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TEACHING INTRODUCTORY LABORATORY COURSES

Suggestions for Graduate Teaching Assistants Instructing College-Level, Introductory, Laboratory Classes

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> *"The intuitive mind is a sacred gift and the rational mind is a faithful servant. We have created a society that honors the servant and has forgotten the gift."*
> *--Albert Einstein*

A laboratory class is a superb setting in which to teach and learn science. Students are given opportunities to think, discuss, and address real world problems. Learning during a laboratory period is often accomplished through personal discovery, group discussion, and interaction with the instructor. A laboratory experience models how scientific knowledge is constructed and how new knowledge is related to what is already known.

It is difficult to learn to do science, or to learn about science, without participating in science. The purpose of this document is to offer ways to make laboratory classes an enjoyable and successful setting in which to pursue scientific inquiry and enhance scientific understanding. The following suggestions, thoughts, and ideas are intended to guide you in this pursuit.

I. Preparations

A. *Pre-Lab (things to consider before the lab even begins)*
1. Speak with the professor of the class to clarify goals for the lab course.
2. Ensure that lab exercises coincide with or complement lecture material.
3. Make sure you're able to clarify the links between lab and lecture material.
4. Assign pre-lab activities, such as reading material and pre-lab questions, prior to class.
5. Complete the lab in advance and anticipate questions students will ask.
6. Make any necessary handouts.

B. Pre-Lab Talk (possible material that can be included in your mini-lecture)
1. Prepare a pre-lab talk approximately fifteen minutes in length to introduce the lab activities.
   a) Provide information necessary for students to conduct the lab, using both oratory and visual cues to make your points.
      (1) Introduce new methods and terminology.
      (2) Write key terms on the board and illustrate your points with graphs, drawings, or other visual examples to help a greater number of students "see" the information.
      (3) Introduce and demonstrate how to use new equipment or how to do a new type of analysis or calculation.
   b) Review relevant background material.
   c) Reveal interesting historical or current "real world" aspects of the experiment.
      (1) Anecdotes may increase student motivation by adding new perspective to their tasks.
      (2) Applications make the material seem more relevant and "real" for students.
   d) Discuss the purpose, hypotheses, methods, and potential results of the lab activity.
   e) Thoroughly discuss all safety precautions and concerns.
2. Outline all expectations for the lab write-up.
   a) Explain briefly what type of information the different sections of the lab report should contain.
   b) Clarify your grading scheme beforehand to help students identify the critical parts of the lab.

3. Allow students to take an active role in explaining the lab material.
    a) Let a team of students demonstrate the experiment (or set up the materials) for their peers.
    b) Ask a student team to assist with instruction during the lab. Rotate this responsibility for each lab assignment. Note: This will help students think through materials they will need for an experiment, and students will gain confidence and insight by teaching their peers.
    c) Ask students to work in pairs, rotating the different responsibilities each week.

C. Lab Write-Ups (ways to get students to take lab write-ups seriously)

1. Explain to the students why writing a lab report is important. For example,
    a) Writing is a critical tool for understanding and sharing ideas and helps identify gaps in understanding.
    b) The report helps place the lab activity into the "big picture."
    c) Lab write-ups are an ideal place to practice skills honed in writing classes.
2. Utilize the lab write-ups to help improve the students' science though thoughtful grading comments.

II. During Lab

A. Lab Work (suggestions to keep the lab rolling)

1. Students should be able to complete the lab within the allotted time period.
    a) Inform students approximately how long each task requires so they can pace themselves.
    b) Make an announcement as to when students should start cleaning up.
2. Have students document their work in a lab notebook, rather than on loose sheets of paper.
3. Make sure lab handouts or worksheets are properly completed.
4. Check that observations are reasonable and conclusions are based on the data.
5. Encourage students to work in pairs or small groups.
    a) Encourage each group member to take an active role in the activity.
    b) Encourage equal participation from both men and women and minorities.
6. Circulate throughout the classroom.
    a) Check with students to see how the lab is going.
    b) Ask questions that help you ascertain whether students understand the lab material.
    c) If results from the lab exercise are not as expected, encourage speculation on reasons for the deviations.

B. Follow-Up Discussion (how to wrap up the lab period)

1. Encourage students to share their discoveries with the class.
2. Summarize, synthesize and generalize.
3. Some experiments lend themselves to tabulating results, or performing statistical analyses. In these cases, consider discussing the following questions:
    a) What experimental observations differed among groups?
    b) How do student observations relate to scientific theory?
    c) What theories apply and how were those theories developed (history)?
    d) How do theories apply to lecture material and to real life?
    e) How would such a discovery affect other systems?
4. Students often appreciate an enhanced understanding of lecture material.
    a) Wrap-up discussions during the last fifteen to twenty minutes of class aid understanding; encourage the students to make the connections to lecture.
    b) Discuss and review how the lab activity (and its results) fit into the "big picture."

III. After Lab

A. Grading Lab Reports (suggestions for providing constructive, formative feedback)

1. Ensure that your grading scheme is consistent with course policy.

2. Determine whether students understood the lab.
    a) Assess whether many students missed a critical concept.
    b) Evaluate whether students drew reasonable conclusions from the data they collected.
    c) Reward creative and rational but unconventional thought in application of principles.
3. Read, evaluate and return lab reports in a timely manner with cogent feedback.
    a) Help students improve by telling them how they could have done better.
    b) Focus comments in specific areas rather than on the report as a whole.

B. *Getting Feedback (possible ways to determine your effectiveness as a teacher)*
1. Request constructive feedback on your performance as an instructor.
    a) Gather mid-semester feedback by requesting a Teaching Analysis Poll or videotaping from the Teaching Resource Center (http://trc.virginia.edu).
    b) Take a brief survey to provide feedback on global reactions to the course.
    c) Collect your own feedback by preparing and distributing a mid-semester questionnaire.
2. Evaluate student opinions on the clarity of your presentations.
3. Address student suggestions.
4. Determine one or two changes you'll make next time to improve as an instructor.