Thinking on Your Feet: Teaching Lab Classes Well (Materials Adapted from 2014 Laboratory TA Session)

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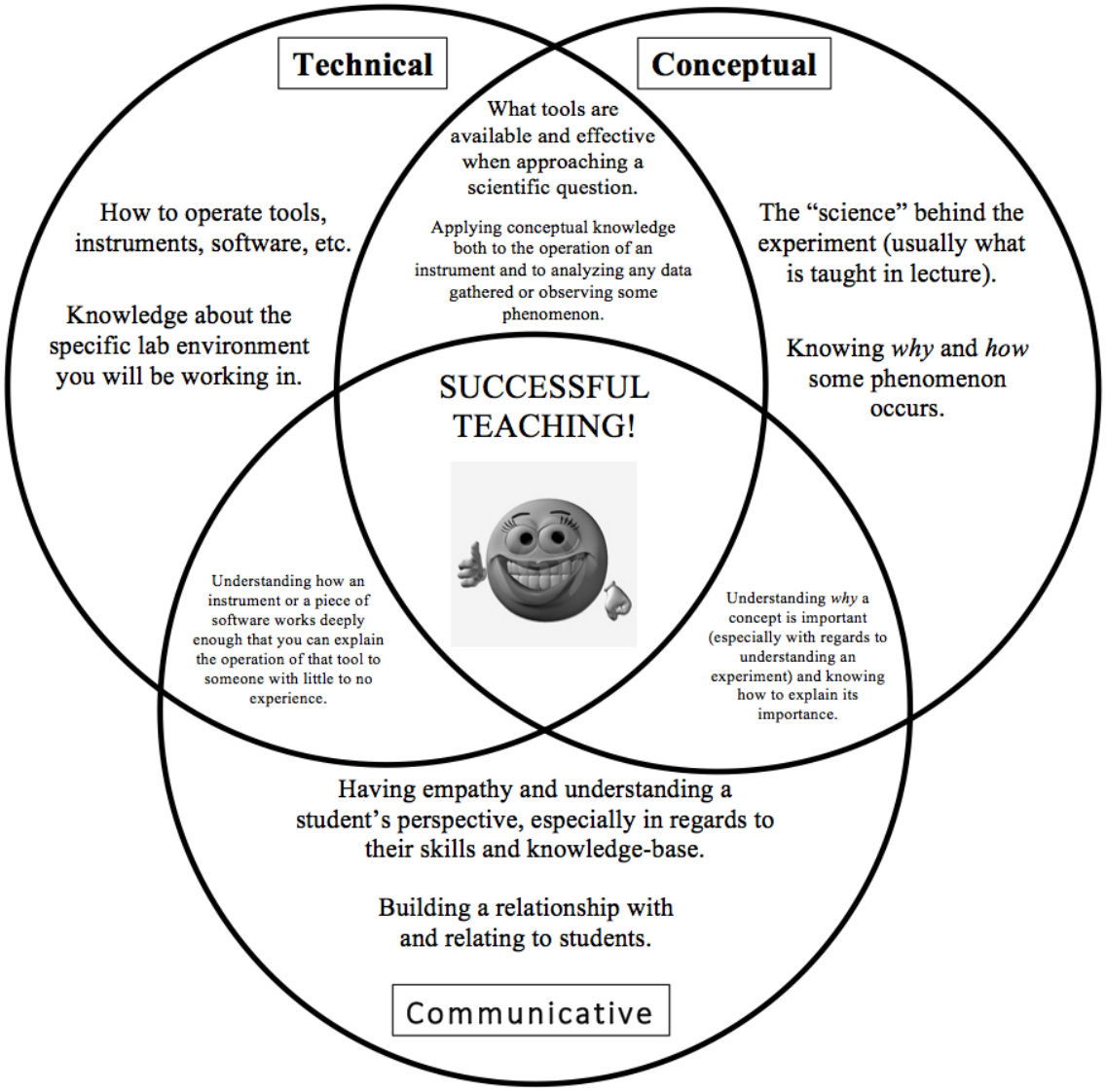
This session will focus on advice for incoming laboratory TAs. The biggest problem typically encountered by graduate students in this setting is the ability to juggle mastery of the material you are teaching with the uncertainty of the questions and problems students will have. We will use specific examples from our experiences as TAs for an inorganic chemistry laboratory to provide helpful tips on how to handle the various duties assigned to a laboratory TA. Warning: Witty banter will be used throughout the talk!

Specific examples from our teaching experience will be used to guide discussion on common problems experienced by lab TAs and ways to solve them. A worksheet of thought-provoking questions that students will answer in small groups and then discuss as a whole will be provided.

Types of Knowledge Necessary for the Student and for You as a TA:



How to Grade Effectively in a Laboratory Course:

Grading is a crucial aspect of laboratory courses and provides a means for assessing a student's understanding of the purpose and technical knowledge that should result from performing an experiment. It is imperative that you methodically and holistically grade a student's work, and the more feedback you provide, the more a student will grow and learn from their mistakes and successes. It is critical that you communicate with the instructor of the course about what aspects of the students' work should be weighted most heavily. Additionally, by having a standardized rubric that assigns grades

based on specific metrics, you will avoid clashing with your students on ambiguous grading and allow yourself more time to focus on the commentary you provide each student on their work. Students devote a lot of time to lab reports and lab notebooks, so acknowledging their effort through feedback encourages them to feel validated and fairly assessed. Below are some of the most common metrics used for grading lab material and an analysis of each metric's contribution to the overall quality of a report or notebook.

Grading Lab Notebooks:

A. Is the lab notebook neat?
    1. Does the student organize their ideas, pre-lab, data, and other materials in a logical and concise manner?
    2. Is their writing and organizational style legible?

B. Has the student completed experiments according to the lab manual?
    1. Did the student obtain and complete every section of the experiment?
    2. Were proper procedure and safety instructions followed?

C. Were appropriate details recorded?
    1. Are all pieces of data recorded?
    2. Are all observations recorded and written in a thoughtful manner?

D. Is the experiment described in the notebook reproducible?
    1. Could you take their notebook and perform the experiment without referring to the lab manual?

Grading Lab Reports:

A. Abstract
    1. Does the student give relevant values with error (if required) obtained during the experiment?
    2. Does the student emphasize one or two important conclusions from the experiment?
    3. In other words, could you read this paragraph and determine the main ideas behind the experiment?

B. Introduction
    1. Does the student discuss important, previous work in the field?
    2. Does the student give relevant background theory that relates to the reason the experiment is being performed?

C. Experimental
    1. Is the procedure followed for the experiment concise and sequential?
    2. Does the student use specific values obtained during their carrying out of the procedure?

D. Data Analysis
    1. Has the data been worked up correctly?

2. Does the student use theory, approximations, and equations appropriately to analyze the raw data obtained in the experiment?

E. Discussion of Results
   1. Is the theory used to correctly and thoughtfully describe the results of the experiment?
   2. EVEN if their results are incorrect, do they discuss why their results are wrong and how they could perform the experiment to improve the data they have obtained?

F. Conclusion
   1. Does the student recapitulate the most important take-aways from the experiment?
   2. Does the student discuss future directions or other "next steps" that could be taken based on their conclusions?

G. Formatting
   1. Is proper formatting used based on guidelines given in the class?
   2. It is IMPERATIVE that you or the instructor emphasize the weighting assigned to formatting.
   3. The expectations for formatting need to be clearly explained, ideally with a sample report that follows the required format.
      1. Do figures have appropriately labeled legends, captions, units, and axes?
      2. Did the student give citations to work that is not their own?
      3. Is the information presented in appropriate sections?
   4. Do the grammar, syntax, mechanics, paragraph structure, and transitions of the report contain minimal errors?

Common Responsibilities of a Laboratory TA:

Office Hours:

- Prepare for office hours by knowing what kind of data analysis is expected from the students and HOW to explain the process of going from raw data to the final plot.
- Explain the components of each lab report and what information is required in each section (Be clear about expectations).
- Explain the theory and how it applies to the lab and the data obtained.
- Explain comments and critiques you have given on graded assignments if asked (be explicit about the existence of a well-defined rubric that delineates the points deducted and the weighting of each section).

Grading:

- Grade lab notebooks and lab reports.
- Provide criteria for the general formatting and relevant information for their lab notebooks.
- Develop rubrics for the grading of notebooks and reports.
- Ensure that the grading criteria is consistent with the instructor's expectations, and ensure that all TAs are on the same page about report grading and criteria.

Lab Section:

- Prepare for experiments by performing the experiments independently prior to teaching your students. Know where all necessary materials are to minimize time wasted for students during the lab period.
- Model proper lab behavior by following proper safety practice and proper handling of equipment, chemicals, etc.
- Model unfamiliar techniques, and observe students while carrying out techniques for the first time to correct improper procedure.
- Inform students of the common problems encountered by students in the lab and how to avoid them.
- Keep students on track by consistently reminding them of the time remaining for each lab period.

General Support:

- YOU were once an undergraduate. Remember the TAs who made the biggest impact on your education to remind yourself of the influence you have over a student's learning in the lab!
- Be there as a mentor, but remember to assert your experience in the field with humility.
- Do not be afraid to acknowledge when you are unsure of something. Students would rather know the right answer in time than be told false information on the spot. You are not expected to know EVERYTHING. Consult the instructor!

Online Resources for Further Information on Teaching as a Graduate Student (taken from the 2014 Laboratory TA Session):

Caltech Center for Teaching, Learning, and Outreach
https://teachlearn.caltech.edu/

Carl Wieman Science Education Initiative
http://www.cwsei.ubc.ca/

University of Michigan Center for Research on Teaching and Learning
http://crlt.umich.edu/gsis/gsi_guide

Stanford Teaching Commons
https://teachingcommons.stanford.edu/grad-support/grad-teaching-development/facilitating-labs

Teaching Perspective from Dennis C. Jacobs, Current Provost, Vice President of Academic Affairs, and Professor Chemistry at Santa Clara University
http://news.nd.edu/news/3797-a-professor-at-notre-dame-sparks-a-quiet-revolution-in-how-chemistry-is-taught/