

The Classroom

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Teaching & Learning in Large Classes

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LARGE classes. It is a phrase that calls for the use of capital letters – the size and the impact are inherent in the words. This issue of *The Classroom* is devoted to the topic of teaching LARGE classes. Included are articles that contain strategies, the TA viewpoint, and the student perspective.

What exactly is a LARGE class? The answer is “it depends.” For some instructors, anything over a seminar of a dozen students is large. Others don’t call a class large until it’s a lecture hall of 300 students. It depends on the mode of instruction and the topic being taught; it depends on the support available and other resources like teaching assistants, graders, and technology; and it depends on the facilities available – moving to a well-designed lecture hall from a long, narrow and flat “bowling alley” classroom can turn the same group of students from a class that feels too large to one that is fine. For the sake of this article, I will say that a class is LARGE when simple tasks become overwhelming. Included in this set of simple tasks are handing out papers, collecting papers, learning names, and grading exams. When the instructor dreads the thought of doing one of these types of tasks, then in my opinion the class has become LARGE.

This summer, CETL invited all faculty on campus who had taught a class of at least 100 students to join a group entitled the Over-100 Club. [If you fall into this category but were not invited, please contact our office to be included. We apologize for any oversight.] During our first meeting, the instructors shared the challenges and opportunities that they find arise from teaching a LARGE class. In this column, I share just two of the challenges from that discussion. It is important to realize that, by the very fact that a class is LARGE, there will be inherent challenges. Rather than allowing these challenges to intimidate or paralyze, it helps to view them as opening the door to new and creative techniques and approaches.

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Perhaps it's obvious, but be aware that LARGE classes affect both the instructor and the students, and they do this in almost a symmetric manner. Looking at the problem from a different viewpoint can help lead to a solution.

Attendance and Participation

Instructors often complain about low attendance and participation in LARGE classes. On the other hand, students often complain that they feel anonymous in these classes and that they are intimidated against speaking out. They fear appearing either too stupid in front of the professor or appearing too smart in front of their peers. A LARGE class magnifies the competitive feel of our campus and students do not want to give out too much information to an anonymous LARGE group of peers. These are two sides of the same issue – the challenge for the instructor is to find a way to turn the LARGE class into a community and to make the anonymity disappear. Doing so, the students will be more likely to participate, as it is much safer to interact with neighbors than it is to interact with strangers. Further, as the class becomes a friendly environment, more students will choose to attend because there are consequences to being absent from a community while no one misses someone they don't know. Later in this newsletter, Melissa Bachman tells about the use of technology to assist with the participation in large lecture classes; Professor Catrambone discusses techniques of asking questions in large classes; and in

his interview, Professor McClellan discusses a different approach to attacking this problem with faculty-led small recitation sections.

Assessing Student Learning

A problem that arises once a class becomes LARGE is the difficulty in finding out whether or not the students are learning the material. It is just too time-consuming for one person to grade that many open-ended questions. Meanwhile, students recognize that they are unlikely to be challenged to prove that they have learned the critical thinking skills associated with the topic being taught and so do not necessarily press themselves to delve deeply into their studying. All too often, what is seen as important is what has been measured rather than the converse. In his article, Sheldon Gen, a teaching assistant, gives faculty some ideas on how to use the extra labor of a TA to help do a better job assessing student work.

In the rush and grind of the academic year, it is often left up to the individual faculty member to figure out the best way to teach the group of students that are enrolled for a course during any particular term. The more that we can learn from others on campus about different things that work, about the resources needed to make them work, as well as what to avoid doing, the more efficiently we can do our job of teaching the students of Georgia Tech. If you have found an approach or technique that works well in your setting, please share it with us – email it to me (donna.llewellyn@cetl.gatech.edu) so that we can share it with others who are looking for good ideas and inspirations. Similarly, if there is an area where you would like to enlarge your toolbox, please let me know that as well so that we can be on the look-out for solutions to help you. ■

The Students' Viewpoint:

What Makes a Good Lecture Professor

by Trey Baltz, Senior, Civil Engineering

Cassie Pope, Junior, Industrial and Systems Engineering

Katie Twist, Junior, Physics

On their first day at Georgia Tech, most new students find themselves in an unfamiliar environment, knowing neither what to expect nor what is expected of them. Seated in a gigantic lecture hall, just one of 250 other students in a class, students quickly realize that the 30:1 student/teacher ratios from high school are not characteristic of entry-level collegiate courses. Many students experience anxiety and intimidation before the first word is spoken.

Larger classrooms can be overwhelming and may seem to inhibit the learning process. Large classes lack the familiarity that a smaller setting can provide. Students feel more comfortable participating and asking questions in small classes, which are more conducive to discussion and interaction between students and the professor. Perhaps the formality of a large lecture hall strongly reinforces the academic gap between the expertise of the professor and the developing knowledge of the student. A student may feel as though the professor is too brilliant or too busy to be bothered with a simple question: these students may not attend office hours for fear of wasting the professor's time. Moreover, professors may find it difficult to address every question of each student in a huge class while trying to cover a large amount of material.

Yet, for some new students, larger classes are not a harsh learning environment, but a place where they can learn valuable skills that will aid them throughout their college careers. Large classes require students actively to seek knowledge and to take control of the learning process. Students must also develop effective study habits tuned to their personal learning styles; otherwise, they will struggle to master the material.

The single-most important trait of an effective lecture class and professor is good organization. A class outline allows the professor to clearly communicate his or her expectations of the students and to eliminate most questions about what to study, what to read, etc. A conscientious professor will also create an organized schedule for each lecture, homework assignment, and test. If a student has a detailed outline and learning objective for each class, he or she can better prepare and contribute.

Proactive teaching is the second most important practice of effective lecturers. The professor should speak clearly and distinctly, periodically checking that he or she can be heard from the back of the room. Successful lecturers persist in asking students for questions and may choose to take questions at one appointed time slot, i.e., the beginning of class, or at intervals throughout the lecture. Professors have great influence in empowering student learning. If a professor consistently addresses student needs, the students will be more likely to participate in class and to utilize office hours for help.

A strong influence in the success of a large class using Teaching Assistants (TAs) is the combination of the skills and abilities of the TA. Put simply, students expect TAs to be able to teach. If a professor selects a TA, then that person becomes a direct reflection of the professor. A professor who works alongside the TA, establishing a mutual understanding of the course material, will tremendously improve his or her students' opportunity to learn and process the material. Often a considerable gap exists between the concepts the professor stresses and the material the TA reviews. Communication between professor and TA is crucial so the TA can understand the focus of the class and can complement the professor's lectures with alternative, helpful explanations. Students would rather have a capable teaching assistant who connects well with the class than a brilliant teaching assistant who cannot translate the material into everyday terms.

From our experience, the most important aspect of the lecture class is clear communication between professor and student. This is the best way to avoid and resolve the problems that can occur in the teaching/learning process and to promote a higher degree of understanding and efficiency in the classroom. From the students' viewpoint, the most effective professors are those who sincerely focus on students' learning, whether the class is large or small. ■

Q & A:

An Interview With Dr. James H. McClellan

**Byers Professor in Digital Signal Processing
Digital Signal Processing Group
School of Electrical and Computer Engineering**

Dr. McClellan received the B.S. degree in Electrical Engineering from L.S.U. in 1969, and the M.S. and Ph.D. degrees from Rice University in 1972 and 1973, respectively. From 1973 to 1982, he was a member of the research staff at MIT Lincoln Laboratory and then a professor at MIT. From 1982 to 1987, Dr. McClellan was employed by Schlumberger Well Services. Since 1987, he has been a professor at Georgia Tech.

His research interests include Computer Technology applied to Education; Sensor Array Signal Processing; Radar Signal Processing; and Software for DSP.

Dr. McClellan received the ECE Outstanding Teacher Award in 1998, and is a recipient of the W. Howard Ector Outstanding Teacher Award. He has also received the IEEE ASSP Technical Achievement Award for work on FIR filter design, the IEEE Signal Processing Education Award, and the IEEE Signal Processing Society Award.

Q: There is more than one definition as to what constitutes a large class. Typically, a large class is described as one with 100 or more students. Another way of defining a large class is when size inhibits the use of certain teaching techniques (for example, group discussion and question/answer). As one who teaches, at what point do you consider a class to be “large”?

Dr. McClellan: My definition of large is the point at which you cannot learn all the students’ names and recognize them. For me that size is about 25 students. Anything larger than that seems to stifle interactions.

Q: What are some of the justifiable reasons for having large classes?

Dr. McClellan: Most often the stated justification is “efficiency” of faculty time. If the role of the instructor is primarily to deliver information, then a one-to-many model is appropriate and increasing the number of information receivers is only bounded by the size of the lecture hall. On the other hand, a better justification would be uniformity of coverage in a required undergraduate class. That is what we are trying to exploit in our course which is a required course for all ECE sophomores. For better or worse, all ECE students have a common experience as they learn the basics of Digital Signal Processing and do some MATLAB programming to implement DSP systems.

Q: Do you see any benefits to having a large class size (to the instructor, the students, and the academic unit)? What extra resources are needed when a class is large?

Dr. McClellan: In order to understand some of my remarks, it is necessary to have a description of the structure of the large sophomore class (ECE-2025, *Introduction to Signal Processing*) that I have taught for the last five years in ECE. Typically, we have 200—300 students registered for this class in any given semester; once it was over 400. There is a large lecture given to the entire class, and the exams are given during that lecture time. However, the key part of our class organization is the integrated labs and

recitations. ECE-2025 is a 3-3-4-credit class, so we have divided up the schedule as follows: 2 lecture hours per week, one 1.5 hour recitation meeting **run by a Professor**, and one 1.5 hour computer lab supervised by TAs and the Recitation Prof. The Lab/Recitation class size is 20 students per section. Thus, we are trying to get the benefits of both a large class and a small class.

One benefit of a large class size is that Georgia Tech can handle the large number of students who want to major in ECE and other “hot” areas. For the academic unit, I suspect that “workload” is the driving force, and there is usually the idea that fewer resources are needed for large classes. This is probably true in a lecture-only course. However, it is interesting to point out that for our course, Roger Webb (chair, ECE) has actually devoted increased resources to ECE-2025 which has helped us develop it into a solid course with a dedicated and enthusiastic staff of Recitation Profs and TAs. Partially this support was needed for the lab component of ECE 2025 which requires many TAs, but the strong ECE support has also enabled the success of the Recitation structure.

Q: What are the drawbacks of a large class size (to the instructor, the students, and the academic unit)?

“I’m a strong proponent of using the web to organize a course and disseminate information. I use a bulletin board in WebCT to answer questions and post official announcements.”

What extra (and perhaps hidden) costs are relevant when a class is large?

Dr. McClellan: The big drawback is little or no interaction between students and the instructor. We have gotten around that with our Recitations, and many students from my Recitation sections continue to visit me for unofficial advising on courses, and later on for

grad school or job recommendations.

Another area of concern is the logistics of giving exams when the lecture hall is packed. We must make several versions of each test, and have several proctors. In addition, we use our TAs to help pick up the tests at the end when 200 students try to leave simultaneously.

Q: Are there specific characteristics that a faculty member should possess in order to effectively teach a large class?

Dr. McClellan: Early in my career, I heard a famous professor say that he liked large classes, and the larger the better because he felt that a big audience helped him to give an entertaining and motivating lecture. I learned later on that he also did some acting in community theaters, so he was probably a natural. At that time, I was still very apprehensive about speaking in front of a large group, but I’ve learned that what he said is true. There is a certain “high” that comes from running a big class if you can captivate your audience.

Another reality about running a large class is organization. You have to be compulsive about making all the schedules fit, and there is a constant need to disseminate lots of information to students who don’t always hear it the first time.

Q: How do you personally plan for teaching a large class? What things do you take into consideration when designing the course structure that you might be able to ignore if the class size were smaller?

Dr. McClellan: In a small class, I can have a flexible schedule. Deviations from the outline and schedule of topics is possible. If some topic catches on, you can spend extra time on it. In a large class, as we teach it, everything is scripted from day one. Schedule changes

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wreak havoc because we not only have a large lecture, but also numerous labs and recitation sections that must operate concurrently.

Q: What role does the course syllabus play in a large class? How about other course documentation and/or the course web site?

Dr. McClellan: I'm a strong proponent of using the web to organize a course and disseminate information. I use a bulletin board in WebCT to answer questions and post official announcements. In a large class this is extremely useful because it frees up much of the time that goes into answering routine questions. Furthermore, we distribute all assignments via the web, so the students have 24/7 access to every bit of information about the course. We have posted a large archive of old homework problems and quizzes along with solutions for self study. Lately we've even been putting recorded lectures onto a server that's linked from the course web site.

Q: Should there be differences in course goals

"It is my impression that a large class forces students to learn more on their own . . . One way to put a positive spin on this is to claim that these kinds of study habits will support life-long learning."

between large classes and small classes (for the same course topic)? What effect might these goals have on how well a student learns in a large class?

Dr. McClellan: The goals should be the same. It is my impression that a large class forces students to

learn more on their own, or at least with a strong peer study group. One way to put a positive spin on this is to claim that these kinds of study habits will support life-long learning.

Q: What are some of the particular issues related to keeping order in a large class? What behaviors are you willing to put up with and what behaviors are unacceptable (e.g., tardiness, chatting, eating, reading newspapers, leaving early)? How do you handle these situations?

Dr. McClellan: I'm pretty laissez-faire, so students tend to wander in and out during lectures. Some come late; some leave early, but I see no way to police this. I'd rather have a student skip class than be bored and disruptive. I don't tolerate talking, so I'll single out students for chatting in order to keep the classroom quiet enough that all can hear. Part of my attitude is that college students are adults, and can pick and choose how to spend (or waste) their time. Some informal research that correlates class attendance with exam performance does suggest that students who skip class are usually doing poorly in the course. Still, I don't feel obligated to be their parents.

Q: Do you have any advice about dealing with logistical issues in a large class – such as handing out and collecting papers and learning students' names?

Dr. McClellan: Use the web for all handouts. That way no paper is handled by the instructor, and lost by the students. Assignments on the web are available 24/7.

For learning names, the only trick that I ever found useful was to call out individual names when handing back graded tests—but this only works if the large class size is about 50; otherwise, it takes too much time.

Q: Is there an attendance problem with the large classes that you are involved with? If so, how do you deal with it? If not, do you do something to encourage attendance?

Dr. McClellan: My impression is that attendance, or lack thereof, is an increasing problem in ALL classes, large and small. Maybe it is a characteristic of this generation of students. It is probably worse in large lectures.

What is interesting to me is that attendance decreases dramatically during the last 5 weeks of the semester, just when the material reaches its most complex form. Maybe students think that they have the class under control after taking a couple of tests. Occasionally, I've even told students that if they plan to skip classes, they should do so during the first five weeks when the material is easy! Nevertheless, we have tried to analyze why attendance is dropping when compared to 10 years ago. One suggestion is that too much material is available on the web, but I don't think that's the whole story.

Q: What specific strategies do you employ to actively engage your students in large classes? How do you ensure that they are active participants in the learning process? How do you overcome the challenge of making sure that students in all areas of the large space are equally engaged with the lecture/discussion?

Dr. McClellan: I have to admit that I don't do much during large lectures. We use recitations to create an environment where interaction can occur.

Q: What are your thoughts on how a student experiences being in a large class? Do you think class size has an effect on students' motivation, morale, and ability to take personal responsibility for their learning?

Dr. McClellan: I think that a large class run in a lecture style forces each student to find help from many different sources other than the instructor. For some students this is beneficial because they take charge of their own learning. For other students this environment leads them to assume an anonymous persona that can avoid any real academic challenges or intellectual interaction with others. This is bad, and might account for the alienated feeling that some Tech students acquire.

So I definitely think class size has an impact! Even though our Recitations are only once per week, I

believe strongly that the 20 to 1 ratio in those classes gives each student a real opportunity to meet and interact with a professor early in their ECE major courses.

Q: Should the large classroom experience be replaced with the individual online experience? What other opportunities does technology potentially (or actually) provide to solve some of the issues of teaching large classes?

Dr. McClellan: I am always on the lookout for ways that technology can be exploited, so it's easy for me to imagine that today's live lectures could all be replaced entirely by on-line videos. 70% of the students would accept this, but I think about 30% really want a live "performance."

If we did record everything, what could we do with all that faculty time that is freed up? I would hope that it would be used for more interaction in small groups such as our Recitations where the instructor acts more as a coach helping the students learn all the material being blasted out in the (recorded) lectures.

Let me close with one thought: "Teaching does not equal learning." I believe that large classes are used because the faculty focuses on the teaching end of the classroom experience. For example, a professor might say, "I can teach 300 students as easily as 30." If we focus instead on the learning end, it is likely that we, the faculty, need to spend more time interacting with students in question and answer situations where student learning is the focus. Perhaps technology can free up some valuable time for more interacting and less lecturing. ■

In the CETL Library:

The Practice of Teaching Large Classes

Teaching Large Classes

Gedalof, Allan J.

Society for Teaching and Learning in Higher Education (1998)

ISBN 0-7703-8464-1

Information: <http://www.tss.uoguelph.ca/STLHE/gguides.html>; Available via <http://www.bookstore.dal.ca/catalogue.html>

Also available in the CETL library.

Teaching Large Classes is one of the self-titled “Green Guides”, a monograph series written by authors involved with two organizations: the Society for Teaching and Learning in Higher Education (Canada) and the Higher Education and Research Development Society of Australasia. Each Green Guide focuses on some particular issue of research, theory, or applied practice in teaching and learning. Allan Gedalof is an award-winning professor of English Literature, Film and Popular Culture at the University of Western Ontario.

This text is a short, easy read, encompassing only 41 pages of topic text (plus additional pages for the table of contents, a list of references, and related information). It can be read quite easily in one sitting, serving as a stimulus for further exploration of the topics it presents. The text is divided into six main sections:

- Preliminary matters
- Preparing for large classes
- Delivering the lecture
- Outside the lecture hall
- Evaluation
- Teaching aids and technology

Gedalof approaches the information he presents in this monograph from two guiding principles:

1) instructors with large classes need to establish *a priori* the content matter of their lectures, versus that information that is best presented in laboratory or recitation sections; and 2) that interaction with students in a large class not only is possible, but it is imperative in order for true learning to be accomplished. While many of the examples/suggestions the author presents do proceed directly from his experience of teaching large English classes, he does take into account other academic disciplines and their particular topics in those examples, as well as citing other experts in large class pedagogy.

In the first section, “Preliminary matters”, Gedalof tries to get the reader to think critically about some fundamental issues for instructors of large classes. He discusses instructor anxiety, the motivation of students, and problems of scale found in large classes, among other issues. In this section, he presents a basic trait of the “ideal” lecture: an instructors who is “less concerned with imparting raw content and more with helping students to learn, to *want* to learn, and to learn *how* to learn”(pg. 14).

“Preparing for large classes” is a short, practical guide for putting together successful lectures. Gedalof gives tried and true steps to follow, including

- check out the classroom beforehand;
- have more material ready than necessary;
- judicious use of handouts;

and the like. What is most appealing about this section, however, is the fact that all of the hints are practical not just for the large class, but for any classroom situation. All instructors, and especially new teachers, can benefit by reading and following this set of guidelines.

A Book Review

by David J. Shook, Ph.D.
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The subsequent text section, “Delivering the lecture”, really presents Gedalof’s personal interest and passion regarding large class pedagogy. Two principal currents of thought flow through this section: 1) large classes should adopt and reflect that positive qualities found in small-class instruction; and 2) successful instructors of large classes are performers, just like actors. Taking these ideas as a whole, then, Gedalof presents a number of different teaching strategies and exercises that require and enhance the interaction of the large-class instructor with the individual students attend the large class. In the section, the reader finds information regarding making eye contact with students, using movement, responding to student questions, using the one-minute paper, and even team teaching. Each description is general enough for instructors in all disciplines to understand the strategy or method and consider applying each in his/her own large-class situation.

The next section in *Teaching Large Classes*, “Outside the lecture hall”, addresses the use of “tutorials” (aka, recitations) to balance out the one-sidedness of most large lecture sessions. Gedalof focuses primarily on those tutorials staffed by teaching assistants (TAs) and, in a short amount of space, presents some very useful and practical suggestions for working and managing TAs to ensure an effective administration of those additional learning situations.

The text ends with two short sections. “Evaluation” consists of two paragraphs stating the evaluation of large classes needs to be addressed in a separate volume, but that school/department administration needs to provide the resources to allow for proper evaluation of the special large-class situations. “Teaching aids and technology” gives some wish-lists for large class equipment, broken down into different class sizes.

As a practical guide, *Teaching Large Classes* functions very well. While the text is not the most comprehensive one available to offer suggestions and guides for effective large-class pedagogy, the suggestions it provides are easily understood and implemented. Any instructor who is looking to enhance his/her teaching in a large class and the learning of his/her students in that class, could benefit from reading this text, especially the middle two sections: “Preparing for large classes” and “Delivering the lecture”; faculty teaching with TAs and/or adjuncts should examine the section “Outside the lecture hall” in particular. Even instructors of “small” courses can gain some useful ideas to engage more students in their classes by reading this book. School chairs might want to make this text, or pertinent parts thereof, available to their faculty members to stimulate discussion during course development and curriculum review.

As Gedalof makes clear, the effectiveness of our large classes is not out of our control. As he states, “Anybody can provide students with facts or with the body of knowledge that comprises a discipline” (pg. 14); it is up to us as responsible instructors to guarantee a real and effective learning environment in our large classes. ■

TAs in Big Classes Carry the Potential for a Win-Win-Win Situation

by Sheldon Gen
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My first two experiences as a graduate teaching assistant were in sections of POLS 1101, Government of the United States. The two classes had about 100 and 220 students. My responsibilities grew between those two successive semesters, and from those experiences I've learned how the quality of big classes can improve with a professor and TA creatively working together. A teaching assistant in a large class can certainly help the professor with the administration of the class: copying handouts, grading homework, proctoring tests, and keeping a class website current are usual tasks for the TA that give the professor more time to concentrate on the content of the course. However, the help of a well directed TA can enhance the quality of large lecture classes in so many more ways: ways that benefit the professor, the TA, and the students.

A win for the professor

I suspect that many professors view TAs as substitute labor to ease their work load. Limiting a TA's responsibilities to class administration might be a reflection of this. The contents or delivery of the class doesn't change with or without a TA, nor the total work load. Only the work distribution changes. This is an understandable view to have, especially when the assignment of TAs to classes may be unknown prior to the beginning of them. But another way to view a TA is as supplemental help. With this *extra* labor, the TA and professor together can implement class activities that would be difficult with just a professor.

First, a TA can be used to reduce the student:teacher ratio from a dismal 100:1 to a still-dismal-but-much-better 50:1. Periodic, optional tutoring and review sessions in smaller groups can be offered in which students can hold real discussions that are not possible during the lecture hours. An alternative is to offer extended office hours between the professor and TA.

A professor and TA together can also experiment with different pedagogic methods. In one of the POLS 1101 sections I assisted, the professor had me set up a semester-long role playing simulation that would be a key component of the students' learning of Congressional processes, activities, and perspectives. Feedback from the students and their test scores on that unit confirmed that they both enjoyed the simulation and learned much from it. Other teaching methods available to a large class with supplemental TA labor include essay tests and short term papers, group projects, mock debates, etc.

A more subtle but very powerful way one of my supervising professors employed me was to learn the names of the students, observe who was participating in classes and discussions, and take note of questions and problems students present inside and outside class. The professor and I met periodically to address problems and review names. This had the effects of meeting students' needs and breaking the anonymity of the large lecture class. Students are surprised when a professor of a large class can call them by name, and that loss of anonymity usually increases their motivation to prepare for classes.

A win for the TA

For the teaching assistant, more experiences and more variety in the experiences is better. Graduate TAs, especially doctoral students, are typically looking for more than a paycheck when they choose a teaching assistantship over a research assistantship or an off-campus job. They are looking for significant classroom experience to explore that potential career path and to make them competitive in the job hunt. A few TAs may cringe at my writing this, but I think most will agree that TAs want *more* responsibilities in the classrooms.

Beyond administrative duties, the most obvious teaching experience to give a TA in a lecture class is, of course, lecturing. This task is second nature to seasoned professors, but some have forgotten how difficult it was for them when they first started, and how challenging it is for a TA stepping in front of a lecture hall for the first time. When assigning lecture responsibilities to a TA, professors need to provide the TA with much guidance and feedback before and after lectures. My supervising professors saw the relationship as an apprenticeship, and I found this approach very helpful. Before the beginning of the semester, I met with my professor to plan and divide the lecture topics between us. During the preparations for individual lectures, I got guidance from the professor on resources to review, points to emphasize, use of visual aids, etc. He also assured me that it is normal to spend three hours preparing for a 45 minute lecture when first starting, something I thought I was alone in doing.

After my lectures, I met with the professor to go over strengths and weaknesses of the contents and delivery. Those were incredibly humbling but powerful experiences from which I have learned the most about teaching in a large class. Once my professor arranged to have my lecture video taped for my own review later. I only had to watch that dreaded video once to curb my “uhms” and improve my projection, voice inflection, and presence.

Another significant experience for TAs of large classes is outside the classroom and inside the office. It is during office hours that TAs learn about other significant parts of teaching: tutoring students struggling with an assignment or topic, teaching study strategies, accommodating students with individual needs, providing academic counseling, negotiating grades, etc. (These are also the times when TAs learn the names of the students.) These tasks also require coordination between the professor and TA, to assure a united presentation of class policies and content.

A win for the students

The expanded opportunities that come with a TA in a large class can add up to a win for the students too. When students enroll in a large lecture class, they don't bring particularly high expectations with them. They typically anticipate an experience consisting of passive listening to lectures, getting little to no one-on-one time

with the professor, and taking multiple choice tests. Significant improvements on all these fronts is attainable when the professor fully utilizes a TA. Examples described above illustrate this. Some lecture time can be replaced with more interactive exercises or supplemented with discussion groups outside of class. Individual attention can be increased through expanded office hours and again through interactive exercises. And multiple choice tests can be replaced with more in-depth assessments of knowledge with little loss of timely feedback.

Above all, the greatest potential improvement a TA can bring to the students' learning experience in a large class is individual attention, and a little attention can go a long, long way. Simply calling them by name and recalling the questions and comments they've made can pull students out of a passive role and into active learning. Adding other opportunities for more individual attention only enhances that affect. One professor of POLS 1101 who employs group activities in his classes once told me about some glowing feedback he received in a course evaluation. One student wrote him a note of thanks saying how ironic it was that the most student and professor interaction he has had in any class was in this class of over 100 students.

Invest to win

Do all these benefits come at a cost to the professor? Of course they do. It is still much easier to use a TA as substitute labor rather than supplemental labor. But the investment in planning and preparation can result in a much enhanced class that benefits the professor and TA, as well as the students. Mentoring is the key cost to the professor. Some TAs start their work with no teaching experience or pedagogic training, and a decent fear of public speaking, so professors need to coach their TAs through their initiations as teachers. Again, an apprenticeship is an effective approach to follow.

During the last academic year there were 162 sections of classes at Georgia Tech that had student enrollments of at least 100. That's over 16,200 student experiences in large classes. The opportunity to improve the qualities of these experiences is huge. If a TA may be so bold as to offer advice to professors, then let me give it by encouraging them to collaborate with their TAs to enhance the learning experiences of these classes. ■

Making I.T. Work

Students Actively Participate in Large Classes with the Help of Wireless Transmitters

by Melissa Bachman

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In hopes of improving learning in large classes, professors are experimenting with a new technology that requires each student to respond during class using a wireless transmitter or keypad that looks something like a television remote. This fall, five large classes are using the Personal Response System, a wireless, infrared system of transmitters (one per student) and receivers that are set up around the classroom. Each student transmitter has ten digits and can be used to track student responses to multiple choice questions. Future capability will allow multiple digit responses. Dr. Mike Schatz is using PRS (Personal Response System) in two sections of Physics 2211 with approximately 180 students in each class. Dr. Kent Barefield is using PRS in Chem1311 with almost 140 students. Dr. Hans Klein will implement the system in PST3127 with a class size of 180, and Dr. Doug Flamming will use the system with his HIST2112 class of 180 students. During the spring semester, there will be additional courses taught using the system. The Personal Response System hardware was funded by student technology fees.

In Dr. Schatz's classes, students enter the large lecture hall and collect the transmitter assigned to them from a set of labeled boxes at the front of the class. A large grid appears on the LCD projector at the front of the class, and each cell on the grid contains the last name of a student. As students find their seat, they press a key on their transmitter and watch

for their assigned cell on the grid to respond with a green color. As students arrive, more cells on the grid become green. Each student knows which cell on the grid corresponds to responses from his/her transmitter. Fifteen minutes into the class period, several beeps indicate that students have one more chance to test their transmitters and indicate their attendance. At various points during the lecture, Dr. Schatz asks the students to work a problem. He gives them a set amount of time, six minutes or so, to work out the problem, and they get a warning beep during the last 30 seconds. During the six minutes, students are actively involved in solving the problem. Some look through their notes. Others wear out the erasers on their pencils. Everyone is trying to solve the problem. Once an answer is worked out, each student replies with the transmitter and watches for the green cell that indicates their answer was received. As soon as the time expires, Dr. Schatz immediately posts the results in the form of a histogram that indicates the correct answer and the percentage of students who answered correctly. "I think it seems to help get students more actively engaged in the classroom," says Dr. Schatz, "but it is too soon to tell whether this is having an impact on student performance."

Students in Dr. Barefield's Chemistry class checked out transmitters from the Chemistry stockroom prior to the end of the first week of classes, and are responsible for bringing their transmitter to class each day. Dr. Barefield uses the PRS system to collect

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student responses to “Concept Test” exercises and in-class quizzes. Using their transmitters, students answer a question individually, and the results are displayed. In both cases students receive immediate feedback as to the correct answer and its basis through subsequent discussion with peers or the instructor. Peer discussion provides feedback to students about the validity of their answers and provides an opportunity to reassess their answers in the case of Concept Tests. Student responses to the questions asked during class are retained by saving the file generated by the PRS software. The quizzes are marked by the software and account for a small percentage of the course grade. Attendance is recorded in either case.

During the spring semester, Dr. Gordon Kingsley plans to use the system with his class of 200+ students to help with a simulation of the United States Congress. The system will be used initially for in-class public opinion polls on significant policy issues of the day. In providing their public opinions the students will also be creating a political profile within the PRS system. During the congressional simulation phase of the class the political profile contributes to a student’s assignment to a political party and caucus affiliations. The PRS will also be used in electing a Speaker of the House. The simulation requires that congressional committees be formed to consider and vote on proposed bills. Once the bills have come out of committee they are presented to the Congress for a class vote. The PRS system will again be used to determine which bills pass.

The use of PRS at Georgia Tech varies from one instructor to the next, but the intent is similar. Many instructional theories stress the importance of active participation and feedback. Students need to actively engage in problem solving. They need independent practice and immediate feedback as they are learning and applying new skills. Interaction and dialogue with instructors and peers help students analyze their misconceptions and understand fundamental concepts. All of these interactions are difficult in a large class. Wireless transmitters give instructors more opportunities, more options for creating an interactive class, even in a large lecture. Students can be held accountable and asked to actively participate in class. The results are not in yet, but the signs are looking good. At a CETL hosted faculty development seminar on Thursday, March 20th, 2003, faculty using the PRS technology in large classrooms will share their experiences. For those interested in using the PRS system with smaller classes, CETL has a class set of fifty transmitters with receivers that can be loaned for use in classes with up to fifty students. ■

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Asking Students Questions in a Large Lecture Class

by Richard Catrambone
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Few things are more discouraging to teachers and more boring for students than to be in a situation in which the teacher lectures for an hour while the students sit slumped in their seats taking notes. The teacher faces a sea of uninterested faces, and the student disconnects from the topic and slips into automatic note-taking behavior. No one is having much fun, and few are learning much.

Large lecture classes are presently a fact of life. However, they do not have to be mediocre learning situations. There are a number of things a teacher can do to help learning in a large lecture class. In my experience, a key one is to ask questions during the lecture. There is evidence, both anecdotal and from cognitive and educational research, that people learn better when they are actively engaged with the information being presented. Answering questions posed by the teacher, or that occur to the student on his or her own, is a good way of actively processing the lecture material.

There are some dangers in asking questions of the class. For instance: What if it is the same few students who answer the question each time? What if no one volunteers to answer the question? Many lecturers share the fear of the above outcomes occurring. How does one ask good questions, and how does one deal with the potential problems mentioned above (short of not asking questions at all)?

First, stop *frequently* during lecture to ask questions. You want to get students used to answering them. In fact, during the first day (or lecture) of class, it would be useful to ask some opinion or thought-experiment questions that either have no right or wrong answers or can be answered based on everyday experience. The

idea is initially just to get students into the mind-set that they can answer questions in class and nothing bad will happen to them. You might be thinking now, “How do I ask opinion questions in *my* class because I am teaching _____ (fill in the blank), and there just are no such things as opinion questions?” Is that really true? In introductory physics, could you not ask opinions about whether it is better to try to determine all the forces that act on a bridge and then build the bridge to those tolerances or whether one should just overbuild using other successful bridges as models? Could you ask students what acceleration “feels like?” These sorts of question are engaging, non-threatening, and might spark debate and even perhaps some interest in why formal physics sometimes has a disconnect with our daily experiences and why it is important to develop new “intuitions” about the domain.

Second, make the questions easy. This might seem like sacrilege, but it is important. Keep in mind that what seems easy to you, the expert, is not easy for the student who is encountering the material for the first time. If you lecture for 20 minutes and introduce several concepts and then ask a question relating those concepts, all but the brightest (and bravest) students will be unwilling to answer. You are asking them to assimilate new ideas and put them together in some new way. That is a tough task for anyone to do on the fly! This approach will lead students to tune out when you ask questions. They will just wait for the unpleasantness to be over. Save the tougher questions for homework.

The questions you ask should be about something you have *just presented* in the last minute or two. The question should be sufficiently constrained so that the students know that only the information from the last few minutes is relevant. Two good things will happen

with these sorts of questions. One, you may find many students offering to answer the question. This will make you feel good, and it will indicate that a large proportion of your class is following what you are saying and is interested enough to answer the question (and this is not even counting the shy or less confident students who might be answering the question to themselves and *not tuning out*). Two, students will be actively engaged in the class and will be learning the material better. Even if students end up producing wrong answers, the ensuing discussion to correct misconceptions will help the students and also help you pinpoint which features of the lecture are unclear or which features of the topic are especially difficult. This will help you when you present a lecture on this topic in the future.

Frequent question-asking (using reasonable questions) provides a student multiple opportunities to discover whether he or she understands what you are talking about. If a student does not know the answer to a question or does not understand the answer that someone else provides, he or she will then have the opportunity to ask *you* questions—if you have created an atmosphere in which questions and answers fly

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freely about. This will give you a chance to be on the answering end more frequently and gain insight into what it means to form good answers. Perhaps more importantly, you will also have the opportunity to learn to appreciate the importance of clear questions.

This approach to question-asking will build on itself, and as time goes on, you might find more and more students volunteering to answer questions as well as becoming more capable of formulating useful questions

to ask you. Teachers do often ask the class if there are any questions, and they then take the lack of questions to indicate general comprehension. In fact though, the students might not be asking questions because they are sufficiently baffled that they cannot even begin to form a question. Some, those who do not give up, might come see you after class. However, it would be better if students were following the material sufficiently well so that they could form meaningful questions during class. These questions would provide you with an opportunity to address more efficiently some confusions that could exist for a lot of people in the class.

With the above framework, there is a lot of room for tailoring to suit your students, the topic, and you. It works for smaller classes, too. I recommend erring on the side of too many questions rather than too few. Use the questions as comprehension checks and as opportunities for *small* extensions and applications. My experience is that the resulting class is more interesting for both students and the instructor.

A final related piece of advice is to let students volunteer to answer questions rather than calling on them.

Calling on students can create an adversarial situation. Students do not volunteer to answer questions for a lot of reasons including poor questions, shyness, lack of knowledge, and lack of interest. In my opinion, our job is to present information clearly and, hopefully, interestingly and to *offer* students the chance to work with the information by answering questions (either out loud or to themselves). Our job is not to harass a student into answering a question out loud if he or she does not want to. I know that this is an issue that some instructors feel very strongly about and that they believe it is important that students know that they might get called upon in class and that perhaps this will lead more students to be prepared for class. This might be an issue where instructors will have to agree to disagree. ■

Fall 2002 Events

Faculty Development Seminars

September 19	Adding Educational Components to Grant Proposals
October 17	Faculty Showcase - Creating Instructional Video
November 21	Panel from the "Over 100 Club" - Tips on Teaching Large Classes - What Works and What Doesn't Work

Other Events:

September 10	New Faculty: Breakfast with CETL
September 13	New Faculty: Breakfast with CETL
September 24	"Over 100 Club" Meeting: Teaching Large Classes
October 9 - 13	POD Conference, Crown Plaza Ravinia
October 17	Multimedia Workshop Open House - Library West Commons
October 14 - 15	GTREET (Georgia Tech Retreat Exploring Effective Teaching), Amicalola Falls Lodge

For more information on these events, visit the CETL website or call us at 404-894-4474.

The Classroom

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