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American Chemical Society

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Survey of Master's Degree Programs in Chemistry

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- 2009 ACS Directory of Graduate Research
- PhD Programs in Chemistry Survey Report (2008)
- PhD Recipients in Chemistry Part I (Spring 1999)
- PhD Recipients in Chemistry Part II (Fall 2000)

The principal goals of the Committee on Professional Training (CPT) are to promote and assist in the development of excellence in postsecondary chemical education, to collect and disseminate data on trends and developments in modern chemical education, and to cooperate with professional and educational groups having mutual interests and concerns. The ACS approval program for four-year bachelor's degree programs and the *ACS Directory of Graduate Research* (DGR) are perhaps the most obvious activities of the CPT that are germane to these goals. The CPT, however, also conducts periodic studies of graduate education at both the master's and doctoral levels. These studies are conducted via questionnaires completed by graduate departments. In spring 2008, such a report on PhD programs was published by CPT. This report is the companion study on programs that grant master's degrees.

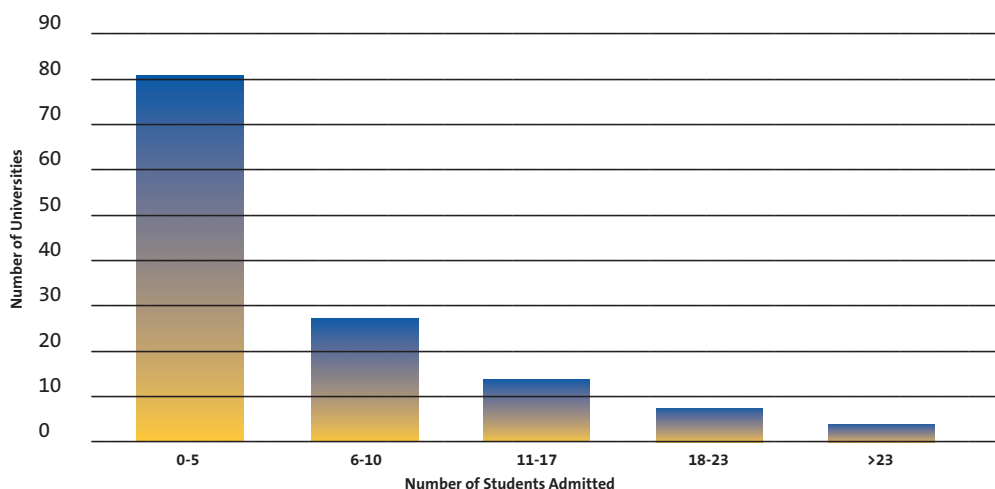
Since master's degrees are granted by departments at both comprehensive and doctoral institutions, both sets of data are included in this report. When there is no significant difference between the data sets, combined data are presented. When the data sets are significantly different, they are presented independently. Data from PhD-granting programs (PGPs) were abstracted from the 2006 survey of 196 schools. These data do not distinguish between students that enter specifically for a master's degree and those who were originally PhD-bound. The 109 master's-granting, but non-PhD-

granting programs (NPGPs) known to CPT, were surveyed in June 2008. 139 PGPs and 66 NPGPs provided usable data for this report. Although some overlap occurs, the surveys were not identical. Where appropriate, the findings from the current survey are compared to the recent PhD survey. Comparisons to CPT's 1998 survey of master's programs are made at the end of this document. It should be noted that with the exception of the gender and ethnic diversity data, the information presented in this report is based solely upon interpretable data from the programs that responded to the CPT surveys (~71% of PGPs and ~61% of NPGPs).

Master's degree programs continue to account for almost 50% of the graduate degrees awarded in chemistry.

Types of master's programs. Master's degrees vary in type. Of the responding programs, the most commonly offered degrees are the Master of Science (92%) and the Master of Arts (14%). Also offered are Professional Master's (3%), Master's of Material Science (1%), and miscellaneous degrees (~ 5%) in Education and in Natural or Integrated Sciences, especially catering to in-service teachers. Roughly 17% of master's

Figure 1. Number of Students Admitted Annually to PGPs & NPGPs



programs offered two master's degrees, only 1% offered three or more degrees. In PGPs, 19% of master's programs were interdepartmental such that the degree was not granted by the chemistry department alone. This number rose to 27% for NPGPs.

Admission, duration, and graduation. The total number of students admitted annually for study in the master's program was 1081 (as reported by respondents) of whom 33% were admitted to NPGPs. At NPGPs, the number of students admitted per year varied between 0 and 40 (average = 9.2; Figure 1). Of NPGPs, only 20% have no minimum time to the master's degree; of the vast majority of programs with minima, the distributions are one year (17%), two years (81%), and three years (3%). About 65% of students completed degrees in two years, 30% did so in three years, and only 5% of students finished in four years. At PGPs, the number of students entering the master's program varied from 1 to 20 (average = 5.8; Figure 1). Half of the PGPs indicated that they admit students who specifically target the master's degree only. The annual number of graduates ranged from 1 – 40 (the highest number among NPGPs is 25). Overall, 69% of all

programs graduated fewer than 5 students annually and only 3% graduated more than 18 per year. On average, PGPs account for 67% of the 1085 master's graduates annually. The graduation rate at both PGPs and NPGPs is ~ 5.4 students per year.

Requirements: course work, theses, and examinations. At reporting NPGPs, the number of non-research, formal credit hours required for a degree varied from 15 to 33 (average = 27.3; Figure 2), but at reporting PGPs, the number varied greatly

from 2 to 64 (average = 20.6; Figure 2). Interestingly, PhD programs require an average of 20 credit hours to earn the degree. Thus, master's and PhD students at PGPs essentially take the same number of credit hours, and this number is less (by roughly two 3-credit courses) than the requirements for a master's degree at NPGPs.

It is possible to earn a master's degree by doing course work only at 30% of NPGPs. At 35%, the degree can be earned by taking course work and performing research, but not by writing a thesis. An equal number (32.5%) of NPGPs allow the option of taking course work and writing a library thesis. At PGPs, the percentages are 32%, 44%, and 24%, respectively. Of NPGPs, 57% offered both thesis and non-thesis options, 41% had only the thesis option, and 2% had only a non-thesis option. About 36% of NPGPs did not require a thesis for graduation; at PGPs, this number rose to 43%. Some form of qualifying (placement or entrance) or comprehensive (exit) exams are required of master's students at 57% of PGPs (for 59% of these the exams are the same as for PhD students). At NPGPs, this number rose to 70%: 28% required qualifying exams only, 30% required comprehensive exams only, and 12% required

Figure 2. Number of Formal Non-Research Credit Hours Required for Degree.

Figure 2a. At NPGPs

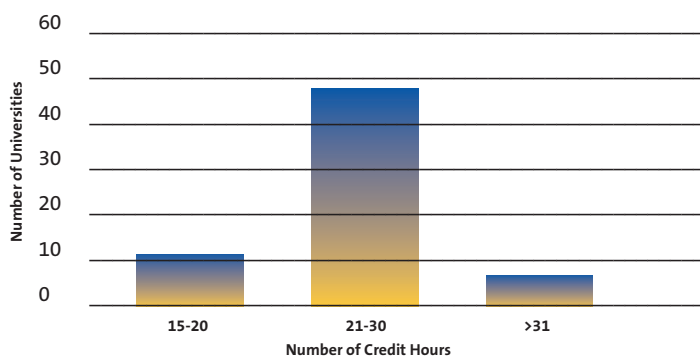


Figure 2b. At PGPs

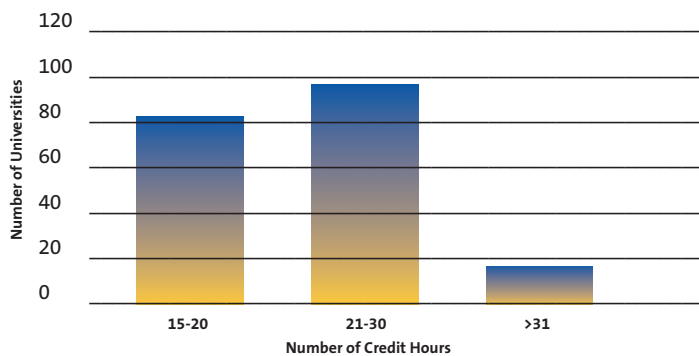
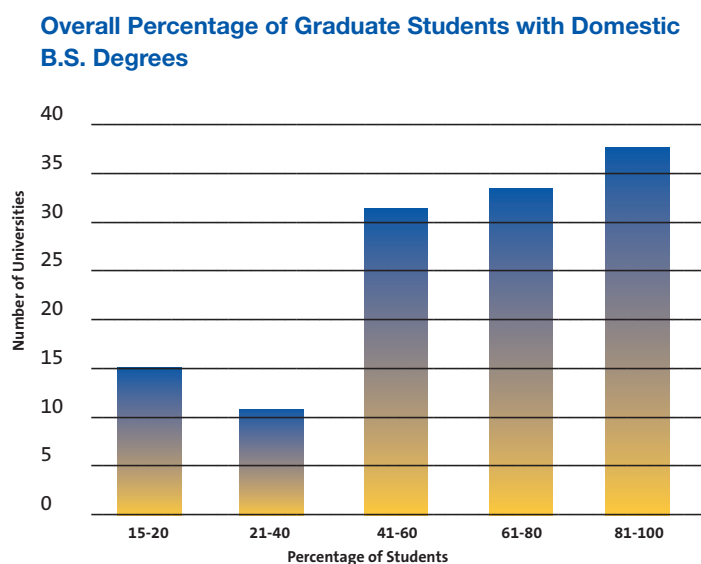
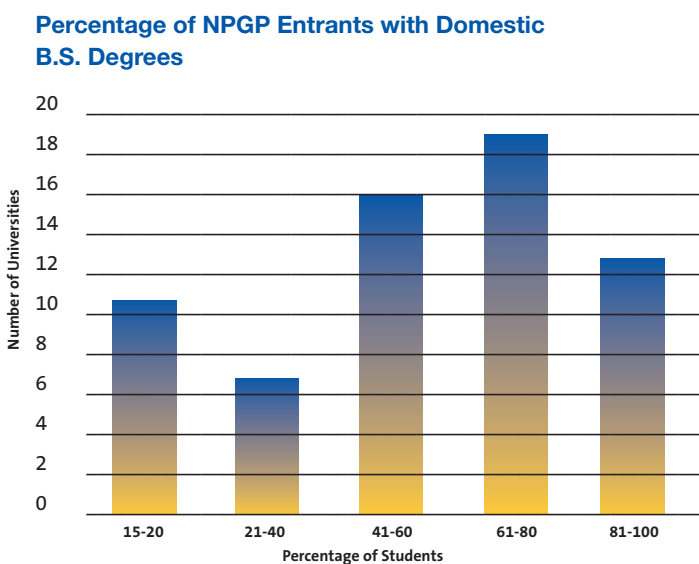


Figure 3. Distribution of Graduates with Domestic B.S. Degrees at NPGPs and Overall



both. By comparison, 71% of PhD programs require qualifying exams, and 31% require comprehensive exams. Only 4% did not require any non-course work exams.

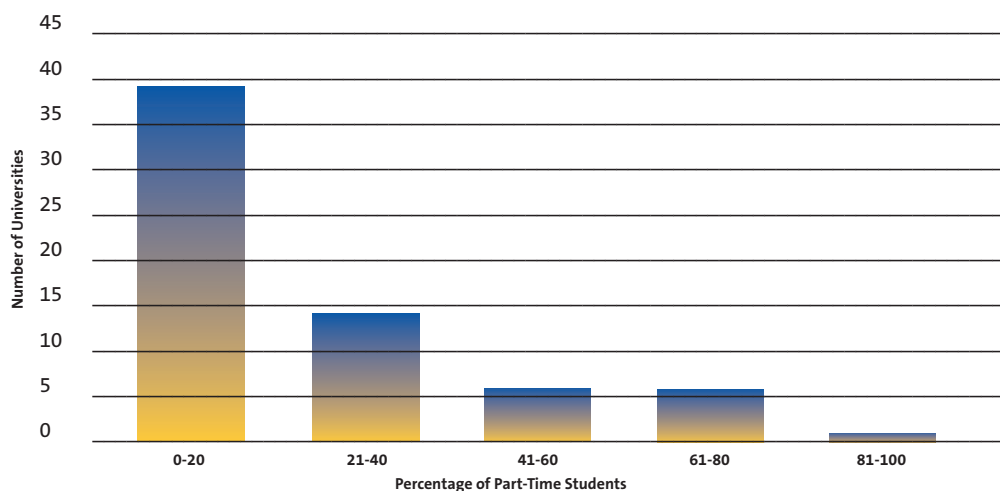
Financial support. An overwhelming 91% of reporting NPGPs provide support to graduate students via teaching assistantships. Another 66% provide support via research assistantships, and 21% provide support by other means including tuition waivers, summer stipends, fellowships, and scholarships. In general, 67% of NPGPs provide multiple means of student support. The situation at the PGPs is unclear, as 79 departments did not report on this statistic. Of the 60 that reported, 98% provided teaching assistantships, 83% provided research assistantships, and 12% provided other means of support. Only 2% did not provide any support for their master’s students. These data contrast to findings at PhD programs where 38% of graduate students are on teaching assistantships and 40% are on research assistantships.

(5.7% of PhDs) and underrepresented minorities (Black, Hispanic, American Indian, Alaskan Native) accounted for 7.8% (5.8% of PhDs). It is not possible to extract from the data the number of master’s degrees to women or ethnic minorities at PGPs and NPGPs. The diversity indicators examined in the current study were the percentages of domestic and part-time students. On average, 59% of entrants at NPGPs earned their bachelor’s degree at a domestic university. This number rose to 69% at PGPs (Figure 3). Interestingly, the recent PhD survey suggested that, in general, the level of diversity rose as program size fell. For example, the percentages of domestic students at large, medium, and small PhD programs were 62.7%, 47.4%, and 47%, respectively. This relationship appears to be echoed in the master’s programs as well. Roughly 81% of NPGPs reported that part-time students made up less than 40% of their student body (Figure 4). Of this population of part-time students, about 61% were

Diversity in the student population.

The most common metrics of diversity - ethnicity and gender - were not determined in this survey. However, from the most recent NSF survey (2006)³, 49% of master’s degrees in chemistry were awarded to women in that year (compared to 31.4% of PhD degrees). According to the most current NSF data, 67.3% of master’s degrees in chemistry were earned by US nationals and permanent residents (59.8% of PhDs)⁴. Asians/Pacific Islanders accounted for 6.2% of chemistry master’s

Figure 4. Percentage of Part-Time Graduate Students at NPGPs



supported at least 50% by their employers, indicating significant buy-in from these stakeholders in advancing the education and training of their workforce.

Goals of program. Master’s-granting programs often carve out specific niches with respect to the training of graduates. At NPGPs, specific program goals were:

- preparation for more advanced study (97%)
- preparation for industry [75% (compared to 78% for PGPs)]
- combined bachelor’s/master’s degrees (62%), and
- teacher training [43% (compared to 37% for PGPs)].

Of NPGPs specifying industrial preparation as a goal, only 7% were in partnership with a specific employer (compared to 21% among PGPs), while 28% (29% among PGPs) trained students for a particular sector of industry. When teacher preparation was identified as a program goal, 58% of NPGPs matriculated in-service teachers (compared to 57% for PGPs), 36% (48% for PGPs) accepted pre-service teachers, and 31% targeted both pre- and in-service teachers. Only for 19% of NPGPs is a master’s degree program specifically designed to prepare students for employment with the master’s as the highest earned degree. About 50% of these programs are Professional Master’s or forensic science programs.

Departmental budgets at NPGPs. There are tremendous variations in the levels of funding available for research and related activities at NPGPs (Figures 5a-e). The departmental budget for research varied from 0 (11% of programs) to 1 million dollars (average = \$86K, median = \$20K). More than 53% of programs have a budget of \$20K or less, whereas almost 20% have annual research budgets in excess of \$100K (Figure 5a). Almost 70% of programs operate on a library budget less than \$5K per year (average = \$27K; median = \$2.5K). A full third of programs have no departmental allocations for library resources. Roughly 12% of programs have annual library budgets greater than \$100K (Figure 5b).

With respect to funding to procure instrumentation, more than 9% of departments have no allocations for instrument purchase. Almost half (49%) operate on an annual budget of \$20K or less, while only 9% enjoy budgets greater than \$100K for purchases. The average departmental allocation is \$45.5K while the median is \$25K (Figure 5c).

Similarly, for instrument maintenance 9% of departments have no funds, and 76% of departments have an annual budget of \$20K or less. No departments have allocations over \$100K for instrument maintenance. The average departmental allocation is \$17.5K, while the median is \$10K (Figure 5d).

Another fiscal issue facing departments is funding for temporary/adjunct faculty: 14% of programs report no allocations to hire such faculty, and 38% had an annual budget of \$20K or less. Thirteen percent of departments had annual allocations greater than \$100K for this purpose. The average departmental allocation is \$49.5K, while the median is \$35K (Figure 5e).

It is not clear how much concern should be raised when one considers that a significant fraction of NPGPs do not appear to have “appropriate” budgets. Obviously some fraction of these apparently “underfunded” programs do not conduct or require laboratory research. Therefore, research and instrumentation are not priorities, and funding for these are low or nonexistent. In the larger fraction of programs that do have a research component, it is likely that they are supported, at least in part, by the largesse of their undergraduate programs and/or by direct or indirect funding from faculty grants. Funds may also be provided on an “as needs” basis after petitions to their administration, or by some other fiscal mechanism that may well suit their goals and needs. The level of concern regarding low and nonexistent library budgets is also difficult to gauge. Master’s programs in departments with

Figure 5. Budgets at NPGPs

Figure 5a. Research Budget at NPGPs

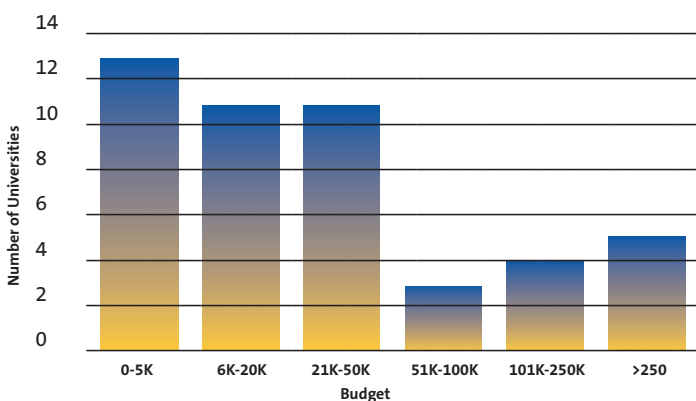


Figure 5b. Library Budget at NPGPs

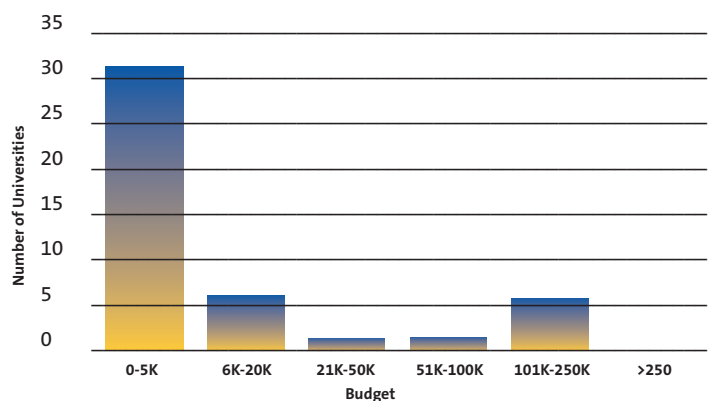


Figure 5. Budgets at NPGPs

Figure 5c. Budgets for Instrumentation Purchases at NPGPs

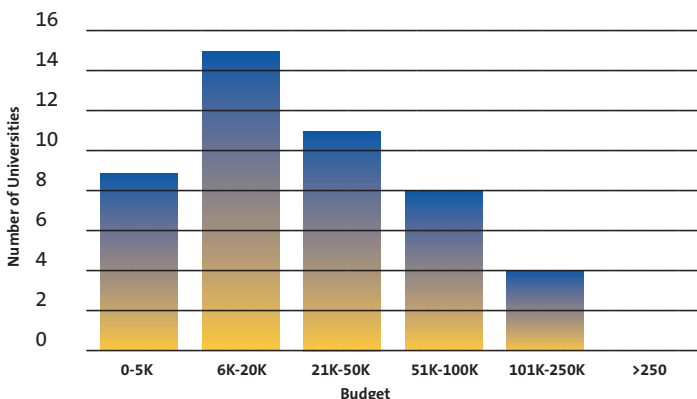
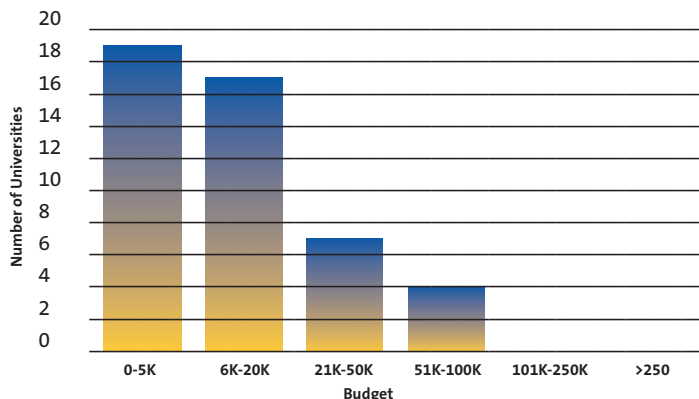


Figure 5d. Budget for Instrumentation Maintenance at NPGPs



an ACS-approved bachelor's degree program may have a well-stocked library that meets and exceeds requirements, but the funding is entirely through the library and not the departmental unit. Additionally, a library may allocate funds for departmental expenditures through the library's budget, but this arrangement would not be measured by the survey instrument. Finally, the funding for temporary/adjunct faculty obviously would be based upon program needs. For programs with a full complement of faculty, an appropriate budget would be zero. For those that have significant turnover, lack full-time expertise in certain subdisciplines, or rely on temporary/adjunct faculty to proctor laboratories or teach courses to non-majors, allocations may be significant.

There may be many more scenarios that account for the sizes and variations in departmental allocations. Like beauty, "appropriate" may be in the "eye of the beholder" and may vary between programs to match individual program needs and objectives. One hopes that programs have the resources necessary to effectively train this important segment of the national technological workforce.

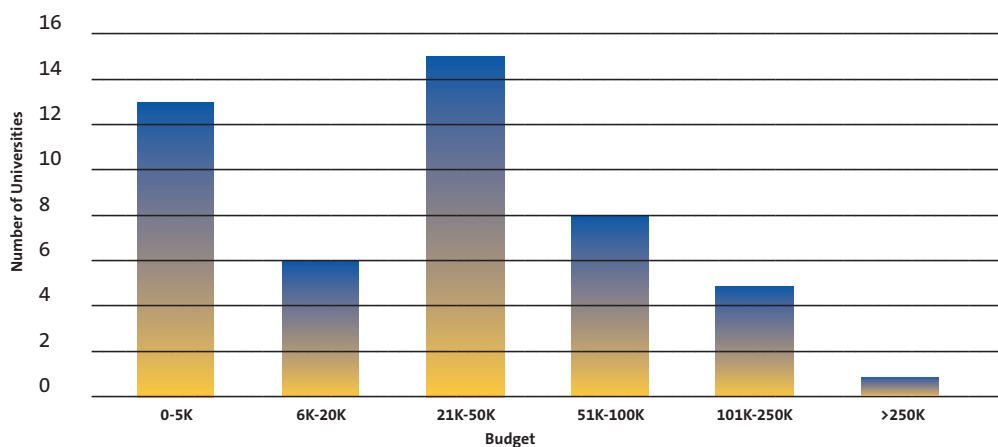
Trends observed over the past decade.

Table 1 compares some of the key results of the current survey with the parallel survey in 1998. In comparing results from these two data sets, caution must be taken since the statistics reported for each set depend completely upon the characteristics (size, type, etc.) and numbers of responding institutions in each survey (79% in 1998 vs. 67% in 2008). This caveat does not apply to the NSF data where there was more than a 99% response from programs.

In 1998, 49% of master's-seeking students were at NPGPs; in 2008, this number fell to 33%, suggesting a major shift toward matriculation at PGPs. There was also an overall 14% decrease in the number of students admitted for master's degrees. Additionally, there was a 9.2% decline in the total number of graduates with the greater decline apparently occurring at NPGPs. PGPs accounted for 62% of earned masters in 1998; in 2008 they account for 67%. There appears to be a 10% drop in the number of part-time students seeking master's degrees at NPGPs (no comparable data from PGPs). Whether this trend reflects a diminished interest by employees in seeking master's degrees, a decreasing commitment from employers to encourage and support employees pursuing these degrees, or a diminished capacity of master's programs to attract and support students, is unknown.

The percentage of graduate degrees earned by women rose by roughly 3% at both the master's and PhD levels. Except for ~ 2% drop in degrees (both master's and PhD) to Asians/Pacific Islanders, there is little change in the chemistry graduate ethnicity profiles. Interestingly, while

Figure 5e. Budget for Temporary/Adjunct Salaries at NPGPs



the percentage of master's degrees earned by US nationals and permanent residents rose by 0.8%, there was a 7.1% decline in PhDs earned by this group. Although the minimum time to earn a degree appears to have risen, the average time taken to earn the degree seems to have fallen slightly (no data available for PGPs). Interestingly, it appears that the population of master's students with domestic bachelor's degrees has decreased slightly because of a small decrease at NPGPs, but a relatively similar increase at PGPs. The thesis requirement seems to have declined significantly at all institutions, whereas it has become more common to earn a degree by course work only at NPGPs, but less so at PGPs. Many more programs across the spectrum appear to require at least one type of formal examination not related to course work. Evidently, fewer NPGPs prepare students specifically

for industry, but the trend is reversed at PGPs. However, teacher training seems to have grown in importance at both types of institutions.

Summary. The master's degree continues to be an important component of graduate education in the chemical sciences accounting for almost 50% of the graduate degrees awarded in this field. The current report provides an analysis of the survey data on master's-granting programs across the United States and is, at best, a snapshot of these programs. It compares statistics between programs where the master's degree is the highest offered by the department and those where the PhD is also offered. The report also highlights the evolution of master's degrees, and the programs offering them, over the past decade.

Table 1. Comparison of Selected Results from the 1998 and 2008 Surveys

Survey Question	1998 Survey Results			2008 Survey Results		
	Combined	NPGPs ¹	PGPs ²	Combined	NPGPs	PGPs
No. of students admitted	1257	611	646	1081	355	726
No. of graduates	1195	452	743	1085	358	727
% Master's degrees to women ³	45.9	*	*	48.8 ('06)	*	*
% PhD degrees to women ³	31.4	*	*	34.3 ('06)	*	*
% Master's degrees to US citizens & permanent residents ⁴	66.5	*	*	67.3 ('04)	*	*
% PhD degrees to US citizens & permanent residents ⁴	66.9	*	*	59.8 ('04)	*	*
% Master's degrees to underrepresented minorities ⁴	8.0	*	*	7.8 ('04)	*	*
% PhD degrees to underrepresented minorities ⁴	5.5	*	*	5.8 ('04)	*	*
% Master's degrees to Asians/Pacific Islanders ⁴	7.9	*	*	6.2 ('04)	*	*
% PhD degrees to Asians/Pacific Islanders ⁴	7.8	*	*	5.7 ('04)	*	*
Minimum time to degree	1.7	1.7	1.7	N/A	2.2 yrs	*
Average time to degree	2.5	2.5	2.5	N/A	2.4 yrs	*
Credit hours	28.6	30.3	27.7	21.9	27.3	20.6
% Domestic Bachelor's	65	60.5	67.3	63.8	58.7	69
% Part-time students	23	33.3	16.7	N/A	23	*
% Requiring Thesis	74	82	70	59	64	57
% Course work only	35	25	42	31.7	30	32
% Requiring specific exams	52	66	44	61	70	57
% Preparation for Industry	76.2	89	59	76.8	75	78
a) Partnership	6.2	3	11	16.8	7	21
b) Sector	3.8	5	2	28.8	28	29
% Teacher training	30.8	32	29	41.9	43	37

* Not surveyed. ¹Non-PhD-granting programs (programs where the master's degree is the highest offered). ²PhD-granting programs. ³Data from [NSF 08-321]. ⁴Data from nsf.gov-SRS Sci. & Eng., (degrees by citizenship, race/ethnicity of recipients).

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