Are *Lectures* a Thing of the Past?

Tips and Techniques for Success

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This article justifies using the lecture format in college science classes and summarizes 10 research-based ideas lecturers should consider. The article then outlines and discusses the four main components of an effective lecture, using concrete examples from actual college science lectures.

Recently, I was asked to present a lecture on mollusks to a nonmajors zoology class at a large university in Arizona. My task was to talk for 50 minutes to 200 college sophomores about a phylum of animals not commonly found in their local desert environment. I find mollusks fascinating, but could I make them interesting to others?

While preparing my presentation, I reflected on the zoology lectures I attended as part of my own university science coursework. No memories of stellar lectures on snails, slugs, or clams popped into my mind. So, left to my own devices, I prepared the type of mollusk lecture I wish I had received in college. My preparation paid off; the lecture in Arizona was a great success and proved to me that there is a place for lectures in the college environment, provided they are well designed and executed.

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A Timeless Tradition

In the early days of higher education (during the periods of enlightenment in ancient Greece and Rome), extensive printed material was unavailable. The only way an apprentice or student could learn about a topic of interest was to listen to an expert or "lektor." Aristotle and Socrates were notable science lektors, and both had large followings of students anxious to hear about the natural world. This teaching tradition of students gathering around a lektor and answering questions posed by the speaker continued well into the 1400s.

With the invention of the printing press and the end of the Dark Ages, knowledge about all fields, including science, became more accessible and easily disseminated. As a result, many more interested learners could acquire information about a topic without having to interact with an actual orator. Today, students of all ages and ability levels have access to information about virtually any science topic from a seemingly limitless source of print, audio-visual, and electronic media. With access to information literally a keystroke away, many people are questioning the appropriateness and usefulness of traditional college lecture courses.

As we enter the age of online courses and distance learning, the temptation to throw out traditional instructional approaches is growing. However, sometimes a good lecture can be the most effective, timely, and efficient source of information. In addition, electronic or audiovisual media often simply cannot compare with the effect of an engaging, interactive, personalized presentation given by a live human. When de-

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livered properly, there is simply no substitute for a good lecture.

When justifying a lecture, instructors should consider the following:

- Do students absolutely need to know this information?
- Is the lecturer the best resource for this information?
- Is there a limited amount of time available to cover the information?
- Is there a large group of learners?

If the answer to all of these questions is yes, then a lecture, rather than a discussion, lab, or other alternative activity, is probably the most appropriate instructional technique.

Worthwhile Considerations

Presenting an effective lecture is like writing a good drama—you must have a worthwhile story to tell and tell it in an interesting way. If certain information in the textbook is not worthwhile or essential, then don't teach it. And, if you as an expert don't find the information interesting, chances are your students won't either. An effective lecturer needs to connect with learners. Based on research on teacher-directed instructional strategies, I have identified 10 important considerations for science lecturers.

1. Active Student Involvement. Sitting for an hour and taking in new information is difficult, even for the most internally motivated college student. To be most helpful to students, a lecture should not be entirely passive; instead, interactive components must be included, even in a class of 500 or more students. Research has consistently shown that learning is more permanent and meaningful when learners take a more active role in the process (Sojka 1992). As part of a lecture, student involvement can be in the form of brief question-and-answer sessions, review activities, or brainstorming.

2. Relevance. When nonmajor students were interviewed about their past college science experiences, many commented that the topics covered were irrelevant to their personal and/or professional lives (Schamel and Ayres 1992). Most students majoring in nonscience fields such as business, history, foreign language, journalism, or architecture do not see a need to memorize the Kreb's cycle or phases of meiosis. So, when organizing a lecture and deciding what information to present, lecturers should select content that is potentially relevant or useful to learners.

In my lecture, I wanted students to appreciate mollusks' diversity, uniqueness, behavior, and ecological significance in marine and freshwater ecosystems. Traditional zoology textbooks tend to emphasize anatomical structures and functions. To me, however, it seemed more important for students to know that the giant squid is the largest known invertebrate in the world today; bivalves such as clams and oysters are the vacuum cleaners of the sea, absorbing heavy metals, pollutants, and even neurotoxins that can kill or harm people who eat them; octopi can learn and have memories; and 500 million years ago nautiloids were the premier predators of the sea, until the emergence of fishes.

3. Interest. Holding student interest throughout an entire lecture is difficult, even for the most seasoned lecturer. Research indicates that simple motivational techniques—such as using costumes or props to grab student attention; conveying enthusiasm for the topic via voice inflections, gestures, or body movements; sharing vignettes to highlight humorous or unusual dimensions of a topic; or including discrepant event demonstrations to foster curiosity—can lead to significant increases in student interest (Nisbett et al. 1987).

When entering the room for my mollusk lecture, students were greeted by an image of a clam displayed on a large screen. Unlike a textbook drawing, the internal body parts were not color coded or labeled. Instead, students saw only a brownish blob. On the board, I wrote these questions: What is this thing? Is it alive? Is it a plant, animal, alien, or forgotten leftovers from my fridge?

To hold students' interest, I included unique tidbits regarding each organism discussed. College students are fascinated by the reproductive and parental behaviors of organisms and always seem interested in strange trivia. So, for instance, to increase their interest in cephalopods, I described the "party animal" behavior of Pacific squid, which congregate annually in large groups, and, after several bouts of mating and egg laying, all die. I also described the maternal behavior of the female octopus who lays thousands of eggs on the wall of her den and for several weeks does not eat or leave the den, but instead blows water over the eggs, keeps them clean, protects them from predators, and then dies soon after her brood hatches.

4. Expert/Novice Differences. The lecturer is usually an expert, and students are usually novices in the field. As a result, they receive and process information at different rates and in different ways. To make learning meaningful for novices, new information must be linked with previously mastered information; abstract concepts must be linked with more concrete ideas; and presentations should progress from simple facts to more complex generalizations (Rowe 1983). Various strategies can provide this important organizational framework, including advance organizers, concept maps, and lecture outlines.

5. Cognitive Overload. Often, to cover vast amounts of material in a short period of time, lectures are information-dense, leading to cognitive overload of learners. One observable physiological response to cognitive overload is pupil dilation, often referred to as the "glazed expression" instructors often see on their students' faces. Unfortunately, although lots of factual information is transmitted in a fast-paced lecture, learners receive and process only a small fraction of it (Merriam 1988). Interspersing brief reviews within lectures can help students summarize and clarify chunks of related information before moving on to new material.

6. Scientific Jargon. Science can be one of the most difficult subjects to understand because it requires mas-

Figure 1. ***Fact or Fiction? Statements that pique student interest in mollusks.***

1. There are more than 100,000 species of mollusks. (Fact)
2. Giant squid can grow to be more than 80-m long. (Fiction)
3. Some mollusks have no heads. (Fact)
4. All mollusks have at least a partial shell. (Fiction)
5. Most mollusks breathe using gills. (Fact)
6. Scallops can swim. (Fact)
7. Male octopi care for eggs until they hatch. (Fiction)
8. Some mollusks have three hearts. (Fact)
9. Some mollusks have more than 90 tentacles. (Fact)
10. Some mollusks can kill humans. (Fact)
11. Male and female squid die soon after they mate. (Fact)
12. Squid can swim at speeds of up to 100 km per hour. (Fiction)
13. Giant clams can weigh 225 kg. (Fact)

tery of a different language composed of Greek- and Latin-based technical terms (Shamos 1988). Some of these terms, such as *cytokinesis* and *homozygous* are used only in science contexts and are often new to students in introductory science courses; others, such as vacuum and medium, are confusing because they have one meaning in everyday language and a different one in science contexts.

As the famous phrase says, "Language precedes logic." If students cannot comprehend the meanings of words used by a lecturer, they cannot understand the ideas being conveyed. If lecturers want students to comprehend their presentations, scientific jargon should be kept to a minimum. When introducing new technical terms, lecturers should explain the derivation or meanings of words.

During my mollusk lecture, I introduced and explained the derivation of terms essential to understanding the taxonomic classification of mollusks this way: "The term *mollusca* is derived from the Latin word *mollis*, which means soft. Hence, mollusks are invertebrates with soft bodies enclosed in a blanketlike mantle. Although there are seven classes of mollusks, the three main ones are Gastropoda, Bivalva, and Cephalopoda. *Gastro* means stomach, and *poda* means foot; hence, gastropods are stomach-footed mollusks. *Cephalo* means head, so cephalopods are head-footed mollusks. *Valve* means shell, so bivalves are mollusks with two hinged shells."

7. Mental Lapses. When sitting in a lecture hall, students are confronted with various external and internal stimuli. Sometimes these stimuli attract more attention than a lecture presentation; students often experience brief mental lapses and miss information. A good lecturer needs to monitor the audience for mental lapses and be ready to provide additional or alternative explanations of material. If you see that glazed look in your students' eyes and you know they are not getting it, repeating the same thing louder and more slowly will not do the trick.

Good lecturers need to find other ways of explaining potentially confusing material or allow students to have the material explained to them by a peer (Larson 2000). Stopping every 10 minutes or so and allowing students to discuss what was just covered with classmates for 1 or 2 minutes can be an effective tool for helping them recover from mental lapses and obtain missed information. This strategy allows students to promptly clarify areas of misunderstanding or fill in missing notes; it keeps students from becoming hopelessly lost as the lecture progresses.

8. Note-Taking Skills. Although we expect students to be good note takers, many college students did not learn these skills in high school. Without proper guidance, they do not know how to take notes from an oral presentation, identify main ideas, and hierarchically outline and organize notes (Carrier and Titus 1981). Students without these skills are easily frustrated at the pace of many lectures because they try to write down everything a lecturer says. As a result, they are so busy writing, they miss half of what is said.

Using prepared visual aids such as overhead transparencies or PowerPoint presentations to cue students into what is important during a lecture can help eliminate some of these problems. Helping students develop good note-taking skills is essential to their success in college science classes because notes can serve as a form of external memory and help students remember what was covered in a lecture days, weeks, or even months after it is over.

Figure 2. ***Big ideas–core ideas I want students to take away from my lecture about the phylum Mollusca.***

Mollis means "soft."

There are more than 100,000 species of mollusks.

They are mostly marine, slow-moving, bottom-dwellers.

There are seven classes of mollusks.

Most species fit into three major classes:

- Bivalva—meaning "two shells"; these have no head.
- Gastropoda—meaning "stomach-foot"; these are most common.
- Cephalopoda—meaning "head-foot"; these have feet modified into tentacles.

Mollusks have four body parts—the visceral mass, foot, gills, and mantle.

Mollusks reproduce by spawning (bivalves) or contact (gastropods and cephalopods).

9. Confronting Misconceptions. Most students enter college science courses with pre-existing notions about the topics to be covered (Ewing and Mills 1994). Unfortunately, many of these conceptions are inaccurate or incomplete. If the new information is not powerful enough to challenge existing misconceptions, students often memorize the material required for a test but continue to believe the alternative conception that makes the most sense to them. Interviews with college graduates regarding topics such as evolution, the seasons, and photosynthesis show just how powerful personal misconceptions can be.

As an example, most college-level courses focusing on evolution teach that genetic mutations are the driving force behind evolution and reinforce the idea that individual organisms cannot direct their own evolution. Yet, the majority of college graduates completing these courses retains Lamarkian views, believing that giraffes developed long necks because they kept stretching to reach higher leaves on trees. Good lecturers need to be aware of the misconceptions students bring to class and directly confront and address them. In addition, the correct scientific interpretation must be plausible and understandable to students if we expect them to forsake their pet beliefs for our new explanation.

10. Learning Modalities. When learning, we take in information from one of three major sensory channels or learning modalities—visual, auditory, or kinesthetic. Lab components and outdoor field experiences usually provide the kinesthetic and visual components of college science courses, whereas lectures provide the auditory component. Unfortunately, research on learning indicates that few of today's college students are good auditory learners (Lawson, Rissing, and Faeth 1990). Instead, most students need some visual or kinesthetic stimulus to accompany the information they hear.

We live in a highly visual society, and a good lecturer needs to take advantage of demonstrations, videos, overhead transparencies, or other visual aids to make lectures more concrete and understandable. Many science textbook packages include full-color transparencies for use during lectures. Some text companies even sell videodisks containing thousands of images to accompany their textbooks. Visual aids such as a photograph of a bioluminescent nudibranch, a video-clip of an octopus caring for her clutch of eggs, or an actual giant clam shell on top of a podium can bring a mollusk lecture to life.

Lecture Components

Generally, an effective lecture consists of four main components:

Opening Statement

A lecture opening needs to accomplish two goals—gain the attention and interest of the class and provide an advance organizer to help students develop a mental framework for processing the material. I recommend three types of advance organizers for science lectures—rhetorical, expository, and comparative.

Rhetorical advance organizers pose a series of questions that cue students into the important topics to be covered. For instance, to introduce a lecture on blood and its components, the following questions could be posed: What types of cells are found in blood? What are the relative amounts of each type of cell? What are the functions of each type of blood cell? Where are the different types of blood cells produced in the body? How long does each type of blood cell live? What kinds of diseases/disorders affect each type of blood cell?

To make lectures more interactive, I use a modified version of statements to introduce my lectures. Each student keeps an index card with the word "Fact" on one side and "Fiction" on the other. To open my lecture, I present a series of statements regarding the day's lecture topic and ask each student to hold up a card indicating whether they think the statement is fact or fiction (Figure 1, page 455). These statements cue students into the important ideas I cover during lecture, and student responses help me quickly identify persistent misconceptions regarding the topic.

For example, because of movies such as *20,000 Leagues Under the Sea*, most college students believe giant squid are fast-swimming (statement 12), huge, killer behemoths close to 100-m long (statement 2); in fact, their maximum length is about 18 m and their maximum swimming speed is about 35 km per hour. I also use this opener to highlight unusual, interesting, or relevant dimensions of the topic and capture student interest. For example, most college students are not aware of the deadly toxins in the needlelike radulas of cone shells and do not realize they have actually stabbed and killed humans who have attempted to pick them up (statement 10).

Expository advance organizers are simple descriptions that relate the current topic to previously covered ideas. When introducing a lecture on spiders, a short description of the similarities and differences between spiders and insects can be presented. For instance, I say: "Today we're going to talk about insect relatives that also have jointed feet and an exoskeleton, but have major differences. Whereas insects have three major body parts, arachnids only have two; insects have six legs, and arachnids have eight; unlike the class Insecta, which contains herbivores, carnivores, and omnivores, all spiders are carnivorous and venomous; and whereas most insects have wings, I have never seen flying spiders, have you?"

Comparative advance organizers help students link potentially unfamiliar, complex, or abstract content with familiar, simple, or concrete concepts. To introduce a lecture on the cell and its organelles, I present a short description comparing cells and their organelles to a city and its components. Perimeter highways with toll booths surrounding the city can be compared to the selectively permeable cell membrane, and two-lane roads in the town can be compared to the endoplasmic reticulum; the nucleus can be compared to a decision-making body like city hall; mitochondria are analogous to power plants and substations; contractile vacuoles are similar to reservoirs of water treatment systems; and food vacuoles are similar to grocery stores. Examining these comparisons helps students see that major functions essential to a city's survival also are essential at the cellular level.

Body of the Lecture

This is the heart of the presentation. Content presented in the body needs to be carefully selected and sequenced. Alternative descriptions of key points are helpful, as is extensive use of examples, anecdotes, and illustrative materials such as graphs, pictures, or film clips. Pacing of the presentation of the lecture body is also important. Repetition of important points, redundancy of key ideas, and short periods of silence that allow students to catch up are all important pacing tools. Allowing students to ask relevant questions can also help pace a lecture.

Summaries Within Presentations

Given what we know about the limitations of short-term memory, a good lecturer should stop after presenting every three to five bits of new information and summarize or chunk these related bits for students. Chunking activities such as review questions or even simple summary statements can help students see the relationships between important points, thus making it easier for them to store the information in their long-term memories and, hopefully, retrieve it later. During my lectures, I summarize within my presentation using a "Big Ideas" sheet (Figure 2, page 455). "If you remember nothing else, remember this..." is my usual mantra for the Big Ideas sheet.

Wrap Up

Before dismissing students, lecturers should close with a culminating activity to review or highlight major points, link the lecture with previous or future learning, or pose a problem and actively involve students in discussion and application of the lecture information. Concluding remarks can help students see science's tentative nature and perhaps raise additional questions scientists have not been able to answer regarding a particular topic.

I always allow a minimum of 5 to 7 minutes to wrap up lectures. I use this time to revisit the introductory Fact or Fiction sheet and make sure students have clarified their misconceptions; I often review by having students play a simple version of Trivial Pursuit. I conclude my mollusk lecture with a game of Malacologist Trivial Pursuit (Figure 3). I divide the lecture hall down the middle aisle and alternately ask a student from each side to answer one of the questions. No extra-credit points or other tangible rewards are involved, but students enjoy the gamelike atmosphere.

Figure 3. ***Malacologist Trivial Pursuit.***

Sometimes I play this game at the end of a lecture to sum up the main points.

1. What does mollusk mean?
2. What are the four main body parts of a mollusk?
3. What is the largest invertebrate in the world?
4. What are the three main classes of mollusks?
5. What kinds of mollusks are called "butterflies of the sea"?
6. What class of mollusks contains filter feeders?
7. What mollusk was the premier predator of the sea before fish appeared?
8. What is the radula used for?
9. What is the most common class of mollusks?
10. Which class of mollusks has an operculum?

Parting Thoughts

Many of the arguments posed by opponents of college lectures have merit. Students are bored, can learn the same information by buying course lecture notes or reading the text, or can watch videotapes of a lecture at their leisure instead of attending a class at a particular time and place. At times, I myself have agreed with the move to eliminate college science lecture courses, but after researching the area more thoroughly, I am convinced of their continued importance. ■

References

Carrier, C.A., and A. Titus. 1981. Effects of notetaking pretraining and test mode expectations on learning from lectures. *American Educational Research Journal* 18(4): 385–397.

Ewing, M.S., and T.J. Mills. 1994. Water literacy in college freshmen: Could a cognitive imagery strategy improve understanding? *Journal of Environmental Education* 25(4): 36–40.

Larson, B.E. 2000. Classroom discussion: A method of instruction and a curriculum outcome. *Teaching and Teacher Education* 16(5–6): 661–667.

Lawson, A.E., S.W. Rissing, and S.H. Faeth. 1990. An inquiry approach to nonmajors biology: A big picture, active approach for long-term learning. *Journal of College Science Teaching* 19(6):340–346.

Merriam, R.W. 1988. A function in trouble: Undergraduate science teaching in research universities. *Journal of College Science Teaching* 18(2):102–106.

Nisbett, R.E., G.T. Fong, D.R. Lehman, and P.W. Cheng. 1987. Teaching reasoning. *Science* 238(4827):625–631.

Rowe, M.B. 1983. Getting chemistry off the killer course list. *Journal of Chemical Education* 60(11): 354–356.

Schamel, D., and M.P. Ayres. 1992. The minds-on approach: Student creativity and personal involvement in the undergraduate science laboratory. *Journal of College Science Teaching* 21(4):226–229.

Shamos, M. 1988. The lesson every child need not learn. *The Sciences* 28(4):14–20.

Sojka, F.A. 1992. The need for hands-on science. *Journal of College Science Teaching* 22(11):4–5.