Advice for New Faculty Teaching Undergraduate Science

Sarah L. Keller*
Department of Chemistry, University of Washington, Seattle, WA 98195-1700; *slkeller@chem.washington.edu

Andri L. Smith
Department of Chemistry, Quinnipiac University, Hamden, CT 06518-1949

This article is a product of the experience gained in our first years of teaching undergraduate chemistry at the university level. We have written it to pass our advice on to our colleagues who are now accepting teaching positions and will soon be facing the same hurdles.

A short description of our backgrounds is in order. For our undergraduate degrees we both attended private universities in which research was emphasized. As teaching assistants in graduate school, we led tutorials and labs, but did not lecture per se. We have each been in our faculty positions for about five years, and we teach both lecture and lab courses.

There are differences in our teaching experiences. A.L.S. teaches first-year chemistry (a survey course in general, organic, and biochemistry) to approximately 30 students, a separate course in organic chemistry to 40 students, and the corresponding laboratory courses. Her university is known primarily for undergraduate teaching; increasing emphasis is being put on research. Her department does not grant graduate degrees in chemistry, and resources are not currently available to support teaching assistants. Before attending graduate school, A.L.S. was a teaching intern in science at a college-preparatory school. While in graduate school she participated in a one-semester seminar on community-college teaching. After graduate school she had a teaching postdoctoral fellowship at a liberal arts college; in a second postdoctoral position she developed chemical education materials.

S.L.K. currently teaches a senior-level physical chemistry course for 80 biochemistry majors, honors first-year chemistry to 50 students, a physical chemistry lab, and a graduate seminar course. Her university is a large state school with a chemistry department known for its research and its graduate program, which supports approximately one teaching assistant for every 80 students in undergraduate lecture courses, and one teaching assistant for every 20 students in laboratory courses. S.L.K.'s two postdoctoral positions had no teaching component. Her formal post-graduate pedagogical training has been in the form of a short course given by the university. She has received a Cottrell Teacher–Scholar Award, and a Department of Chemistry Outstanding Teaching Award.

For both of us, the primary hurdle in the first year was learning how to deliver effective undergraduate teaching within our time constraints. Menges et al. report that a "crucial variable related to new [faculty] welfare is time management" *(1).* As aptly summarized by Norbert Pienta, "chemists… in academic settings… must consider how to wisely use the time dedicated to teaching" *(2).* A serious source of stress and concern among professors is time pressure *(1, 3–5).* According to a survey by Boice, faculty reflect on their first year as "the busiest, most stressful year of their lives" *(6).* This resonates with our own experiences, and as new faculty members we were disappointed to learn that we could not always find the time to provide our students with the individual attention and extensive homework grading that we valued in our own undergraduate careers. As universities face increasing budget constraints and class sizes become larger *(3),* our experiences will become more widespread. Many of the following hints represent compromises that we would rather not have to make, yet they result in better overall teaching under time constraints.

The comments below are relevant to the general structure of a standard undergraduate lecture course and do not address the important issues of how to actually teach well (e.g., how to choose class material or lecture well). As described in *Survival Handbook for the New Chemistry Instructor (7),* there are many resources available for new faculty to hone their pedagogical skills, including books *(8–17),* and journals such as *Journal of Chemical Education (18), Journal of College Science Teaching (19, 20), Journal of Research in Science Teaching (21), Research in Science and Technological Education (22),* and *Chemical Engineering Education (23).*

Rather, our intent is to help new professors conserve time in the administrative tasks of teaching so that they can devote more attention to refining their teaching methods and course content. Bunce and Muzzi note "the time spent on organizing your course may free you to spend the majority of your time with students dealing with the chemistry concepts" *(7).* Similarly, Boice notes that a majority of new faculty do not participate in faculty development programs because they feel too busy *(6);* in other words, they are too busy teaching to improve their teaching.

The suggestions compiled below originated from print sources, from our own experiences, from suggestions of the anonymous reviewers of this article, and from a variety of colleagues in a range of teaching situations. Lastly, we do not claim to have fully succeeded in implementing all of our own advice, even if we recognize its validity.

What Will You Teach?

Repeat Courses

Preparing a new course can consume a great deal of energy. By teaching the same course again you can amortize your effort over time *(24, 25).* You might volunteer to cover an introductory course taught every term. Doing so can present a situation in which everybody "wins": You benefit from reduced preparation time in subsequent years, your future students benefit from your experience in teaching the course, and your department benefits from having a dedicated faculty member instructing introductory students on a regular basis. Perhaps you can teach more than one section of the same class in one term *(25).* Also, within your startup package you may be able to negotiate a commitment in writing to teach the same course several times in a row. However, such a commitment may be terminated if it places undue constraints on the department chair.

Keep in mind that many departments offer a lighter teaching load in the first year *(26)*. You may have flexibility about which academic term you choose to be your lightest.

Introductory Graduate and Special Topics Courses

If you need to attract graduate students to your research group, teach an introductory graduate course that will allow you to identify promising students.

The opportunity to teach a special topics course is often offered as a favor to new faculty, even though the department may benefit more if you teach a course in the standard curriculum *(2)*. First, ascertain if teaching a special course is being offered simply out of good will, without a strong departmental need. Next, evaluate if you need the course to train your own research students or if it will be relatively easy to teach (a new course, particularly one that is new to your department, can be a tremendous amount of work). Based on this, you might approach your department about either changing assignments or delaying your special topics course. Furthermore, in most departments, the opportunity to teach a special topics course is rare and will not arise again for many years. In order to amortize your effort, the course should be so good that students demand that it be offered in following years.

Conserving Your Time outside the Classroom

Office Hours

Encourage students to come to your office during your regular office hours, or those of teaching assistants *(24)*. Schedule one of your office hours directly before or after your lecture. You will already be thinking about the material and will answer questions better. In addition, the rest of your day will not be fragmented. Students who cannot attend office hours can be encouraged to make an appointment. Students who appear at your door and cannot be immediately served can be gently told that you are using your time outside of office hours to perform tasks (e.g., preparing for another class, writing a grant, working on research, performing university service) that will improve the quality of their education. Undergraduates have little conception of the requirements on professors outside of class contact hours. Students should understand that you would like to help them but you would prefer to give them your undivided attention during office hours or during a scheduled appointment. If you decide to immediately attend to a student who appears at your door, you can ask them to use office hours in the future *(24)*.

When you need uninterrupted time to prepare course materials, choose a place away from your office *(25, 27)*. Students may be less upset if they cannot find a professor than they would be if you are in your office without time to talk *(24)*.

Study Sessions

Schedule optional study sessions so students can work on homework together. Learning in small groups can enhance achievement and student attitudes *(28)*. Students who have previously been frustrated by their competitive pre-med peers particularly appreciate this collaboration. If you or a teaching assistant attend these sessions (perhaps as an office hour), let the students know you will arrive late by as much as half an hour and they should use this time to work. The primary advantage of this is that students will ask each other the easy questions first. When students tutor or work in cooperative learning teams, all members of the group learn more and come to respect their classmates *(29)*. Second, it encourages students to work on their own without waiting to be fed answers. Study sessions work best in a room with large tables rather than an auditorium lecture hall. When you arrive at the study sessions, talk to small groups of students rather than addressing the class from the front. It is useful to explain a concept to a small group of students, and then announce to everyone that this group now understands the concept and can explain it to other groups.

Online Threaded Discussions and E-mail Responses

Many universities host Web sites at which one student can ask a question and another student can comment on that topic. If students have not used such a site previously, they can be motivated by receiving extra credit. Rewarding participation as a fraction of the grade rather than as extra credit has not been successful for us. When the Web site is used well, students will answer each other's questions. Refer questions that come by e-mail to the Web site where either you or other students can provide an answer for the entire class to view. If you do not have a Web site, but are lucky enough to have a teaching assistant, forward questions that you do not have time to answer to that person *(30)*. This will help to decrease your student e-mail load while still serving the students. The University of Washington uses Web site discussion software called Epost (*http://catalyst.washington.edu/tools/* [accessed Nov 2005]). Other course management programs are discussed below. Although instituting online discussions can ideally decrease your load, there are caveats. The site needs to be monitored occasionally so that incorrect answers are not propagated, but not monitored so often that it becomes a time sink.

Turn off your computer's audible notification of new e-mail messages *(30)*. When teaching large classes, establish a separate e-mail account to keep the potentially large volume of course e-mail messages distinct from the rest of your correspondence. Use free Yahoo or Hotmail accounts if necessary. Keep text files of common responses that can be copied and e-mailed back to students. For example, you can keep text that explains course procedures and protocols *(2)*, how student questions should be redirected to the discussion Web site, what you require for a letter of recommendation, or what to do when a class is missed. If you cannot respond promptly to e-mail, students will accept a reply of "I will think about it and respond later" *(31)*.

Letters of Recommendation, Paperwork, and Publishers

Letters consume a large amount of time. Decide beforehand what your policy will be and inform students how to comply. Remind students to fill out all forms, to paperclip all forms to appropriate envelopes, and to give you addressed, stamped envelopes. Retain copies of letters to modify when students ask for additional letters in the future.

Reserve time: relegate paperwork to a certain time of the day. Paperwork is infinite and can expand to fill all available time.

Publishers often respond to requests for free copies of textbooks and CD-ROMs that you use in your classes, or

are considering adopting. Including overhead images from the CD-ROM in your lecture helps save preparation time, and providing students with handouts containing these images (properly referenced, of course) allows students to have important graphs and figures while you are lecturing.

Service Commitments

While committee work is a necessary aspect of promotion and good citizenship, be selective about the number and time commitments of committees you join, which will range from the departmental level, through college or university level, up to the national level *(27, 30)*. Ask your tenure committee what minimum service is required, and if additional service will significantly improve your tenure decision. If you have the luxury to choose your committee assignments, select one or two that you feel are important, for which your hard work will produce satisfying results for both you and your department.

Creating an Effective Syllabus

A well-crafted syllabus can put your course on the right track from the beginning. Seek out advice and examples. In particular, see the excellent outline and example of a syllabus in the *Survival Handbook for the New Chemistry Instructor (32).* These are the essential elements to include on your course syllabus:

- Logistics. Contact information, course meeting times and place, exam dates, required textbooks and supplies, prerequisites, tutoring services, and course policies (grading, attendance, makeup exams, plagiarism, and cheating).
- Expectations for Class Behavior. Give notice of how you will react if students arrive late or leave early, when they read newspapers in class, or when a cell phone rings.
- Tentative Schedule. Many students treat a syllabus almost as a legal document. If you are not absolutely sure of something (e.g., an exam date), use the syllabus to notify students that it is not guaranteed *(24).*
- Course Policies. Present a hard line on all rules and put them in writing. Implementing penalties for late or missed assignments or exams prepares students for "real-world tradeoffs they will have to face on the job" *(33).* Think about your course policies before the start of the semester, so you can fall back on them when questions arise. If you wish, you can make exceptions in person later, and students will indeed ask for those exceptions. Your colleagues will have experienced many of the situations you will face, so ask them for copies of their old syllabi *(34),* and implement the policies that make most sense to you.

Using a Course Web Site

Creating a Web site can be a large investment in time *(4),* so keep your course Web site simple: a bare-bones site will do. When students ask questions, you can refer them to information posted on the site. This decreases the number of obvious questions. These are the most critical items to include:

- Course syllabus, with handouts and course assignments
- Exam dates (including any study or review sessions)
- Announcements, especially if dates change

Course Management Software

Many universities have an office of instructional technology or support course management software that enables easy publication of Web sites.

Some course management software allows students to complete computer-graded quizzes or homework online. Popular tools are Blackboard, WebCT, WebAssign, and OWL *(35–38).* Students appreciate being able to do these assignments on their own time. In addition, Web sites can be set up so that students can take quizzes over until they earn full credit. This allows students to realize weaknesses in their understanding before taking a formal exam. These resources are not always available for upper-level courses, and the learning curve for administering online grading systems can be steep. Moreover, checking for errors in test banks can be time consuming, and modifying content can be difficult *(32).* Therefore, these systems are best used when you plan to teach the same course repeatedly.

Assigning and Grading Homework

Before assigning homework, review the assignments and your policies. Students who are not prepared for the course learn less well and need more help. This can be ameliorated by covering prerequisite material in a short self-test assigned as homework the first day (Figure 1). All students benefit from the review. Cautioned that the material on the self-test will

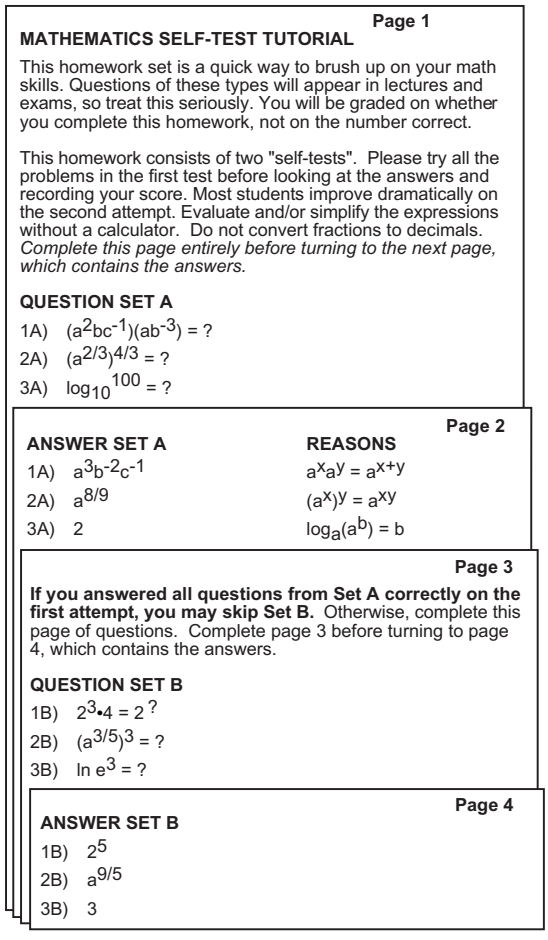

Figure 1. Sample mathematics self-test tutorial.

be needed for the course, unprepared students are motivated to seek tutoring or to enroll in any missing prerequisite courses.

Solve all homework problems before you assign them to avoid questions that cannot be solved or are at an inappropriate level for the course *(24)*.

Grading Homework

When homework is not machine or Web-graded, or when you do not have extensive time or teaching assistant support, one option is to grade only one homework question, chosen at random *(24)*. Regrades are not allowed on homework, except in cases of egregious error. Table 1 provides a sample breakdown to include in a syllabus (note that the extra point for neatness helps you or the teaching assistant to grade more efficiently).

Table 1. Sample Homework Grading Rubric

Component	Point Value	Component Characteristics
Effort	12	Have you done the homework in a thoughtful manner?*
Content	6	One randomly chosen homework problem will be graded for content.
Neatness	1	Are the questions all in order? Are the answers and the question numbers boxed or highlighted? This point is easy to get.
Challenge	1	This point is harder to get. Once you are done with a question, you should reflect upon what your answer means. Numbers are meaningless without context.

*Copying the answer is plagiarism, not a "thoughtful answer".

SAMPLE EXAM COVER SHEET

Name _____

This exam consists of eleven (11) pages, with six (6) questions, worth 100 points total. Point values are summarized on page 2. A periodic table is appended at the end.

Before you start:
- Verify that you have all 11 pages and the table.
- Write your name in the space above.
- Note the grading policy on multiple choice questions.

At the conclusion of the exam:
- Sign the integrity statement below.
- Turn in all pages and the table.

Integrity statement:
I have neither given nor received aid on this exam.

_____
Your signature

GRADE SHEET

Question 1 _____ **/ 24 points**
Question 2 _____ **/ 10 points**
Question 3 _____ **/ 10 points**
Question 4 _____ **/ 24 points**
Question 5 _____ **/ 12 points**
Question 6 _____ **/ 20 points**
TOTAL _____ **/ 100 points**

Figure 2. Sample exam cover sheet and grade sheet.

Students should collect their graded homework in a place physically apart from your office, even if it is just down the hall, to reduce fragmentation of your day.

Creating and Grading Exams

Allow students to make their own card or page of equations to bring to the final exam. This helps students review and reduces their anxiety. As a bonus, students are impressed by your generosity. If you would like to limit the content on note cards to equations or structures, require students to turn in their note cards with their exams. Another option is to provide students with a list of relevant equations and definitions on the exam, and let students know they are responsible for knowing how to apply this information to problems. Student stress decreases if this list of equations is made available well before the exam.

Ask students to write an exam question as homework. Innovations for implementing this are available *(33)*. Sometimes a student produces a clever, well-written question that can be used after the student graduates. This also demonstrates to students how difficult it is to write a good question.

Types of Questions and Responses

Include a few multiple-choice questions in your exam to simplify grading. Practice in answering multiple choice questions benefits students—particularly those who will later take multiple-choice board or graduate entrance exams. Writing excellent multiple-choice problems is difficult. Many textbooks are accompanied by test banks that include a variety of questions, including multiple choice. The ACS Examinations Institute also offers exams *(39)*. Several authors endorse including problems that test relationships *(33)* or concepts because many students can solve algorithmic questions without being able to solve corresponding conceptual problems *(40, 41)*. Helpful resources for writing thoughtful conceptual questions are available *(42, 43)*. Similarly, pitfalls in writing multiple choice exams are covered by Eubanks *(44)*. Some teachers mitigate the use of multiple-choice or true-false questions by awarding partial credit, including pictorial questions, providing "answer baskets" of all possible answers on the entire exam, asking students to identify the only true or false statement in a set of statements, grouping statements thematically, requiring corrections of false statements, phrasing questions as narrative completions, or by allowing either justifications, exam reworks, or challenges to a question *(33)*.

To simplify grading of essays and word problems, break down questions into multiple parts of increasing complexity, where the first part of the question is straightforward and calls for factual information (e.g., recalling a formula or defining a term), and the second part requires applying the knowledge of the first part to a new problem. One approach in essay questions is to limit student answers to one sentence. This forces students to write clear and concise answers, and also simplifies grading.

Formatting the Exam

Exam grading can be made significantly easier by formatting the document well. For each question, make an "answer box" in which students must place their answers, so you do not have to search the page. As Figure 2 shows, create a summary score sheet on the second page of the exam listing the

points available. This keeps you from having to draw a new one as you grade every exam, and notifies students of which questions are more valuable. Placing the score sheet on the second page (or on the back of the cover page) rather than on the front of the exam is helpful for two reasons. First, it may help convince students that you do, in fact, grade fairly and "blindly", without viewing student names *(33)*. Second, it enhances student privacy; when exams are returned, only the students' names—not their grades—are visible for other students to see. Figure 2 also provides some useful information for exam cover sheets, including a sample integrity statement.

Exam Grading Rubrics

Try to grade exam problems holistically (e.g., decide whether a given answer is 80% or 50% correct) *(32)*. This will help you quickly decide how many points should be deducted. Exam grading can also be made easier by creating a grading rubric that records how many points are deducted for specific mistakes *(32)*. This saves the time of hunting through a stack of exams to verify that the same grade was given for the same mistake. Also, it ensures uniformity when there is more than one grader. If possible, divide grading assignments so that only one grader is responsible for each question, and all grading of one problem is completed before moving on to the next.

Grading Policies for Exams

Your department may already have policies for regrades, makeup exams, and final exams. If not, require written requests for regrades to be due within one week *(24)*. Set a low regrade limit, at maximum 5% of the overall exam score. Students must dispute the minimum number of points in order for a regrade to be considered. This is particularly useful in classes with a heavy pre-med contingent, in which students will argue vociferously for an inconsequential grade change.

To deter frivolous excuses and requests, consider requests for makeup exams on an individual basis rather than advertising a policy of administering makeup exams *(32)*.

Final Exams

Although students should be allowed to view their exams in your office, do not return the final exam to the students. This allows you to reuse questions. Moreover, if you implement a new teaching method, you can directly compare the performance of two groups of students on identical exams.

Students' Involvement in Writing Assignments

Peer-Reviewed Writing

If your course has a writing component, assign students to review each other's draft papers as in a peer-reviewed journal. The reviewer writes a formal letter to the author (using guidelines that you provide), then the author makes corrections and turns in the final paper (along with the draft and review) to you. This iterative process not only improves the quality of student writing but also eliminates your need to grade rough drafts. Furthermore, it discourages plagiarism because students write their papers in stages. Plagiarism often occurs when a student panics at the last minute. Students are graded both on their final papers and on the quality of their reviews. If students have very weak writing skills and will be unable to provide useful peer reviews, a similar process can be used on just the introduction section of a longer paper. Students write anonymous assessments of what they think the main point of the paper will be, and whether the introduction makes them want to read further. Another approach is to require students to have their rough drafts reviewed by a writing tutor, if such a resource is available. Writing tutors can help with grammar, documentation, organization, and flow of the paper. This results in a higher caliber of writing and allows you to focus more on content when grading the final drafts.

Peer Evaluation of Lab Reports

If your course requires lab reports, consider a "read around" strategy *(32)*. Early in the term, students submit simple, short reports with their names on cover sheets. The cover sheets are removed, the reports coded, and randomly distributed in class. Students quickly read a fraction of the reports, and choose the best one, giving two positive reasons. After all fractions are evaluated, the groups discuss the best papers, listing the report codes and reasons on the board. Students quickly arrive at a consensus of what makes a good lab report, using only positive comments. Report quality increases, grading becomes easier, and students are sympathetic to the instructor's plight of grading many reports in little time.

Enlisting Aid from Others

Help Your Teaching Assistant Help You

At larger universities, faculty are highly dependent upon teaching assistants (TAs). It is helpful to compile a simple document with policies and guidelines for teaching assistants in your course. For example, you may want to advise a TA to grade holistically, or to use discussion sections for group work. TA training advice is available *(24, 45–46)*. Have your teaching assistants keep track of the hours spent. Once your TAs have started working, query them if there is something simple you can do to help them. (See the sections on exams and homework.) If they work more efficiently, they can help you with more tasks such as offering advice on your exams, helping you write exam problems *(30)*, or covering more office hours, which may also help them to become better teachers. Nominate excellent teaching assistants for awards. They will return the favor by asking to work with you again.

Staff, Colleagues, and Mentors

Think about whether you underutilize the assistants or staff there to help you. Seek out colleagues and mentors. Your teaching colleagues are often happy to share class notes, syllabi, and exam questions. Establishing a teaching and research mentor is important *(47, 48)*.

Conclusions

University teaching can be a tremendously rewarding experience if a healthy balance can be achieved among teaching, other university commitments, and life outside the university. Strategies to conserve time and effort include:

- Teaching courses repeatedly
- Bundling tasks (paperwork, lecture preparation, phone calls, e-mail, etc.) into blocks to keep focused and save time

- Keeping files of responses to common questions and recommendation letters to help avoid "reinventing the wheel"
- Clearly stating and documenting course policies to provide a guide when dealing with infractions
- Using an assessment rubric to simplify the grading process
- Making full use of university resources to save time and to fit other commitments into your schedule

We have found these principles help us save time in performing the administrative tasks associated with teaching and also allow us to spend more time refining our teaching techniques and helping students learn the material.

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