Lab-Based Learning

What is Lab-Based learning?

Laboratories are wonderful settings for teaching and learning science. They provide students with opportunities to think about, discuss, and solve real problems.

Writing about laboratory teaching at the college level, McKEACHIE said:

Laboratory teaching assumes that first-hand experience in observation and manipulation of the materials of science is superior to other methods of developing understanding and appreciation. Laboratory training is also frequently used to develop skills necessary for more advanced study or research.

Why use Lab-Based Learning?

Since late in the 19th century, science educators have believed that the laboratory is an important means of instruction in science. Laboratory instruction was considered essential because it provided training in observation, supplied detailed information, and aroused pupils' interest.

Science labs can be among the richest experiences students have at the university. It is one of the few opportunities students will have to practice science in a similar way that professionals do. In order for labs to be effective, students need to understand not only how to do the experiment, but why the experiment is worth doing, and what purpose it serves for improving students' understanding a concept, relationship, or process.

Shulman and Tamir, in the Second Handbook of Research on Teaching (Travers, ed., 1973), listed five types of objectives that may be achieved through the use of the laboratory in science classes:

1. **Skills** - manipulative, inquiry, investigative, organizational, communicative
2. **Concepts** - for example, hypothesis, theoretical model, taxonomic category
3. **Cognitive abilities** - critical thinking, problem solving, application, analysis, synthesis
4. **Understanding of the nature of science**- scientific enterprise, scientists and how they work, existence of a multiplicity of scientific methods, interrelationships between science and technology and among the various disciplines of science
5. **Attitudes** - for example, curiosity, interest, risk taking, objectivity, precision, confidence, perseverance, satisfaction, responsibility, consensus, collaboration, and liking science (1973, p.1119).

Lab-Based Teaching Strategies

Developing and teaching an effective laboratory requires as much skill, creativity, and hard work as proposing and executing a first-rate research project.

Think About the Goals.

Before you begin to develop a laboratory program, it is important to think about its goals. Here are a number of possibilities:

- Develop intuition and deepen understanding of concepts.
- Apply concepts learned in class to new situations.
- Experience basic phenomena.
- Develop critical, quantitative thinking.
- Develop experimental and data analysis skills.
- Learn to use scientific apparatus.
- Learn to estimate statistical errors and recognize systematic errors.
- Develop reporting skills (written and oral).

Preparing Lab Sections

The most important thing you can do to ensure that your lab sections run smoothly is to be well prepared. Your preparation, prior to the start of the semester, should include being acquainted with the storeroom of the lab so that time won't be lost during a lab looking for necessary equipment or materials, and if applicable, knowing the location of the first aid kit, basic first aid rules, and procedures for getting emergency assistance.

What Makes for Great Lab Instructor?

Not only an awareness of the basics of presenting, but also a greater understanding of how group work fits within a larger context.

- Good lab instructors are both great teachers AND great managers. They get their students to understand the importance of the day's activities by first clearly explaining the significance of the activity.
- Good Lab instructors are always seeking to make experiments and practical problems relevant. In fact some of the best lab instructors turn their experiments into practical problem solving exercises.
- Good lab instructors spend time early in the semester preparing their students to work in groups. They assign them to work within specified roles, to use one another to reach solutions, to in effect "jigsaw" results by using different lab groups to provide different pieces of the solution "puzzle."
- Good instructors offer just enough help, forcing students to solve problems on their own. Finally, great lab instructors have eyes in the back of their head and are always alert for potential problems. They ALWAYS address safety issues before turning students loose on experiments.
- Good lab instructors provide specific clear instructions are more useful than vague "remember what I said last week".

Asking and Answering Questions

Asking questions

Establishing contact with students as they work involves learn names and using them in conversations with students. Asking questions means you can watch out for students who look like they're coping well but are really putting on a show. You will discover your own best way to interrupt, but here are some **suggested questions:**

- You seem to be getting on well?
- Where have you got to? Are you stuck?
- This looks good. What are you going to do next?
- Why do you think that happened?
- Have you finished? What are you going to do next?
- What sort of thing did you take notes on?
- Have you thought about how you will write up this project/experiment?
- What have you got out of today? Has it been worthwhile?
- Other people have said such-and-such. Do you agree?
- How do you think this fits in with the rest of the course?

Answering questions

No matter how long you teach or how thoroughly you prepare, there will always be questions that take you by surprise or you don't know the answer right then. Remain calm, honest, and try one of these approaches for responding:

- **The student can be encouraged to find out the answer (especially when it is their responsibility).** Where do you think you could go to find an answer to that question? Hey, you're smart enough to find out an answer to that. Have you looked in that book or tried this?
- **You can go and find the answer.** Can I think about that and come back to you?
- **You and the student can explore together.** Why don't you try looking in that book and I'll try this one.

Managing Laboratory Sections

Labs are sometimes offered in conjunction with large lecture courses so that students may acquire technical skills and apply concepts and theories presented in lecture. Labs, however, are often "stand-alone" classes with no connection to a parent course. Even where they are related to another course, they often have their own agenda that may not be related to the lecture. This hands-on experience encourages students to develop a spirit of inquiry and allows them to live for a semester as practicing scientists. It may sound trite, but you really do have an opportunity to help students develop some appreciation of the mysterious scientific method.

Evaluating What You’ve Done.

As the lab section draws to a close, you'll want to assess your success as well as that of your students in the lab. As in most situations, evaluations can be conducted both formally and informally.