Selected Online Resources for Teaching

Resources at Columbia

Dr. Mowshowitz's faculty web site has links to lots of teaching & learning information. There are links to a manual on explaining scientific concepts, a manual for TAs, the ‘How To Collection’ and info on the Brown Bag on Science Teaching (BBST). Go to

http://biology.columbia.edu/people/mowshowitz

The ‘How To Collection’ contains multiple items, including the explaining and TA manuals, tips on grading, guide lines for reading papers, etc. You can go directly to the ‘How To Collection’ at:

http://www.columbia.edu/cu/biology/faculty/mowshowitz/howto_guide/menu.html

A video of a workshop on how to run a discussion section in a science class is at FOS online http://frontiersofsci.org/ (Search for 'Mowshowitz'.)

The Center for Teaching and Learning (CTL) has many services to help train teachers. They are at

http://ctl.columbia.edu/faculty/

There is a lot of info on how to use electronic resources such as Canvas at the CTL knowledge base.
There are tip sheets on many aspects of teaching from the old GSAS teaching center (the now defunct predecessor of CTL). The page with the links to the tip sheets is at http://www.columbia.edu/cu/tat/pdfs/ . For the pdfs, scroll to the bottom of the page.

Other General Teaching Resources

The Idea Center site (which originated at KSU) has many short 'idea' papers on all aspects of teaching, such as how to run groups, and lots of other resources. The list of available ‘idea papers’ is at
http://www.ideaedu.org/Research/IDEA-Paper-Series

The Vanderbilt Center for Teaching has lots of good information. The teaching guides on all aspects of teaching are at http://cft.vanderbilt.edu/teaching-guides/ This includes a guide on teaching first year students.

The Derek Bok Center for Teaching and Learning at Harvard also has a lot of info. (I think a lot of the Vanderbilt materials are from Harvard, but some are different). The teaching resources are at

https://bokcenter.harvard.edu/resources

Felder's Teaching Page. This is a wonderful web page with hints on how to teach from an expert teacher (Felder). He has written a lot, so there's a lot to read here, but you can easily search for your favorite topic.

http://www4.ncsu.edu/unity/lockers/users/f/felder/public/

Other University Teaching Centers. Many other Universities (Stanford, Cornell, NYU, & Brown just to name a few) have teaching centers with copious online information. Some of these centers only advertise the services for their faculty, but some have lots of good tip sheets. Many of the teaching centers borrow from each other, so the sites above cover a lot of the important issues, tips, and techniques. A good additional one is

University of Washington Center for Teaching & Learning
http://www.washington.edu/teaching/teaching-resources/preparing-to-teach

The National Teaching & Learning Forum. This group has a newsletter you have to subscribe to, and it is now part of the Wiley Online Library. You can reach the NTFL web site from this link: http://www.ntlf.com/ I think you can get access to the newsletter and the Wiley online library through the Columbia Libraries.

All links checked 6/20/17. Please feel free to contact me if you find any broken links, or have any questions about these resources, or about teaching in general.
Deborah Mowshowitz
dbm2@columbia.edu

Selected Print Resources for Teaching

All these books are available from Amazon, and presumably, from other sources as well. They are listed in approximately my order of preference.

1. Teaching Science: A Guide for College & Professional School Instructors by Barbara Gastel. Oryx Press, 1991. This book is out of print, but you can get a used copy through Amazon, and the book is a gas. It has hysterical cartoons and is an easy read. It is aimed more at Medical School instructors than at teachers of undergrads, but most of the material is equally useful to undergrad instructors. The book doesn't deal with computer technology, but it is great on everything else. It is written with a light touch, but it is dead serious, and extremely helpful.

2. McKeachie's Teaching Tips: Strategies, Research, and Theory for College and University Teachers by Marilla Svinicki & Wilbert J. McKeachie. Cengage, 2010. (This is the 13th edition; any edition is okay.) Written by a psychology prof, but hits almost all the issues any college instructor will run across. Easier to read than Uno (#3), but not as focused on biology.

A typical review (lots more on Amazon – after all, this is the 13th edition!): The President wants to make college more accessible to all Americans, but to make post-secondary education more effective, he ought to first put this book in every university instructor's hands. Higher education in America is a multi-billion dollar business taught by professional researchers who often are amateur teachers. University professors, college instructors, and teaching assistants have (or are getting) Ph.D’s in their areas of expertise, but few are trained to be teachers; they know linguistics, but often know nothing about how to teach linguistics. They have Ph.D’s in chemistry, but have little understanding of how to create the "chemistry" of a good class. They are experts in political science, but are often ignorant of campus politics. This book is meant to be a one-volume guide for the new professor, the first-year teaching assistant, or the old hand who wants a new perspective. Thirty-four short chapters tackle every subject and problem from "Teaching Large Classes" to "Teaching in the Age of Electronic Information," from "Organizing Effective Discussions" to "How to Win Friends and Influence Custodians." These chapters are pithy, often tantalizing and sometimes too brief, but each has a short list of references and the volume as a whole has a very good bibliography.
This is a book that everyone who teaches college should own. It is a manual, a "cookbook," a list of suggestions. It does not have a single agenda nor does it push a particular method. Don't look to this book for long-winded obscure discussions of theories of cognition, methodology or extensive research notes. It is not the last word in pedagogy, but it probably should be the first.
ISBN-10: 0495809292
ISBN-13: 978-0495809296

3. Handbook on Teaching Undergraduate Science Courses: A Survival Training Manual by Gordon Uno. 1st ed. 1999 (Saunders College Publishing); 2nd ed. 2002 (Brooks/Cole). By a biology professor. A little harder to read than McKeachie, but focuses more on biology, and covers everything a biology instructor needs. For first edition:

- **ISBN-10:** 0030259266
- **ISBN-13:** 978-0030259265

(review on the other side)

Handbook on Teaching Undergraduate Science Courses: A Survival Training Manual by Gordon Uno.

A review from Amazon: I read Dr. Uno's book prior to beginning my first semester teaching undergraduate biology at a small, liberal arts college. The content is well organized and includes pragmatic as well as philosophical/theoretical information, with particular emphasis on the former. It includes advice on planning the course, understanding how students learn, teaching practice (with an excellent treatment of inquiry), assessment, lecture and discussion strategies, and dealing with common problems.

The book is especially credible not only because it is written by a college teacher who understands the difference between "teaching material" and "student learning" (and one who writes clearly and unpretentiously) but because it grows out of case studies centered around the real experiences of six new faculty members. Every new faculty member will see himself/herself in one of the situations described and connect the practical suggestions to real-classroom situations. For those unable to read the book from cover to cover due to time limitations (probably many readers), the simple organization facilitates rapid identification of items of immediate interest. This really is a survival manual. It is helping me to anticipate and make sense of a frantic, stressful, and exciting first year of full-time teaching. I would recommend this book to anyone interested in teaching college science.

4. Scientific Teaching by Handelsman, Miller & Pfund. 2007. New York: W. H. Freeman,.
ISBN-10: 1-4292-0188-6
ISBN-13: 978-1-4292-0188-9
This book is an attempt to summarize the education literature in a form that scientists will find readable and useful. It is pretty dense, but clear, and includes teaching materials for workshops on 'scientific teaching.' The scenarios for the workshops are gems – both accurate and hilarious.

Review: This book has a great mix of the theoretical and practical for new (or not so new) instructors. This book provides easy to understand summaries of several key areas of educational research. It provides great real-life examples of what NOT to do as a new teacher, and practical usable advice on what to do. It even has a section on how to train others to use educational best practices. Best of all it’s short and to the point! I have read quite a few books on education theory and I would rate this at the top. *(See Amazon for all 8 reviews – 6/8 are 5 stars. Remaining 2 are 4 stars.)*

5. Tools for Teaching by B. G. Davis, 2nd ed. 2009. (1st ed. is good too.) This book is very comprehensive and covers teaching issues from virtually every angle. It considers more aspects of teaching than any of the others. You may find it overwhelming, or you may find it very useful.

Reviews: (1) The book by Davis is more of an encyclopedia. It is a reference manual for teachers, and includes an exhaustive list of anything you ever wanted to know about teaching a class. However, the coverage of each topic is extremely brief, and typically limited to a small paragraph of 3-4 sentences. It is a very good guide, but outside reading would be required to fully answer questions many new teachers may have.*

(2) This volume gives a plethora of teaching pointers that cover everything you can think about as you prepare for and practice teaching. I am impressed at how comprehensive it is. It is a good volume to own.
ISBN-10: 0787965677
ISBN-13: 978-0787965679

** The book includes extensive references if you want more details.*

Ideas on Teaching Science to Undergraduates – 6/17.

1. Stress how science is done. That is, how we know, how we did it, famous experiments etc. Not just results or facts. Process is more important than the end result.

2. Require thinking, problems, etc. Not just memorization. (Allow them to bring a study sheet to each exam.)

3. It takes longer than you think to get a "robust" understanding of basic scientific ideas, such as evolution, central dogma, etc. (You can't explain the tip of the iceberg without setting up the berg first.)

4. Context is very important. Why is this important? Who cares about this, and why?? How does it relate to societal concerns, daily news, etc.

5. Historical development is important because of (1) human interest aspect, (2) students are often historians, etc., (3) ontogeny recapitulates phylogeny = how it was worked out is often most logical way to explain it, as it seems to mimic the way the human brain works. What was asked first historically is often what students ask first, and (4) the historical approach often makes current terminology and way of thinking clearer.

6. Using recent articles (from newspapers, periodicals, or online sites) seems to help provide interest. Therefore sticking *only* to historical issues has its limitations. The more connections you can make between what you are teaching and current articles (& issues), the better. Once you know what you want to talk about, you can almost always find something in a current article that connects. (How does the discovery of this new drug relate to protein structure, or receptors, or drug design, or evolution/selection, or epidemiology, etc.) Nobel prizes and obituaries are good openings. For biotech, the business section of the *Times* is a gold mine.

7. Too organized is boring; too scattered is confusing. A middle path makes for a more interesting class. You must be prepared, but come to class with a list of topics, not a rigid lesson plan.

8. Start where *they* are -- with something the students find interesting. Not with the most fundamental thing like chemistry or math. You will need to cover fundamental but difficult stuff eventually, but students get scared off if you do it too soon. They will do it (if grudgingly) once the need is really clear. So first make them feel the need for it, and then provide the nitty gritty details. In general, try to provide details only in response to need -- to a question from them or you.

9. Terminology. Don't use unnecessary terms, but when a term is useful, give real definitions (and use real terms) so they can look it up if they are confused. (Say ‘chromosome’ or ‘chromatid’, not ‘thingy.’)

10. To follow is not the same as to understand. So you should do everything twice or 3X – explain it once, maybe chew it around a bit, and then let the students try a Q or problem for themselves. The 3^{rd} step is NOT redundant. It sometimes works very well to have them do the problem right there on the spot (in pairs or small groups). Alternatively, try homework. (A short hand version: 'I do, we do, you do.')

11. Being interested and excited about the subject you teach is more important than what the exact topic is. Generally, if you are excited about a topic, the students will be too. Excitement isn’t always catching, but boredom certainly is. So if you are bored…. Therefore, talking a lot about your area of interest is ok if you don’t overdo it. Try not to get into the fine points too much, and always relate it to the ‘official topic’ of that section of the course. Remember that the stress should be on how science is done, not on any particular area.

12. Being excited is necessary, but not sufficient. Professional training conditions you to see things as an expert, and distances you from seeing things as your students see them. It takes practice to learn how to communicate your expertise and excitement to an undergrad or any non-expert. See the manual on ‘Teaching Scientific Concepts & Problem Solving’ for some tips to help bridge the communications gap. The manual is part of the ‘How To Collection’ at http://www.columbia.edu/cu/biology/faculty/mowshowitz/howto_guide/menu.html which includes a TA manual, as well as guides to grading, lecturing, explaining, reading the literature, etc.

10 PRINCIPLES TO ENHANCE STUDENT LEARNING = Mintz's 10 Commandments

CONNECT
Build rapport with your students. Students who feel connected to you are much more willing to devote time and energy to your class.

ENGAGE
Arouse student interest in your class' topics. Remember: There is no learning without engagement. Begin your class with a bang: A provocative quotation or statistic, an anecdote, a paradox, a problem, a news story. Then trigger engagement throughout your session with audio-visual materials including art works or film clips, or with simulations.

FOCUS
Formulate clear objectives for each class session and present your students with a well-organized agenda. Students crave clarity, substance, and organization.

VARY
Present information in multiple ways. Your pedagogical approach might include lectures, discussions, visuals, problem solving, short readings, and other activities.

INCLUDE
Involve all students in classroom activities. Effective methods for encouraging participation include brainstorming, small group work, debates, surveys, and role playing exercises.

INVOLVE
Foster active participation. After all, students learn most when they are actively engaged in inquiry, rather than passive recipients of information.

You can get students involved in various ways, such as case studies and activities emphasizing inquiry and problem solving. Asking questions is another way to engage students, but note that there are effective and ineffective ways to ask questions.

Avoid "guess what I'm thinking" questions, in which you have an answer in mind. Also avoid rhetorical questions (Does anyone have any questions?) and questions with yes or no answers. Rather than relying on questions that emphasize recall, use questions that involve higher order thinking:
- Prediction: What will happen next?
- Justification: What evidence led you to conclude that…?
- Rationale: What is the reason…?
- Generalization: What can you generalize…?

SHARE
To give students ownership of the course material, share your grading rubrics and your learning strategies and tips with them.

ALIGN
Align your assignments and exams with your learning objectives.

ASSESS
Monitor student learning throughout the semester and adapt your teaching based on your findings.

REFLECT
Encourage students to reflect on their own reasoning.

For New Teachers 6/17 – What I learned from Observing New Teachers

During the last few years I observed 5 new teachers. All shared some of the same strengths and weakness. I think they all unintentionally illustrated what inexperienced teachers do. (Many researchers, or others who are very pressed for time, do the same.) They concentrate on what to cover. Which is important, but it isn't everything. They don't put enough time into thinking about HOW they will present the material or how they will know that the students have got it. This is what 'scientific teaching' is about – how to get it across, and how to know when you've done it. For how to get it across, most researchers think there is nothing to this part, or they don't have time to do it, or no one knows how to do it, or you can't teach anyone how, or only educationists waste time on this nonsense, etc. Whatever their excuse, they don't put much time into planning how they will teach. They spend all their time deciding what to teach, or what 'it' is. They may spend a lot of time preparing lectures, but most of that time is spent on finding the right information, or the right slide/picture, etc. In class they don't spend enough time explaining why this is so important, or why they chose it, or what it means, or how to avoid the common misconceptions, etc. They think if they show it, they are done.

As for assessment of whether the students have got it, most instructors just assume that if they've 'covered it' the students have 'got it.' (Which is false, but they only discover this, to their chagrin, when they give exams, and by then it's too late, and so they just blame the students for being lazy, stupid, not knowing how to study, etc.)

An experienced teacher, who is trying to avoid the Morrison effect (full notebooks & empty heads), thinks about how to get it across, and/or adjusts his or her lecture to be sure it gets across. Some think about how to get it across more in advance; some do it more on the fly. But all constantly monitor the class as they go, and consider the issues listed below. (To put it another way, an experienced teacher understands the meaning of 'explain.') Watching the novice teachers, I can see what they DON'T do, and that makes it much clearer what a teacher SHOULD do. What you should do (or aim for) is -- in no particular order:

1. Go through the steps in a complex process carefully, avoiding shortcuts.*

2. Identify common misconceptions and explain them. (You need to explain why this mistake is common, why it is wrong, and why the right idea is right.)

3. Figure out what the students do not understand and clarify it. (It is necessary to do this repeatedly throughout the lecture, not just once.)

4. Make connections, & point out general principles when doing examples. Go back and forth from the big picture to details and mechanism.

5. Use new material to review old material (without seeming to simply repeat yourself).

6. Handle student responses well. Repeat student questions (& answers). You don't have to repeat the entire comment, but say enough so other students (who couldn't hear the student speaker) can make sense of your response. Speak to the whole class, not just to the student who spoke. (See #7.) Before you answer a question, probe or think for a bit to be sure you understand what the problem is. (What is the real question or issue?)

7. Involve as many students as possible in answering questions, thinking, etc. Try to switch students from passive to active mode as much as possible. (Allowing student talk or problem solving in small groups or pairs, or working through a problem carefully as a class, all help with this.) Don't let a few students do all the talking.

8. Plan in advance what you are going to do but be flexible. Don't plan out everything so carefully in advance that you end up reciting it, reading it, or sticking to it rigidly no matter what. Too organized and rigid is boring. (A common problem with PP.) Don't over-plan or treat the class like a job interview or talk at a scientific conference where every move is carefully thought out and practiced before hand. This does NOT mean you do not need to prepare.

* I think this usually works better 'live' with chalk or overheads, drawing as you go, but it can be done with a PP slide if the instructor walks through the slide carefully. Providing handouts or printouts for students to annotate makes it much easier for them to follow and take notes. Many new teachers & new PhD's are much more comfortable with PP than chalk. Therefore they find it easier to build off of a PP slide, as in a seminar, than to draw from scratch with chalk. Also many classrooms are not set up for optimal use of both chalk and PP. I think many instructors start out using PP and gradually switch to chalk or markers.

Learning Objectives (or Outcomes):
Promoting learning and designing effective lectures

From Hilary J. Schmidt, Ph.D.; edited by D. Mowshowitz 2017

Learning objectives or outcomes are statements of specific tasks or behaviors that students should be able to perform after participating in a lecture, course of study, or set of learning activities. Well-framed learning outcomes help a lecturer identify an approach to organizing a lecture, selecting examples, demonstrations, and visual aids. (Objectives/outcomes can be included in syllabus materials to help students focus their learning and organize the material, but they are very useful even if the students never see them.)

Compare the two sets of objectives/outcomes for the same lecture on Protein Structure below:

Example 1

Protein Structure: Students should know about the following topics:

1. Amino Acids
2. Polypeptides primary structure
3. Non-covalent forces in protein structure
4. Secondary and supersecondary structure
5. Tertiary Structure
6. Domains
7. Quaternary structure
8. Cysteine and cystine
9. Role of disulfide bonds in protein structure
10. Polypeptide folding

Example 2

Protein Structure: Students should be able to:

- Recognize and draw the 20 basic amino acids that comprise the building blocks of mammalian proteins
- Classify amino acids based on the charge and polarity of their side chains
- Apply the Henderson-Hasselbach equation to predict ionic forms of amino-acids
- Explain acid/base properties of amino acids in physiologic solutions. Interpret and explain titration curves for a variety of amino acids.
- Explain how amino-acids combine to form polypeptide chains.
- Describe the structural properties of the four organizational levels of protein structure (primary, secondary, tertiary, quaternary,) and the bonding types associated with each level. Explain the relationship amongst the four levels.

Most students and faculty agree that the learning objectives in Example 2 (right hand box) are more useful than those in Example 1 (left hand box). Example 1 is merely a list of topics to be covered, while Example 2 highlights important aspects of protein structure, and point the learner to concrete steps in approaching learning. They serve to guide learner's thinking, reading, & study activities. The lecture that would correspond to the learning objectives in Example 2 is much easier to imagine and design, and the focus and question types for student assessment follow naturally from the list of desired outcomes.

Learning objectives are **NOT** statements of topics to be covered (as in Example 1), **NOT** statements of learning activities, and **NOT** statements about the teaching methods. *AVOID the WORDS 'appreciate', 'understand', 'know'* – replace these words with statements about what you will ask the learner to do to demonstrate knowledge or understanding – what outcome will you expect?

KEY WORDS: The following key words highlight some "verbs" that are useful in framing learning objectives/outcomes for knowledge, understanding and critical thinking:

Knowledge: Define, repeat, list, record, identify, recall, name, describe, diagram, draw

Understanding: Restate, discuss, explain, report, review, teach.

Analysis: distinguish, analyze, differentiate, compare, contrast, calculate, predict, criticize, debate, solve, examine.

Application: translate, interpret, apply, use, illustrate, employ, dramatize, predict, makes inferences appropriately, recognize new instances.

Synthesis: compose, plan, propose, design, formulate, arrange, assemble, prepare, construct, create, set up, organize, arrange.

Evaluation: estimate, measure, assess, rate, revise, critique.

References: Wolfe, RM Educational Objectives. Chapter in: Evaluation and Education: foundations of competency assessment and program review. (3 ed) Praeger, 1990