Chapter 3

The Teaching Process

Many non-science students enjoy and benefit from astronomy courses. Papers in this chapter discuss improving teaching abilities and handling and testing students in the large general astronomy classes. Large courses for non-science students are prevalent in North America. One paper deals with a summer institute for training teachers of such courses, primarily in small institutions. We also hear of "education at a distance" — teaching of astronomy by correspondence to students in the United Kingdom and the United States. We finally read more philosophical discussions on how to structure an astronomy course.

STARTING OUT: THE DILEMMA OF THE BEGINNING COLLEGE ASTRONOMY TEACHER

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Most beginning college professors in the United States receive little if any help in the important task of learning how to teach well. Occasionally, a colleague or department chairman can provide some guidance, but in general most American college faculty are taught how to teach by the "sink or swim" method. There are many resources that can help the new professor swim, rather than sink, but in my case at least, I found out about them many years after I needed them the most. This paper will identify some of the literature, journals, and on-campus facilities that can help both new and experienced faculty members develop and hone teaching skills.

The literature on teaching and learning is vast. Fortunately, the new teacher need not spend years becoming an expert on this literature; much of it is like the astronomical research literature in that it is full of jargon and it requires some expertise to distill useful, easily implementable ideas from it. Fortunately, there are a few (too few!) books that distill this vast literature into practical advice from it.

Wilbert McKeachie's *Teaching Tips for the Beginning College Teacher* (McKeachie, 1986), now in its eighth edition, is a classic. I think all new faculty members should be given this book along with their first paycheck. Another book along the same lines is *The Art and Craft of Teaching* (Gullette, 1982). Chapters in these books carry titles like "Countdown for Course Preparation," "The First Day of Class," "Stimulating Discussion," and "How to Win Friends and Influence Janitors." You can read these chapters and implement the ideas immediately in your class.

Familiar physics teaching journals such as *The Physics Teacher* and *American Journal of Physics* often contain articles on astronomy teaching. *The Teaching Professor*, a newsletter, may be less familiar; like the books cited above, it contains short, easily implementable articles on generic teaching problems. For example, the May 1988 issue contains a one-page article on "Questions: Making Learners Think." It provides examples of "higher order questions," question that require students to think rather than to memorize, questions that can provide a way of keeping a discussion section moving along rather than degeneration into a small-sized lecture. A 12-issue subscription costs $39; write to 2718 Dryden Drive, Madison, Wisconsin 53704. *College Teaching* is another good general resource.

Many colleges and universities have set up local organizations to foster better teaching on campus. The University of Delaware's Center for Teaching Effectiveness has a part-time faculty director, two professional staff, and a graduate student. A major focus of our activities is confidential consultation with individual faculty members. We give grants to faculty for teaching improvement. We run a series of panel discussions, presentations, and workshops; topics range from those addressed primarily at beginning teachers (for example, "Lecturing Well") to topics of more general interest (for example, "Balancing Teaching and Research"). I find these programs interesting both because of their content and because they allow me to meet other people on campus who really care about teaching. We can make arrangements to videotape classes. I found this useful both as a beginning teacher and even after I'd been teaching for years. It's useful to watch the tape with someone else around. Another way of getting feedback is to talk with your students or ask them to give you written, anonymous feedback a few weeks into the term (not just at the end).

It helps to learn a little about students' learning and reasoning styles. Ten years ago, a number of American physicists discovered Piaget's learning theories (Fuller, Karplus, and Lawson, 1977). In some extreme cases, these ideas were overpromoted as the "magic bullet" that would solve all the problems of physics teaching. They didn't, of course. However, students don't think in the same way that their teachers do; the primary reason that universities exist is to transform people from memorizers into thinkers. Understanding the differences in thinking and problem solving styles can help bridge some communications barriers between teacher and student. Because this is an active area of current educational research, there are no authoritative, compact books like McKeachie's. Beginning and experienced teachers might find articles by Fuller, Sheila Tobias (1985) on math anxiety, Jill Larkin on problem solving styles, and a forthcoming book by Kurfiss (1988) to be good starting points.

Especially in the current student climate, the examinations given in a course communicate a teacher's expectations far more powerfully than anything that's said in class. Science teachers like to emphasize thinking and problem solving, but American astronomy teachers then proceed to give their students exams which, if the questions in instructors' manuals for textbooks are any guide, almost always ask for simple memorization and recall. We can do better. Educators have developed ways of constructing more sophisticated multiple-choice questions; Ebel's *Essentials of Educational Measurement* (Ebel, 1986) contains some hints, though it has many of the flaws of educational writing at its worst. (Skip the first half.) One tactic I use, for example, is to ask students to demonstrate that they know the connection between observations and the conclusions that are drawn from them. For example, "Most objects in the Universe contain 25-30% He by mass. This observation shows that (i) the Big Bang theory is probably correct, (ii) ...." If the multiple choice questions are machine graded, software packages like ITEMAL (available for most mainframe systems) can analyze the examination and pick out those disastrous questions that the weak students answer correctly and the stronger students answer incorrectly.

Because astronomy is such a visual science, slides, videos, and movies are an excellent resource. I usually obtain slides from the Hansen Planetarium, the Astronomical Society of the Pacific, or the European Southern Observatory. Videos are a bit harder to find; the Planetary Society (65 N. Catalina Ave., Pasadena, CA 91106) has a few. NASA maintains a number of teacher resource centers in the United States where a visiting teacher can bring a blank videotape and copy anything that is available at the Center. Movies can also be borrowed from NASA, though the use of this medium seems to be fading fast.

References

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Discussion

R.J. Dukes, Jr.: *If facilities or time do not permit video taping, audio taping using an inexpensive recorder can prove helpful in analyzing what has happened in your class.*

O. Gingerich: *Videotaping class sections has some unanticipated advantages over* *audiotaping. For example, one of our best teaching fellows discovered she had idiosyncratic habitual motions that she had been entirely unaware of. Another was very surprised to see the expressions on the students' faces when he was writing on the blackboard with his back to the class.*

H. Shipman: I agree; videotaping should be done if available. Audio tapes are better than nothing.

TEACHING 7000 STUDENTS PER YEAR

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The undergraduate program at the University of Texas has grown into the largest astronomy teaching program in the world, with some 7000 students per year (almost 20,000 credit hours). The department has 22.5 Ph.D.-level teaching faculty, about 45 graduate students, and about 40 pre-professional undergraduate majors. But most of the enrollment is in courses that satisfy the science requirements of students in liberal arts and non-technical majors. In 1985–86, 96.4 per cent of our undergraduate credit hours taught were in such classes. It is instructive to examine the historical reasons for our growth and its educational consequences, and to draw some conclusions from both for other programs.

The Early Growth of the Department: "Reclaiming" the McDonald Observatory

Up until 1958, there was no astronomy department at all at the University of Texas — only the McDonald Observatory, named for the Texas banker who left the money to build it in 1926. It was run by Yerkes Observatory, but when efforts began to bring the University of Texas into the first rank of academic institutions worldwide, it was decided to develop a competitive, major astronomy department in Austin and "reclaim" the observatory from the University of Chicago. To this end, in 1963, Dr. Harlan Smith was brought in to be both the director of the observatory and the chairman of the new department; shortly thereafter, the 2.7-m (107") telescope was begun at the observatory. (For more details, see *Big and Bright: A History of the McDonald Observatory*, by David Evans and Derral Mulholland (University of Texas Press, 1986)).

The original goals called for the new department to grow to about 12 faculty members, a number judged appropriate to support a major observatory. However, it has now grown to almost double this targeted size, and we will see below that undergraduate teaching has been responsible for this.