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Insights from a Survey of Astronomy Instructors in Community and Other Teaching-Oriented Colleges in the United States

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1. SIZING UP THE POPULATION

Estimates are that approximately 100,000 to 125,000 students take introductory astronomy classes each year at colleges and universities that do not grant bachelor's or higher degrees in physics or astronomy (Fraknoi 2001). This represents roughly 40% to 50% of the total number of students taking intro astronomy in the United States.

Such nonresearch institutions include community colleges (of which there are approximately 1,200 in the United States), smaller liberal arts colleges, and state colleges and universities with only a general science department. The ongoing statistical reports from the American Institute of Physics indicate that about 830 universities and colleges grant physics degrees (bachelor's and up), out of the total number of 2,200 four-year colleges and universities.

The instructors of introductory astronomy at research universities and top liberal arts schools are likely to possess PhDs in astronomy or physics and to have been graduate students and teaching assistants (TAs) at institutions like those where they teach. But who teaches Astronomy 101 at the other lower tier institutions, which outnumber the AIP list institutions by four to one?

To answer this question, we needed more data on these unsung and untalented colleagues.

2. SURVEY METHODOLOGY

The survey was announced in 1996 at meetings of the American Astronomical Society (AAS) and the ASP, and information about it was disseminated through the journals and newsletters of such organizations as the American Association of Physics Teachers, the National Science Teachers' Association, the Lunar and Planetary Institute, and the National Association of Geoscience Teachers.

The problem with publicizing the survey in this way is that members of such organizations are more likely to be full-time instructors with a degree in physics, geology, or astronomy. As we will see, much of the teaching of Astronomy 101, especially at the community college level, is being done by instructors with degrees in other fields and by part-time instructors, some of whom hold other jobs besides teaching. We are likely to miss such instructors by using the established scientific societies in the different disciplines.

To overcome this selection effect, we: (a) enlisted a number of instructors who had already taken the survey to distribute forms to part-time and full-time instructors in their regions; (b) put notices of the survey into *Sky & Telescope* and *Astronomy* magazines, which are the popular magazines most likely to be read by nonspecialists trying to keep up with the field; and (c) put the survey on the ASP's Web site (with a round of e-mail exploder publicity).

Below we report on the 400 survey responses we have received thus far. (There were actually more responses than this, but those from instructors at research-oriented institutions were not tallied. Several eager people also filled out the survey more than once, either to update information or because they thought that the Web-based survey had somehow supplanted the mail-based one. Only the latest survey from such repeaters was counted.)

3. INFORMATION ABOUT THE INSTRUCTORS

Of the 400 instructors who filled out the survey, 70% teach in community colleges. The other 30% teach in four-year colleges without research emphasis (see Table 1). Geographically, 44 states and the District of Columbia are represented, with the largest number of respondents living in California (96), New York (26), Washington state (21), and Illinois (20). Eighty percent of the respondents teach in public institutions and only 20% in private colleges, reflecting the fact that community colleges that offer astronomy are likely to be public institutions. (Private community colleges tend to be business or vocational schools for the most part.)

Table 1. Instructor Data

Community Colleges	279 (70%)
4-year nonresearch	121 (30%)
Total surveys returned	400

About one fourth of the respondents are part-timers, which means that we were somewhat successful in reaching this population. Still, given the increasing trend in community colleges in relying on part-time instructors, we suspect they are underrepresented in our survey.

We asked the instructors about their highest degrees. One hundred ninety-five (or about 49%) have a master's degree, 45% have a PhD or EdD, and 6% have a bachelor's. If we look only at community college instructors, 63% have a master's as their highest degree, 31% have a PhD or EdD, and 6% a bachelor's.

Table 2. Levels of Instructor Degrees

Highest Degrees	All Institutions	Community Colleges Only
PhD/EdD	179 (45%)	87 (31%)
MS	195 (49%)	175 (63%)
BS	26 (6%)	17 (6%)

One of the most interesting results was the array of fields in which the respondents earned their highest degrees. Among the full list, only 101 (25%) have a degree in astronomy; among the community college instructors, only 23% have astronomy degrees. As one might expect, more instructors have degrees in physics, both because astronomers often get physics degrees and because physicists are most likely to be asked or to volunteer to teach an astronomy class. About 38% of the full list and 37% of the community college instructors have physics degrees. About equal numbers (8% - 9%) of the full list have degrees in geology and education; for community college instructors, 11% have geology degrees and 8% have education degrees. Among the other science fields represented in the survey were chemistry, math, and biology. About 12% of the full list (and 13% of the community college group) have degrees in fields outside the normal academic science disciplines, including various types of engineering, sociology, and English. (See Table 3.)

Table 3. Instructor Degree Subjects

Degree Subject	All Institutions	Community Colleges Only
Astronomy	101 (25%)	64 (23%)
Physics	152 (38%)	104 (37%)
Geology	34 (8%)	30 (11%)
Education	32 (8%)	21 (8%)
Chemistry	14 (4%)	10 (4%)
Other	67 (17%)	50 (18%)

4. PROFILE OF THE INSTITUTIONS

We asked a few questions to try to get a picture of the facilities available to the instructors at their institutions. About 34% of the instructors reported that they have an observatory on campus, and about 27% have a planetarium. Twenty-six percent of the instructors said that there is a room on campus used and equipped primarily to serve as an astronomy lab, while 46% have a room equipped with computers with astronomy software. Given that the survey was carried out over seven years, we suspect that this last figure is an underestimate of the current situation. Computer labs are likely to be more common now than they were in 1996-1997. (See Table 4.)

Table 4. Facilities Available

Observatory	134 (34%)
Planetarium	106 (27%)
Computer room	185 (46%)
Astronomy computer room	105 (26%)

When, at the end of the survey, we asked instructors what their wishes are for the future, an observatory, a telescope, and a well-equipped lab room came up again and again on the lists.

Eighty of the instructors (20%) reported that an amateur astronomy group meets on campus, although most of the groups seem to be small, and we would guess that many consist of students.

Community colleges generally like to tout the fact that they offer smaller classes and are thus able to give students more individual attention than the large research universities. To check on this, we asked instructors how many students in total were enrolled each semester in all of the astronomy courses they

taught. Answers ranged from 11 to 500, with the average being 66 students per semester. Because the instructors involved taught anywhere from one to six astronomy classes per semester, this total does not tell us the number of students per class, but it does bear out the contention that the classes in these institutions are smaller than at most large universities.

We also asked if instructors had a budget for the astronomy program, and 63% indicated that they did. Although we asked for an estimate of their annual budget, many declined to give a figure, or indicated that it was difficult to separate from general departmental budgets. Of the 197 who gave a figure, estimates ranged from \$100 to \$8,000, with the average being \$1,127. For the 139 community college instructors who gave a budget figure, the average was \$940, certainly not a princely sum considering the cost of educational or observing equipment.

5. THE LIFE OF A COMMUNITY COLLEGE INSTRUCTOR

Most people teaching in research universities are surprised to learn how different the life of a community college astronomy instructor is from their own (Fraknoi 1996; Tucker 1996). At the community college level, the teaching load is the equivalent of *five* 3-unit courses each and every semester. With salaries lower than at four-year colleges and universities, some instructors take an overload, teaching six or seven courses simultaneously.

Without the presence of graduate students, most instructors must do their own grading (even for courses of several hundred students) or rely on previous students for help. This latter alternative is made more difficult because most students leave after two years rather than four. Students who can act as lab or observing assistants are rare and are often snatched up by faculty in fields closer to their majors. Under such conditions, the work of teaching often consumes all of the professional time an instructor has available, leaving little room for professional development or much deep reflection. For example, it is telling that of all of those writing current astronomy textbooks, only one of the authors (part of a team of three) teaches at a community college.

Typically, instructors teach more than just astronomy; they are likely to have to prepare classes in two or three different subjects in the same semester. For many, preparing for their one Astronomy 101 course must be squeezed in with doing several physics or other physical science classes, which may be the "bread and butter" of their assignment. (For a much longer and general discussion of what it is like to teach at a community college, see Grubb et al. 1999.)

Because many astronomy instructors are part time, it is worth noting that the work of this group is sometimes even more difficult. Part-time instructors are paid significantly less per unit than full-timers, which is why hiring part-time faculty is so popular with budget-challenged administrators. Part-timers have little job security, often receive few or no benefits, and frequently have no office or even phone extension of their own. Holding office hours is something they are encouraged to do, but are mostly not compensated for.

Such part-timers can be divided into two categories: (a) those who have a "regular" job and are doing teaching only because they have a passion for it or need extra income; and (b) the "freeway fliers" (as they are called in California) who try to stitch together a living wage by teaching part time at two or more institutions, and often wind up commuting over long distances to do so. The stresses on both groups are considerable, and you can imagine that the time they have available to keep up with the latest

developments in astronomy or teaching is significantly affected.

The student population at these colleges is also somewhat different from the students at elite universities. Few community colleges have dormitory facilities, for example, so students live at home or off campus, and often commute to school for just the time it takes to attend classes or labs. Sixty-three percent of all community college students are part time, and the majority work at full-time or part-time jobs while going to school. Many students take astronomy in evening classes, for example, after a full day's work, sometimes in three-hour blocks. This makes keeping their attention even more challenging. With more financial concerns (work, unreliable cars) and family commitments, community college students are distracted and stressed in ways that are not in the experience of the typical university student.

The average student age at community colleges is 29, meaning that many of the students are old enough to have families of their own and the responsibilities that go with them. Fifty-eight percent of the students are women. (Statistics in this section are from AACC 2000.) Many students attend community college because their math and writing skills are not sufficient to enter a four-year college, and they spend some of their early time taking classes to sharpen those skills. Virtually all come from public schools where the academic demands may not have been very high, and as a result, the shock of adapting to college-level work can be considerable. All of these factors make it difficult, to cite a few examples, to organize an evening observing session for a day class, to assign homework that requires returning to campus after regular class hours, to use a great deal of math in the course, or to demand a high level of devotion to a class that is generally not involved with either the majors or the vocational goals of most students.

On the other hand, community colleges still embody the "American dream" of students using higher education to better their socioeconomic situations. Forty-six percent of all black undergraduates in a given year are attending community college, as are 55% of Hispanic undergraduates. The average annual tuition in 2000 was \$1,518, making community colleges the last great college bargain. In view of state budget crises around the country, tuition is creeping upward at the current time but is still far below most four-year colleges. An interesting statistic (AACC 2000) is that 65% of all new health care workers in the United States now get their training at community colleges, a good illustration of the role that these schools play in educating important segments of our work force. The special challenge and joy of teaching at such colleges is sharing the excitement of learning and the possibility of academic success in science with students for whom these are often new experiences.

Although there are larger community college or state college campuses where several faculty members teach astronomy, for the most part, the instructors in the survey report being the only astronomy instructor on campus. Small wonder, then, that their comments often reflect a sense of isolation and a wish to be connected somehow to a network of astronomy instructors. Although few could afford the luxury of taking time off for extensive additional training, many expressed a wish for some convenient way to find out what other intro astronomy teachers are doing and to learn from their successes and mistakes.

6. COMMENTS FROM THE INSTRUCTORS

In view of the above, it is enlightening to sample the comments that the instructors made in response to two open-ended questions at the conclusion of the survey.

First, we asked what their proudest accomplishments were. For many, just succeeding in teaching the course was their main source of pride. One instructor with a master's degree in math wrote, "I actually taught two semesters of astronomy without ever taking an astronomy course myself!" (Whether this is a good or bad thing for the world is left as an exercise to the reader.) What many others pointed to with pride was that students of diverse backgrounds and abilities were able to succeed in their astronomy class, or that they were able to begin something innovative (hands-on learning activities, an astronomy club, a grant to get equipment, a second astronomy course, a lab) despite all of the demands on their time.

Then we asked instructors "the one thing [they] wished they had to help [their] astronomy teaching." As we noted above, many of the answers had to do with "bricks and mortar": a planetarium, an observatory, or a lab room. But others wrote candidly about the pressures and isolation they felt. Here are a few of the more poignant responses:

- "I wish I had someone to ask questions of. I am a physicist, not an astronomer."
- "I am always in need of advice on how to approach certain concepts, since I have a PhD in psychology and not the physical sciences."
- "As a part-timer at two colleges, I just wish I could get health insurance."
- "I'd like a quarter off to devote to developing labs and in-class activities (in my dreams...)"
- "What I need is more time!"
- "I need an administration that is not constantly working against the faculty and what they do."
- "At a tiny rural college, I am somewhat isolated."
- "I need more training in how to teach astronomical concepts better."
- "I just wish I had mentors."

7. LOOKING TO THE FUTURE

Much of the recent discussion of reform in the teaching of "Astronomy 101" has taken place at the research universities; see, for example, Partridge & Greenstein 2003. The changes in teaching strategies, the introduction of new laboratory experiences, and the technology revolution brought by the Internet are (perhaps reasonably) finding their way into these universities long before they reach the community college classroom. Yet, according to our best estimates, more than half of the introductory astronomy classes are in nonresearch institutions. (Even though fewer than half of the *students* may be in those institutions, because community college class sizes are smaller, it seems reasonable to argue that more than half of the *classes* are in the kinds of colleges we have been discussing.)

Given that these colleges are such a large interface between astronomers and the educated public, it would make sense for the astronomical community to invest some time and resources in assisting the instructors at these second- or third-tier institutions in their teaching. In the past decade, some efforts to help such instructors have indeed begun, and more seem to be in the works.

For example, under the auspices of the Astronomical Society of the Pacific (ASP), the present author has organized three "Cosmos in the Classroom" conferences on teaching astronomy to non-science majors, which have included outreach to community college instructors as a focus. The first of these was held in the summer of 1996 in Santa Clara, California, and included several dozen astronomy instructors from California community colleges. A somewhat larger gathering was held in Albuquerque, New Mexico, in the summer of 1998, and a volume of handouts from this meeting was published by the ASP. This meeting, by the way, led to the development of the Astronomy Diagnostic Test (Hufnagel 2002) and to a

series of continuing dialogues on Astronomy 101 on the day before each American Astronomical Society (AAS) meeting.

A much larger "Cosmos in the Classroom" meeting was held in Pasadena, California, in the summer of 2000 (with the cosponsorship of the AAS), and the volume of papers and handouts from that conference is still in print (Fraknoi 2000). Grants from the National Science Foundation's Division of Undergraduate Education and NASA's Office of Space Science enabled a number of community college instructors and graduate students interested in teaching to attend the meeting. During the three-day conference, there were meetings of several special interest groups, including one devoted to community college teaching.

The next "Cosmos in the Classroom" meeting will be held in Boston in the summer of 2004, and again we are making a special effort to invite and support community college instructors. The meeting is part of an increased focus on educational support services at the ASP.

Susana Deustua, the director of educational activities of the AAS, has begun organizing a series of "Cool Astronomy" sessions at AAS meetings, where noted astronomers discuss some exciting new developments in astronomical research in less technical language, and local community college instructors are invited to attend at a reduced one-day registration fee.

NASA's Office of Space Science, which is investing significant resources in astronomy and space science education at many levels, has also expressed interest in assisting community college instructors. Their educational programs are organized through a complex EPO Support Network (Sakimoto 2003), and this network has designated the Jet Propulsion Laboratory's Navigator Program as the lead in this effort. In addition to cosponsoring the "Cosmos in the Classroom 2004" meeting, the Navigator program has contracted with the University of Arizona's Conceptual Astronomy and Physics Education Research (CAPER) team, led by Tim Slater and Ed Prather, to offer a series of two-day workshops on effective teaching for community college astronomy faculty around the country. A list of scheduled workshops can be found at <http://caperteam.as.arizona.edu/workshops.html>

However, relatively few faculty have so far benefited from these activities, and thus, much more remains to be done. A casual check a few years ago revealed that the vast majority of those responding to the survey we have been describing were not members of the AAS or the ASP at the time. This makes sense for instructors whose main field is some other science and for whom astronomy is perhaps just one course among 10 that they teach each school year. But it was also true for those respondents for whom astronomy was a major part of their load. Many who taught physics were members of the American Association of Physics Teachers, which has an exclusive focus on educational activities, something that was not true for the AAS or the ASP.

In their open-ended comments, many of the instructors answering the survey indicated that they would value some sort of network that connected them with other professors who had similar assignments. Some activities that such a network might undertake are:

- Regular national and regional meetings or workshops for instructors from nonresearch-oriented colleges
- An accredited virtual seminar on innovative teaching techniques, following some of the models of courses for K-12 instructors offered through Montana State
- A general Web site for exchanging information on teaching techniques and approaches

- A secure Web site for exchanging good test questions
- Group purchases of useful teaching materials, such as slides, transparencies, image CDs, and so on
- Development of a kit of helpful materials for beginning instructors, similar to what the AAPT has developed for beginning physics teachers

There are no firm numbers at present about how many astronomy instructors there are in community and other nonresearch colleges. Estimates are made difficult by the constant shift of part-time instructors in and out of the "pool," by curriculum changes dictated by budget constraints, and by the fact that astronomy courses are often taught by faculty recruited from other fields. Still, we estimate that our sample of 400 represents something like 30% to 40% of the total. We strongly recommend identifying all of the members of this important group and doing more to make them feel welcome in the astronomical community.

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