by encouraging students to investigate and explore how to represent scientific principles via science characterizations, you address the Science as Inquiry Standards and the Nature of Science Standards (National Research Council 1996). You also inherently intertwine content standards (earth, space, physical, and life sciences), thus ensuring that grade-appropriate topics will be addressed in the presentations.

With a little imagination, your students could personify any scientific subject area. For example, a student could be "Pseudopoida," the false foot of an amoeba. Another student could be "Nikki Niche" of ecological fame. A student playing Nikki can explain to the class how an organism's activities and relationships within a community help it acquire and use resources needed for survival, while wearing a green outfit displaying plants and pictures of water. Nikki could be a personification of an area within a 75-mile radius of Wilmington, North Carolina, that has rainfall of approximately 45 inches a year and acidic, sandy soil, which is perfect for the carnivorous plants that are found nowhere else in the world. The number of possible science characters that your students could represent is endless and provides creative opportunities to teach, using multiple-learning modalities. The following two scenarios that discuss pollution illustrate the use of dramatic science in the classroom.

THE USE OF DRAMATIC SCIENCE IN THE CLASSROOM

SCENARIO 1

Teacher: "Okay class, as you know we are going to discuss conservation and the kinds of pollution that we encounter on Earth today. Can someone name one kind of pollution?"

Student: "Air."

Teacher: "Good. I'll write each kind on the board, and then we can discuss them."

Teacher: "Samantha, could you review for us the types of pollution we described today in class."

Teacher: "Excellent. Alec, please list three ways that would help slow the rate of pollution in our neighborhood."

Student: "We could recycle more items, we could walk or bicycle rather than drive, and when we do have to drive, we could carpool."

Teacher: "Wonderful. Let's discuss some other ways."

SCENARIO 2

Teacher: "Today a guest will speak to us about pollution, so feel free to ask him or her any questions that you have about the subject. The guest will also help us perform several hands-on, pollution-related activities."

Student (as guest speaker): "Hello class, my name is Rea Cycleman. Every day, I fly around the world in my invisible, solar-paneled jet to oppose the evil squadron of pollution misers: Aereopollution Al, Wasteful Water Wally, Cluttered Land Laura, and Too Loud Larry. My job as Rea Cycleman is not to directly confront the pollution misers. Instead, I educate people such as you and your family about ways in which we can help eradicate them. Before that discussion, however, we need to talk about how each pollution miser harms the world and then ask what can we do to help reverse the situation, to make our Earth green and beautiful. Are you ready to help me do this, class?"

Of the two scenarios, students usually prefer doing scenario 2, as it is more engaging. This is because scenario 2 permits the students to use their creativity more than in a typical teacher-student exchange. Also, scenario 2 allows many students to play the parts of the pollution misers, which helps promote cooperative learning and a sense of community. As they capitalize on their own creativity, your students will garner more ownership in doing the activity and, consequently, will understand the scientific topic better.

MATERIALS

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Paper
Costumes (dependent on which characterizations the stu-
  dents choose)
Pencils
Hat or box
VCR
Videotapes
Xerox machine
Any other materials that the students find they need to suc-
  cessfully complete the hands-on activities
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IMPLEMENTING DRAMATIC SCIENCE IN THE CLASSROOM

PREPARATION

Before teaching your students the dramatic science activity, you may want to model it for them by dramatizing a character yourself. This will give the students an example to follow and a better understanding of your expectations regarding the assignment.

PROCEDURE

1. Select a scientific topic and assign part of it to a student or group of students (the number of students will depend on class dynamics. A typical group size is 3-4 students). Write down various subtopics and characterizations on small pieces of paper that the students can draw from a hat. For example, in scenario 2, you could use 5 pieces of paper for the characters representing pollution and conservation: Rea Cycleman, Aereopollution Al, Wasteful Water Wally, Cluttered Land Laura, and Too Loud Larry. After the students have selected their topics, permit them, at your discretion, to switch subtopics if they have a strong interest in a particular subject area.
2. Provide the students with ample time in the classroom and at the library to research their topics. Encourage them to contact local agencies (e.g., the local environmental center, recycling plant, or electrical company). Allot a certain amount of time for them to complete their research. Although the amount of research time will vary, depending on class size and resources available, a typical time period is 2-3 class periods.
3. Set a deadline for the class presentations, either individually or as groups. (Note: Stagger the presentations so they will correspond with the topics being discussed in class.)
4. Early on, send letters home to inform parents of their child's assignment. On the letters, request permission to videotape the students' performance and a request for them to supply videotapes, if possible. This is also a good time to ask parents or other adults to help make the costumes that the students will wear as part of their presentations.
5. Arrange a "Parent Night" so parents can come to watch their child's presentation. This helps in fostering student-parent-teacher relations.

ENCOURAGING THE USE OF HANDS-ON ACTIVITIES WITH DRAMATIC SCIENCE

Although when students perform science characterizations in the classroom it helps them to feel more engaged in the subject under discussion, you should also require that the characterizations include representative hands-on activities. For example, Rea Cycleman could lead the class in an activity involving the use of recycled paper. For an explanation of this process, students can visit http://www.exploratorium.edu/exploring/paper/handmade.html, which is a link from the Exploratorium's home page: http://www.exploratorium.edu. One way to help facilitate doing hands-on activities is to use what we call "Make & Takes."

MAKE & TAKES "HOW TO" PROCEDURE

1. If two students play the twins Molly and Kuel, (as our former students Juanita Thompson and Sharon Andrews at the University of North Carolina, Greensboro, did for a summer school class), have them study and take notes on the concept of molecules and molecular motion. Good reference sources are their science textbooks, science reference books, and Internet resources.
2. Next, from their research have them decide what they want to teach the class about molecules and molecular motion and have them list this information on a fact sheet that says "Meet Molly and Kuel" (see Figure 1). (Note: You can provide direction at this point.)
3. Invite the students to develop their characterizations (e.g., molecular motion and diffusion. Molly could play a water molecule and Kuel could play a molecule of Tang).
4. Next, give each group time to design a hands-on activity that pertains to their characterization (see Figure 2). The time frame again depends on the class, but 1-2 class periods should suffice, using one class period for planning and the other for gathering materials and performing the activity.
5. Ask each group of students to make copies of the two handouts and distribute them to the class.
6. Next, allow each group to describe its activity, including giving an explanation and a list of materials needed and procedures to follow.
7. Finally, have them either perform the activity or lead the class in doing it and afterwards hold a class discussion.

DRAMATIC SCIENCE IN ACTION OUTSIDE THE CLASSROOM SCIENCE CITY AT UNION STATION IN KANSAS CITY, MISSOURI

Science centers and museums also use the science-theater approach. Science City at Union Station in Kansas

City, Missouri, opened in November 1999; it combines the best aspects of science centers, theatrical techniques, and immersion experiences. Most science centers have exhibits; Science City offers environments within a city. For example, Dr. Hale N. Hearty's Family Clinic, S.O.A.R. (Scientific Opportunities in Applied Research) Laboratories, and Mister E. Hotel allow visitors to explore the science behind their everyday lives. Science centers normally feature demonstrators wearing lab coats who teach scientific concepts, whereas Science City features citizens in everyday dress. The role of these staff "interactors" (i.e., citizens) is to fully immerse visitors into the environments of Science City and facilitate their adventures within those environments.

Visitors to Science City might be met by Lynn E. Year, a messenger-in-training. Lynn skates around on roller blades while she is applying for her messenger's license. She is having trouble performing some of her deliveries, however. For example, sometimes if she skates somewhere too quickly, she accidentally tosses a package in the air, and it does not always land in the proper place. Lynn asks visitors what she should do to catch the package: speed up, slow down, or stay at the same speed? As they experiment with Lynn, visitors will notice that if Lynn speeds up dramatically after tossing a package, the package will fall behind her. If she slows down, the package will fall in front of her. If she stays at the same speed (and throws the package straight up), the package will drop back into her hands.

Lynn propels the package at an initial upward velocity, and this velocity is slowed by the constant pull of gravity. Gravity is the only force in this demonstration, and only the vertical dimension is illustrated. Forces in the horizontal direction are not demonstrated. Although the package initially moves in a horizontal direction because it is moving along with Lynn, when she releases it, no forces exist to slow it down or speed it up in the horizontal direction. An object in motion will remain in motion (Newton's first law of gravity). The package will move with Lynn until after she releases it and it falls back into her arms.

If Lynn tries to catch heavy packages, on the other hand, she might be pushed backward! Through careful questioning, visitors discover conservation of momentum (momentum changes as a result of a collision between Lynn and the packages) and vectors and direction (an object travels in a particular direction that may be changed as a result of a collision). Lynn asks the visitors' help with solving these and other problems to enable her to pass her messenger test.

Science City also offers a high-wire bicycle activity. Joules Newton assists visitors in getting on and off the bicycle. When Joules is not aiding visitors in this manner, he might pull out a hammer, a fork from his lunch pail, or a meter stick and involve visitors in a variety of demonstrations that illustrate stability and balance. Joules helps visitors discover that the center of gravity is the point at which the weight of an object is centered; this helps them consider where their center of gravity is while they are on the high-wire bicycle.

When Kelvin Dewar comes around with his ice cream cart, visitors quickly realize that he is "dishing up" liquid nitrogen to make ice cream within minutes. He can also alter the properties of bananas, carnations, balloons, and rubber balls using liquid nitrogen. This demonstration helps visitors understand the effect that temperature has on matter; for example, a frozen banana becomes hard enough to be used as a hammer, and gases condense when cooled and expand when heated.

The presence of the citizens populates and humanizes Science City. Visitors soon realize that science is not about listening to experts wearing lab coats or watching or eading about discoveries that have already been made. Science is about exploring, questioning, and making one's own discoveries.

THE NATURAL SCIENCE CENTER OF GREENSBORO

When The Natural Science Center of Greensboro, North Carolina, decided four years ago to pursue regularly scheduled public programs for the general museum visitor, it was, as most experiments are, the testing of a hypothesis. The staff at the Center suspected that the public would respond positively if they offered lively and engaging presentations that entertained while educating. The Center's vision was to provide miniproductions that would blend the substance of serious science instruction with the spirit of lighthearted theater; in other words, a hybridization of drama and education--science on stage. Except on special occasions, visitors did not expect to attend a live show at the Center. That has changed.

Not only are visitors now more aware of the shows, they come expecting to see them. Thus, the experiment has confirmed the hypothesis that, if given the stage, good science instruction can be quite an act. Each show has an original script, requisite science materials, and theatrical props or costumes; musical or video enhancements are also produced to take advantage of the Center's audio-video capabilities (see Figures 3 and 4). Video "trailers" catch the attention of visitors as they walk through the halls of the Center.

Most of the shows feature a program presenter dressed in costume, who assumes a persona and engages in science demonstrations that are tightly integrated into a dramatic story line. For example, in "Mr. Roboto's Lego Robot Circus," the presenter played a ringmaster who presided over a troop of robotic circus performers. The performers are made entirely of Legos and are programmed by computer to go through the paces of their respective acts. Another presenter lent a hand to contestants in the puppet game show, "Wheel of Friction," which addressed the many kinds of wheels that make the world go 'round. Another presenter donned wings and antennae and became a chatty insect with "attitude" in a television news program called "Interview with an Insect."

More recently, one of the Center's presenters assumed the role of a slightly scattered but likeable "professor," replete with lab coat, Hawaiian shirt, and long curly red hair. "Professor Van de Graaff's Electric Funhouse" is a series of energetically charged and fast-paced theatrical "bits" that involve a static electricity generator. Audience members learn about the lives of electrons and the bedrock concepts of electrostatics--the repulsion of like electric charges and the attraction of opposite ones. Other dramatic vignettes in which audience members participate include "Static Survivor"; "The Shock Hunter," starring an exotic Mylar snake; "Electric Wings," featuring silver butterflies; "The ElectriX Files"; "Static Wars"; and "Orville Reddenbacher's Shock Corn."

The Center's most ambitious show to date was a 35-minute program that blended live theater and planetarium effects. In "Starship Adventure," the planetarium became the training bridge of a starship and audience members were cadets who had come aboard for a typical training run to the Orion Nebula. A distress call transformed the routine mission into a race against time, in which the cadets and crew attempted to rescue a stranded science team from a doomed planet. In doing so, they had to avoid a black hole, outrun an exploding supernova, and outwit the captain of an alien craft on a nefarious mission. For all its fun and adventurous format, the show did far more than entertain: it immersed the audience in a science fiction story line that communicated scientific facts.

The sequel to an earlier show at the Center, "Indiana Bones and the Late Cretaceous," stars world-famous paleontologist Indiana Bones who has just returned from the field with fresh finds (see Figure 5). In addition to being funny, adventurous, and exciting, the show teaches audiences about the last days of the dinosaurs on earth and the early days of paleontology in the United States.

In conclusion, the Natural Science Center of Greensboro combines fun with serious teaching. In doing so, it has found that by putting science on stage and raising the curtain, it has fostered a greater interest in science education among its visitors.

EXTENSIONS OF SCIENCE CHARACTERIZATIONS

Students can also pretend to be numerous organisms, such as ladybird beetles (ladybugs), butterflies, anoles, crickets, and pillbugs. Dressed in costumes, they can tell the class about their homes, families, travels, and lifestyles. These "organisms" are usually well received! There is nothing like watching a caterpillar wrap itself in a sheet cocoon and later emerge as a beautiful butterfly.

"Bolt," an elementary education major, was a huge hit at our state science teachers' meeting. Johnny K. Reeder (i.e., Bolt) wore dark sunglasses and dressed all in black (stretch knit pajamas covered with shorts and a T-shirt) except for a yellow bolt of lightning made of construction paper that ran the length of his 6'4" body.

The mnemonic Roy G. Biv helps students remember the order of the colors in the spectrum: red, orange, yellow, green, blue, indigo, and violet. Imagine how much more effective it would be, however, if Roy G. Biv showed up in class one day. A costume for him could be as simple as putting on a rainbow hat or halo and wearing a nametag. Try characterizing Biv. You'll be pleased with the result!

STANDARDS INFORMATION

Teachers can craft the activities to address various state and national science standards. The specific standards that they are applicable to will be a function of the content of the particular characterization. In addition, because of the inquiry-based nature inherent in the Make & Takes, they also address the processes of national science standards.

CONCLUSION

The use of dramatic characterizations is a wonderful tool. It allows students to tap into their creativity and helps them explore the dimensions of a particular scientific subject. Although the ways in which you can carry out this method of instruction vary, each method involves the idea of student ownership. A sense of ownership helps students look at their assignments differently and creates enthusiasm. Hopefully, having your students participate in science theater will help them not only have fun but also understand science on a deeper level.

ADDED MATERIAL

DAVID P. HILDRETH is an assistant professor of education studies at Guilford College, Greensboro, North Carolina. His current research interests include studying teacher attitudes about teaching science and the attitudes of precocious youth on learning in academically accelerated summer programs; improving K-12 science pedagogy; and incorporating technology (distance learning) in teacher education programs.

CATHERINE E. MATTHEWS is an associate professor at the University of North Carolina, Greensboro, with a specialty in K-12 science education. Her research interests include environmental education, gender equity in science education, and multicultural science education.

LAURENNE HESS manages traveling exhibits and develops programs, activities, and products for Science City at Union Station in Kansas City, Missouri.

RON SETTLE is the curator of public programs at the Greensboro Natural Science Center in Greensboro.

Two bird watchers and a bald eagle ready for action.

Figure 2. Make & Take: Discover molecular motion.

Figure 3. (top) Ron Settle as Professor Nick O. Time in a presentation that takes students on an imaginary journey through time. Figure 4. (bottom) Wink Einstein and Fred Newton host the Natural Science Center's "Energy Game," a simulation television game show in which teams of middle school students compete to

successfully answer a series of questions related to energy demonstrations.
Figure 5. Indiana Bones takes learners on a paleontology adventure.
A cricket and an anole lizard at the chameleon display table.
A ladybug and a butterfly show off their wings at the insect display table.

RESOURCES

Science City at Union Station, 30 West Pershing Road, Kansas City, MO 64108-2422; (816) 460-2000; http://www.sciencecity.com.

Greensboro Natural Science Center, 4301 Lawndale Drive, Greensboro, NC 27455; (336) 288-3769; fax (336) 288-0545; e-mail: nscg@greensboro.com; http://www.greensboro.com/science center/

The International Museum Theater (an organization that promotes theater as effective education for museums, zoos, and aquariums) (617) 589-0449; e-mail: imtal@mos.org; http://www.mos.org/imtal.

REFERENCES

National Research Council, 1996. National science education standards. Washington, D.C.: National Academy Press.

FIGURE 1. MEET MOLLY AND KUEL, THE MOLECULAR TWINS, TO LEARN ABOUT MOLECULES AND MOLECULAR MOTION.

MEET MOLLY AND KUEL--THE MOLECULAR TWINS

* All substances are made up of molecules. A molecule is the smallest part of any substance (element or compound) that retains the properties of that substance.
* Molecules cannot be seen without great magnification.
* Molecules are in constant motion. Their motion is temperature dependent.
* Atoms join together through chemical bonding to form molecules.
* There are three possible molecular states: solid, liquid, and gas.
* Molecules of one substance such as Tang spread out or diffuse among molecules of water. Diffusion occurs more quickly with warmer temperatures.