The basis of the JCST Favorite Demonstration Column is to promote the use of classroom demonstrations in college science teaching. Demonstrations can be an integral component of a student’s classroom experience. Plus, they are an entertaining distraction from the term-laden content typical of college science courses. However, it is important that demonstrations are carried out in a manner that contributes to the students’ learning. Usually, there is little time in the curriculum for frivolous demonstrations. Furthermore, demonstrations done solely for fun detract from subsequent “serious” demonstrations and laboratory sessions. The “fun” should be the process of watching the principle in action.

There is a wealth of evidence showing that students can remember many of their science class demonstrations for countless years. This is a good testimony to the emotional impact of demonstrations. More importantly, students get a lifelong recollection of the concept reinforced by the demonstration. Educational literature is replete with information about effective and unproductive ways to carry out demonstrations. One way to make demonstrations into an effective teaching strategy is by taking a MOS approach.

What is MOS?
MOS, or Minds-On-Science, is the foundation of conducting educationally valuable science demonstrations. It is a teaching strategy equally effective as hands-on-learning. Plus, it proves much more effective at reinforcing abstract science concepts than traditional lectures, readings, and audiovisual presentations. MOS has the following characteristics:

- Focuses on core concepts of science
- Uses existing knowledge to build upon new information
- Facilitates understanding of abstract ideas
- Allows students to formulate scientific thinking processes
- Encourages students to share what they observed with others to assess the universality of their understanding
- Stimulates students to question and answer scientific observations
- Brings in higher-order thinking skills such as analysis and synthesis

Science demonstrations are not more than a dog-and-pony show unless they are integrated with and supported by effective pedagogical theory. Traditional demonstrations take on an authoritarian atmosphere. The instructor generally introduces the concept that then uses the demonstration to tell the students how the principle works. This provides no more information than the lecture and in some cases adds elements of confusion or misconception.

How to do MOS
Adding MOS to a demonstration simply means turning the demonstration into an inquiry activity. However, even with the best-designed demonstration it must not be assumed that students have gained value from the inquiry session unless they are assessed during and after the activity. The following pedagogical questions should be addressed before doing any lecture demonstration:

- Does the demonstration fit at least one principle of the lecture topic?
- Does it demonstrate one variable at a time?
- Does it accurately represent the concept?
- Is it reinforcing an abstract concept that cannot be effectively taught with words?
- Are the concepts being portrayed self-evident from the demonstration, or is it necessary to clarify with explanation?

MOS is easily added to a demonstration by working in the following elements:

- Introduce the topic by simply stating, “We are going to learn the principles of __________ today.”
Then say, “Before discussing how this principle works, let’s look at a demonstration of the principle.”

Start the demonstration, announcing each step to the class. For example, say, “Now I am adding the ______. Next, we shake and add some ______.” Tell students to write what they observed with each step. Do not give away the principles of what is going on!

Prepare them for the conclusion of the demonstration by announcing, “Now watch carefully….” Ask the class to explain what they observed. Check to see if all of the students are on-target with their observations.

Students should then be asked to come up with a hypothesis explaining the mechanisms behind what they observed. They should use their observations and any prior information they may have about the topic. Students should be encouraged to work with a teammate.

Give students some reasonable time to come up with solid hypotheses. Then ask them to briefly explain their hypotheses for the demonstration outcomes.

If time allows, feel free to change any variables and redo the demonstration to support or refute the students’ hypotheses.

It is important at the end to summarize the principles of what was observed.

Keep referring to the demonstration in the lecture that follows. Also, use it as a reference for any student queries.

### General demonstration tips

Demonstrations have more merit when they are done accurately, competently, and safely. Students learn best when the demonstration goes well and reveals the intended principle. It is important that students are focused on the principles of the demonstration and not on any follies or mishaps that might compete with concept retention. Errors are fine as long as the instructor can trouble-shoot with the students what might have gone wrong. The following are general hints for carrying out classroom demonstrations:

- Ensure individual and student safety with any demonstration.
- If possible, keep it simple to prepare and clean up.
- Demonstrate one concept at a time to facilitate student understanding.
- Rehearse the demonstration before carrying it out in front of the class.
- Prepare the class for the topic being demonstrated.
- Describe each step of the demonstration as it is being conducted.
- Confirm students are following the logic of what is being done by asking questions throughout the demonstration.
- After the demonstration have the class analyze what happened using the principles being demonstrated.
- Ask students if they can come up with another type of demonstration that would show the same principles, or see if they can think of any everyday applications of the demonstration.
- Be prepared to test student hypotheses and any variations the class wants to test for challenging the validity of the scientific explanations.

### Conclusion

Demonstrations are most effective when placed into inquiry situations. Scientists as well as educators agree that science is best learned through inquiry and not the rote memorization of facts and concepts. Understanding of abstract scientific concepts is best acquired when students assess, apply, and evaluate what they are observing. The famous futurist writer Alvin Toffler summarized the inherent weakness in traditional science presentation in the following statement, “The illiterate of the twenty-first century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn.” Demonstrations must challenge students to assess their knowledge and critically analyze the strengths and inherent weaknesses of scientific explanations of observed phenomena.

### References


