THE ART OF EFFECTIVE DEMONSTRATIONS

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Magic is science without explanations. In presenting demonstrations, either explanations are often omitted or too much information is given. An effective demonstration should promote good observation skills, stimulate thought, arouse curiosity, present aspects of complex concepts on a concrete level, and, most important, be the basis for class discussion. Explanations should contain enough information to satisfy the audience's curiosity as to what took place and why, and should serve as a starting point for further inquiry for those individuals who need more details.

The key to successful classroom instruction is to present an active lesson that involves demonstrations and hands-on activities without using unnecessary hazardous materials and having disposal problems. Some of the things that can be done are:

Use common consumer products to provide a high degree of substance recognition.

Use dilute solutions of potentially hazardous materials.

Use small quantities of materials (i.e., microscale quantities), where appropriate, to minimize or eliminate waste.

For effective demonstrations:

1. **Prepare ahead.**
   Everything should be ready to go before any presentation.
   Have complete procedures written on separate sheets or cards for quick reference. Put all important information onto slides or transparencies so you can always read it to the audience without being obvious. (A word of caution, however, do not cram a lot of information on a single slide or transparency. Use large type such as 18 point and give the basic steps. You can fill in details orally and visually, i.e., demonstrate it.)

2. **Practice the demonstration.**
   Practice all demonstrations in advance to make sure you know what will happen and to gain confidence in performing the demo.
   Follow directions and observe all safety precautions.
   Do not change the demonstration without testing in advance. Quantity changes may affect the results.

3. **Make the demonstration visible.**
   Use large apparatus and large quantities suitable to the room whenever possible.
   Utilize the overhead projector, video, or digital cameras to make small demos larger.
   Use appropriate markings on containers, lighting, backdrops, and raised platforms to provide visibility and contrast.
   Rotate lab apparatus to keep labels from blocking the view of demo.
   Stand behind the demo, do not block the view of the audience.

4. **Present the demonstration to the audience.**
   Speak to your audience, not to the chalkboard or your visuals.
   Asking questions or having a dialogue with audience members increases interaction.
   Bring the audience's attention to the reaction container.

Do not tell the audience what is going to happen, let them observe it and then tell you what took place.

5. **Get the audience involved.**
   Get volunteers to help with the demonstrations. Try to pick the most appropriate member of the audience to help out. (Young children are often the best volunteers to work with.)

6. **Encourage responses.**
   Ask questions and wait for answers. If necessary, ask individuals directly.
   Ask the audience to explain what happened and why.
   Do not ridicule anyone for a wrong answer. Try to guide them toward the desired response. (Remember, this is a learning experience.)

7. **Keep demonstration simple.**
   Avoid information overload. Too many unknowns, or "new" things detract from the audience's attention.
   Avoid a lot of intricate apparatus. Try to use as little apparatus as possible. Keep it simple.
   Use common chemicals and materials whenever possible to increase audience recognition.
   Break complex demonstrations into simple parts.

8. **Practice showmanship.**
   Show surprise at the results.
   Show dismay at demos that go particularly slow.
   Presenting demonstrations is fun. Ham it up with props, costumes, funny signs or slides, jokes, etc... If you are enjoying yourself, so is your audience.
   If a demonstration does not work properly, do not make a big fuss over it. Go on to the next demonstration. You can always repeat that demonstration another day.

9. **Explain the concept.**
   Science includes an explanation, magic does not.
   Work out the explanation with the audience. Use analogies. Draw upon their knowledge.
   Do not avoid *technical* terms, but do take the time to explain them.
   Make the explanation appropriate to the level of your audience.
   Some classroom demonstrations should not be explained until a later class to allow students time to ponder what they observed.

10. **Repeat the demonstration.**
    If possible, repeat the demonstration, or parts of it, to emphasize the explanation or to make some part of it more apparent to the audience.

11. **Practice safety.**
    Observe the ACS Guideline for Safety.
    Inspect all glassware and apparatus for scratches, chips, cracks, etc. and replace any defective items.
    Utilize safety shields.
    Provide goggles and other appropriate safety equipment for helpers.
    Warn the audience of any bright light or flash, or any loud noise.

12. **Summarize.**
    Review the events of the demonstration and the explanation.

For effective activities:

1. **Provide clear, simple directions**.

Even if you hand out directions, have an outline of the procedure, printed in large type, at the work station that the participants can follow. They tend not to read everything when they are anxious to try an activity.

2. **Use common materials.**
   As stated previously, common, or household, chemicals and materials increase audience recognition and minimize fears of working with "chemicals". Safety information must still be included for all substances.

3. **Minimize/simplify measuring.**
   Weighing materials takes time. Try to use equivalents of masses in teaspoons, tablespoons, or other common volume measures. For liquids, use small plastic beakers or cups with dark lines drawn at the proper volumes.

4. **Minimize clean-up.**
   Use paper cups, popsicle stick stirrers, and other disposable-type materials to minimize clean-up time. Cleaning up glassware and equipment can take longer than performing the activity.

5. **Demonstrate the procedure.**
   Do not shortcut the procedure when you demonstrate it, perform the procedure exactly as the participants will perform it. Refer to the written procedure. No matter how good your written directions are, the participants will try to copy your demonstration as they observed it.

6. **Explain/summarize the activity/lesson.**
   After completing the activity, take the time to explain or summarize what took place. Have a discussion rather than a lecture.

How many demonstrations can I, or should I, present in a class?

Ideally, you should have at least one demonstration or activity for every class. In my case, I usually have several, depending on the topic. Let's be realistic. If you do not do demonstrations or activities in class, then you should start out by trying to do one demonstration or activity every two weeks. Be prepared for student excitement and confusion, that is normal until you become more experienced. It doesn't necessarily get better, you just learn how to deal with it more effectively.

As you gain more experience, try to present one demonstration or activity every week. Continue in a similar manner, increasing the frequency of demonstrations and activities. This may take several years, it will not happen in a short period of time. Eventually, you will build a repertoire of several demonstrations per class.

Remember, demonstrations are a means of visualizing scientific phenomena, not a substitute for teaching.

Demonstration management

The "worst" part of doing demonstrations and activities is setting them up as it can be very time consuming. Good demo management, can reduce your set up time.

1. **Find some storage space**
   This can be some cabinets, a closet, or just some open shelves. (A lockable, and, hopefully, ventilated, storage space is preferred for safety reasons.)
   Save cardboard boxes, plastic trays, or other appropriate containers. These will hold the essential items for your demonstrations. Do not use containers that once held food.

2. **Maintain a file of your demonstrations**

On each file card or sheet of paper, you should write the title of the demonstration, the objective of the demonstration, the apparatus needed, the chemicals needed with quantities, any solutions needed with complete directions for preparing that solution (including all masses and volumes), and directions for performing the demo. This minimizes your set up time.
Keep at least one copy in your file and a duplicate copy stored with the demonstration materials.

3. Store the essential materials for the demonstration

You do not have sufficient space and materials to store complete demonstrations.
Store only the essential items that are unique to that demonstration. You have a list of materials needed and should be able to gather them from your regular classroom or laboratory apparatus.
If possible (and if necessary), have containers or bottles for chemicals and solutions clearly labeled with the labels protected by clear, waterproof tape, such as shipping tape. CAUTION: Never use containers that were once used for food materials such as baby bottles or soft or fruit drink bottles. If anyone ingests any materials from a former food contain and becomes ill or worse, there is no lawyer who can save you from the liabilities incurred.
All storage containers should be of manageable size. Do not bring 4-Liter size bottles of liquid or solution if you only need 250 mL of the liquid or solution.

4. Use a rolling cart to transport your demonstration materials

Set the demonstration materials on a cart and roll it around your room or laboratory or to another classroom.
Get some plastic wash basins (rectangular shape preferred) or similar containers, to hold materials for each separate demonstration or activity. This keeps everything together and provides some safety in case of a spill during transport.

5. Clean up and restock after the demonstration

Clean up all apparatus and restock any essential items after your demonstrations or at the end of the day. Don't let a big pile of "dirty dishes" interfere with your day-to-day activities.