

DOCTORATES AND JOBS, 1974 REPORT

by R. D. Anderson*

The data for 1974 employment and for numbers and distribution of doctorates are generally similar to that of a year ago with the most interesting changes noted below. Using comparisons with data from the past several years, some trends are now discernible, a number being encouraging but others alarming.

The good news is that, statistically, unemployment was not worse than last year, the number of new Ph.D.'s in pure mathematics continued to decline (generally in all categories of departments), and the percentage of the new doctorates who are not U.S. citizens went up markedly, from 21% a year ago to 28% this year. From fall 1972 to fall 1973 there was some increase, about 2%, in enrollment in mathematics

courses, reversing the 2% decrease of a year previous, thus some pressure may develop for increasing total faculty size.

The bad news is that we continue to head rapidly toward great inflexibility of our national faculty, a condition where the percentage with tenure or some form of "moral tenure" is very high. With a stable total faculty size, there will soon be very few positions other than replacements for those retiring or dying, except for temporary positions in some Ph.D. producing departments. Thus there are limited employment opportunities in academia for those who have had degrees for four or more years; the plight of nonretained people in this category is severe and probably becoming much worse.

TABLE 1
 1974-1975 EMPLOYMENT STATUS OF NEW DOCTORATES IN THE MATHEMATICAL SCIENCES

Type of Employer	PURE MATHEMATICS											Totals
	Algebra and Number Theory	Analysis and Functional Analysis	Geometry and Topology	Logic	Probability	Statistics	Computer Science	Operations Research	Applied Mathematics	Mathematics Education	Other	
University	41	69	47	5	6	33	28	2	29	7		267
College	49	52	43	5	6	27	21	2	12	9	8	234
Two-year colleges and high schools	11	6	5			1	1		1	2	1	28
Other academic departments and research institutes	1	3	7	2	1	14	13	7	11		4	63
Government		6	4	2	1	9	5	4	10		2	43
Business and industry	9	14	4		4	15	30	13	18		10	117
Canada	8	12	4	3	2	6	10	3	8		5	61
Foreign	20	23	20	3	5	24	14	6	9	1	3	128
Not seeking employment	1	1	3								1	6
Not yet employed	17	34	21	3	3	9	4		15	1	4	111
Unknown	12	17	14	3	8	8	17		8		3	90
Totals	169	237	172	26	36	146	143	37	121	13	48	1,148

* This report has been prepared by the author on behalf of the AMS Committee on Employment and Educational Policy whose other members are Michael Artin, Wendell H. Fleming, Calvin C. Moore, Richard S. Palais, and Martha K. Smith. The data in the report have been compiled by the AMS staff under the direction of Lincoln K. Durst.

This year's table on the Employment Status of New Doctorates (Table 1) is based only on the degrees listed in the October *Notices*; last year's table included degrees listed in both the October and November issues of *Notices* and was therefore more complete. A comparison with last year's figures follows.

(1) Most of the degree and employment patterns were very similar to those of a year ago.

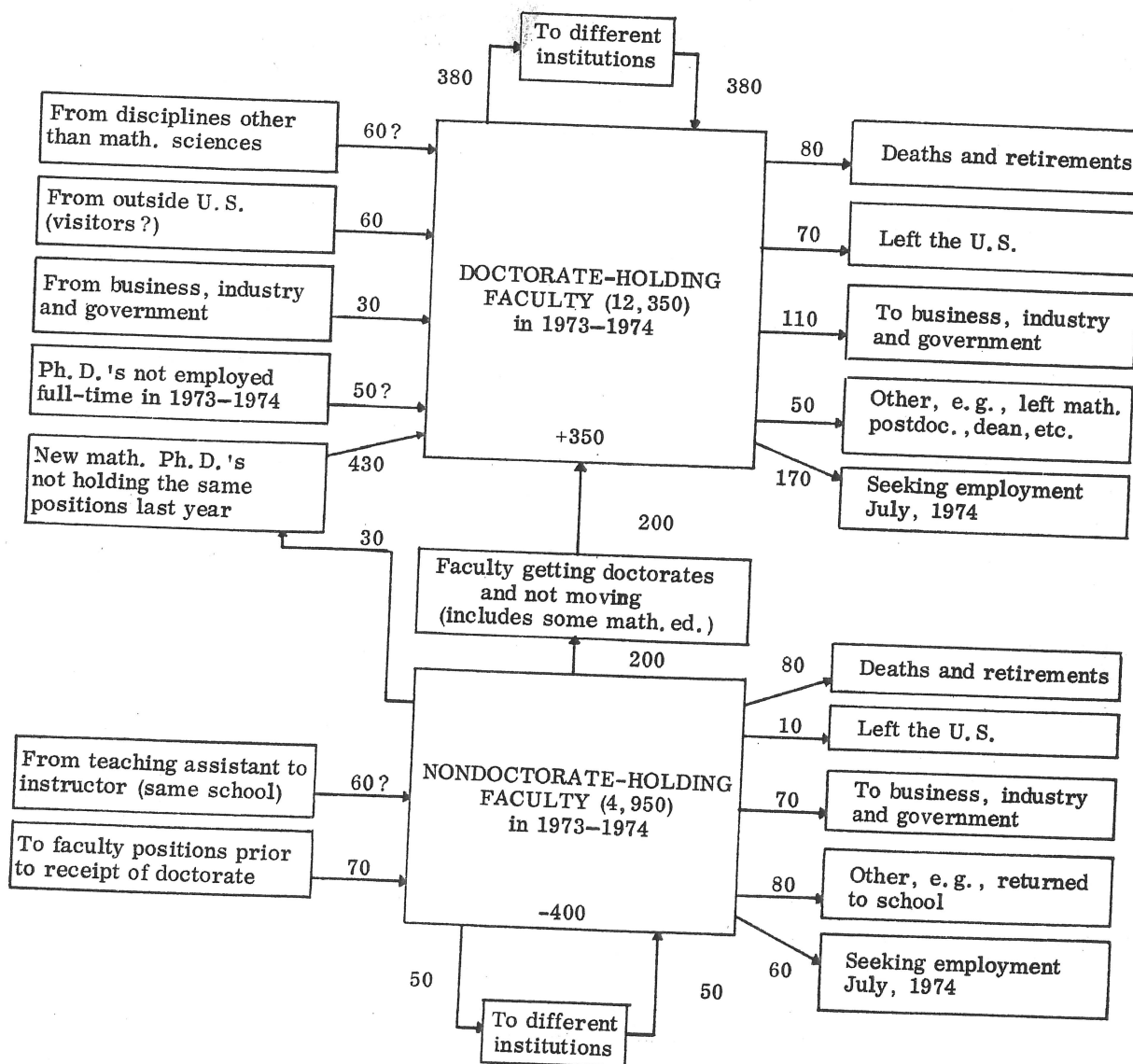
(2) This year a separate count was maintained of new Ph.D.'s taking positions in academic computer centers, research laboratories, or teaching in departments other than the mathematical sciences; there were 50, an encouraging

number, but only six had degrees in pure mathematics. These 50 are grouped with thirteen positions in research institutions in Table 1.

(3) The number taking positions in two-year colleges and high schools was twenty-eight, up from nineteen a year ago but still a very small percentage of the total.

(4) The percentage of the new doctorates going into business and industry was almost exactly the same as last year, of those going into government was down about 10% and those going abroad up about 5%. The percentage of those not yet employed was up less than 5%.

FACULTY FLOW DIAGRAM 1973-1974 to 1974-1975
 Full-Time Mathematics Faculty in Four-Year Colleges and Universities in the U.S.



The Faculty Flow Diagram which includes faculties in statistics and computer science is generally quite similar to that of a year ago except that there was less mobility among the non-doctorate faculty, and apparently the total number of retirements and deaths was down from 240 a year ago to 160 this year. This reduction may be a statistical abnormality or it may represent a tendency to postpone retirement in the face of current and prospective inflation. As before, the diagram represents projections to the total population based on reports from departments involving about half the total faculty. The numbers with question marks are based on inferential rather than direct information.

THE REDUCTION OF NUMBERS OF
 PURE MATHEMATICS PH. D. 'S

As cited in a CEEP report in the October 1974 *Notice*, there has been a reduction in the annual number of pure mathematics degrees over the past three years. That report dealt with numbers of degrees as compiled by the National Research Council giving numbers of all degrees

from fiscal 1968 through fiscal 1973 (i. e. through June 1973). It recorded a slight drop in pure mathematics degrees from fiscal 1971 to fiscal 1972 and a rather sizable drop (about 10%) from fiscal 1972 to fiscal 1973. The author has counted the numbers of pure mathematics degrees reported to the AMS by departmental chairmen over the past three years. The pure mathematics classification is not clear-cut since some degrees in partial differential equations, numerical analysis or probability, for example, could be classified either as pure or applied. However, the same classification scheme has generally been used for the three years and thus the comparative figures are probably reliable. Unfortunately, not all departments report (on time) every year to the AMS; in particular, some lower ranked departments do not report some years.

Table 2 shows the number of pure mathematics doctorates by those departments which have reported in each of the past three years in class I (the top twenty-seven ACE ranked mathematics departments), class II (the thirty-eight other ACE rated departments) and class III (the 91 ACE unrated mathematics departments).

TABLE 2
 PURE MATHEMATICS DOCTORATES

	<u>Fiscal 1972</u>	<u>Fiscal 1973</u>	<u>Fiscal 1974</u>	<u>Percentage Drop 1972 to 1974</u>
Class I	291	281	219	25%
Class II	212	180	169	20%
Class III	158	127	122	23%
Total	661	588	510	23%

In addition, there were 65 pure mathematics doctorates in 1972, 87 in 1973 and 62 in 1974 reported by departments (chiefly in class III) that did not report degrees each year. There are known to be a few other pure mathematics degrees that are (so far) not reported to the AMS.

It is encouraging that the reduction in pure mathematics degrees over the past two years has generally occurred fairly uniformly in all classes of departments and that the reduction has been so pronounced. Had the numbers not dropped about 180-200 (or 25%) over the past three years, the present unemployment situation would be much more severe since almost every employer seeking pure mathematics doctorates has found acceptable and available candidates from among those applying. With a prospective ten-year steady state annual employment demand of perhaps 200-300 pure mathematics doctorates (for long range retention), we should continue to reduce the numbers getting degrees until we are much closer to equilibrium. However, as a profession we can take comfort that we have been reacting far more quickly than had been anticipated. Our total annual number of degrees in the mathematical sciences in the U. S. as counted by the National Research Council has stabilized at about 1,200, far below the earlier projection of the Office of Education for over 2,000 degrees

per year by 1974.

NUMBERS OF GRADUATE STUDENTS

There was a drop of about 6% in the total number of graduate students in Ph. D. producing mathematics departments from 1972 to 1973 but the number in 1974 is expected to remain the same as that in 1973. The number of first year students is expected to rise about 2% from the 1973 level after falling about 5% from 1972 to 1973. The number of teaching assistants in these departments fell 2% a year ago and is expected to drop another 2% this fall.

In master's level departments and in statistics and computer science departments, the number of graduate students, of first year graduate students, and of teaching assistants have generally risen a total of 10% to 20% over the past two years.

CITIZENSHIP OF NEW DOCTORATES

Table 3 shows the percentages of U. S. doctorate recipients in the mathematical sciences who are not U. S. citizens. The data are from the annual National Research Council reports through fiscal 1973 and from recent incomplete AMS figures for fiscal 1974. In fiscal 1973, the comparable AMS figure was 21%, in agreement with the NRC figure.

TABLE 3
 DOCTORATES WITH FOREIGN CITIZENSHIP

Fiscal Years	
1968	15.7%
1969	15.3%
1970	15.6%
1971	17.6%
1972	18.2%
1973	20.8%
1974	(28.0%)

The geographical location of first employment of new doctorates in mathematics is also recorded by the NRC. Of those for whom the region of employment was known, the percentage with foreign employment went up from about 7% in 1970 to 13% in 1973. (The 1974 matrix (Table 1) of areas of degrees and types of initial employment includes Canadians and is not directly comparable to NRC figures.)

EMPLOYMENT OF THOSE WITH DEGREES IN APPLIED AREAS

There was very little unemployment reported among computer science, statistics, and operations research doctorates, either among those previously employed in academia or among those with 1974 degrees. There was indication of a modest number of available positions still unfilled in July. The publication "Employment Information for Mathematicians" also revealed substantial demand for statisticians and computer scientists.

The percentage of new doctorates in applied mathematics as such (presumably classical applied mathematics) who were not yet employed in July was almost the same, 12%, as the percentage of new doctorates in pure mathematics who were not yet employed.

The numbers of new doctorates in computer science and statistics were apparently about the same as last year (or down slightly), but because a substantial number of departments in these areas do not submit reports to the AMS, our figures are not complete or necessarily accurate. The National Research Council figures, which will be available next summer, should give essentially complete information.

WOMEN ON THE FACULTY

There was an increase of about 50 women

doctorates on the national faculty and a decrease of about 90 women nondoctorates on the national faculty. In Ph. D. producing mathematics departments, women comprise about 4% of the doctorate-holding faculty; in masters' and bachelors' level departments, they comprise between 9% and 10% of the doctorate-holding faculty.

TEACHING LOAD PATTERNS

This summer, the AMS collected several types of information relative to teaching loads. They show no increase in average teaching loads from fall 1972 to fall 1973 and a probable slight increase in teaching loads anticipated by department chairmen in fall 1974 as compared to fall 1973. The data for fall 1972 to fall 1973 are based on chairmen's reports of numbers of sections, numbers of students enrolled and numbers of faculty members (full-time, part-time, and teaching assistants). Based upon reports from 40%-50% of all department chairmen, representing more than 50% of the student body, the total number of sections offered in 1973 was almost exactly the same as that of 1972, down about 0.2% for mathematics departments as such and up about 0.2% for all departments in the mathematical sciences. The total faculty was almost exactly stable for those two years, one estimate showing, for example, the full-time faculty the same and another down less than 0.3% (i. e. about 50 out of 17,500). It should be remarked that the data, which show very little if any change, are generally consistent across several classifications of departments. While the numbers of sections were stable, the course enrollments were up slightly, about 2% from 1972 to 1973, offsetting a 2% drop from 1971 to 1972. Thus, with a stable faculty size, there was a slight deterioration in the student/faculty ratio, reversing a favorable pattern of previous years. But such a development should increase the pressure for more faculty.

It was not possible, of course, to get enrollment or section figures for the fall of 1974 so, in order to get information concerning the changes from the fall of 1973 to the fall of 1974, the AMS asked all department chairmen to choose one of five alternatives to describe anticipated changes in average or normal teaching load of full-time faculty in 1974-1975 as compared to 1973-1974. The responses are presented in Table 4.

TABLE 4
 ANTICIPATED CHANGES IN WEEKLY TEACHING LOAD
 1973-1974 - 1974-1975

Response Rate	Class	DECREASE		ESSENTIALLY NO CHANGE	INCREASE	
		More than Half-hour	Half-hour or less		Half-hour or less	More than Half-hour
15/27	I	0	0	13	2	0
23/38	II	0	0	22	1	0
52/91	III	0	1	47	0	4
22/65	IV	0	0	17	2	3
18/106	V	0	1	15	0	2
11/30	VI	0	1	9	1	0
150/325	M	3	1	124	13	9
301/910	B	5	4	253	10	29

Thus a net of about 10% of chairmen expect some increase in teaching loads for 1974-1975, about half of those expecting increases of one-half hour or less per week. Whether this will be borne out by figures available next summer remains to be seen. (For 1973, chairmen expected very minor increases which statistically did not materialize.)

The classifications used in Table 4 are:

- I the top 27 ACE ranked departments
- II the other 38 ACE rated departments
- III the 91 unrated Ph. D. producing mathematics departments
- IV the 65 Ph. D. producing statistics, biostatistics and biometry departments
- V the 106 other U. S. Ph. D. producing departments (64 computer science, 18 operations research and 24 miscellaneous, including applied mathematics)
- VI the 30 Canadian Ph. D. producing departments
- M the 325 masters' producing (but not Ph. D. producing) departments
- B the 910 bachelors' producing (but not masters' producing) departments

THE REPLACEMENT OF NONDOCTORATE FACULTY

For each of the past three years, from 300 to 400 nondoctorate faculty have been replaced by doctorates, perhaps one-half being self-replacements, that is, faculty members who have received doctorates. Among the latter are some who returned to graduate school for their degrees

and others who were hired while writing their dissertations. This replacement of nondoctorate faculty has been one of the important avenues of academic employment for doctorates. However, two recent developments suggest strongly that except for self-replacement and natural attrition by retirement or death, we can expect very little further reduction in nondoctorate level faculty. These developments are:

(1) only about two-thirds as many nondoctorates left faculty positions this summer as last summer and

(2) of all nondoctorate faculty above the rank of instructor about 80% are tenured and at least another 15% are individually expected to be retained indefinitely.

TENURE

The AMS collected data on changes in numbers of faculty with tenure from fall 1973 to fall 1974 on two different forms with slightly different questions. The results showed rises of 3% to 4% in the percentage of doctorate-holding faculty with tenure, the one set of data showing a rise under 3% and the other about 4%. A further question was asked to show how many of the existing faculty without tenure were, as individuals, expected to be retained indefinitely. For the mathematics departments in groups I, II, III, M and B (all U. S. departments except Computer Science, Statistics, Operations Research, and Applied Mathematics) the results are summarized in Table 5 for all full-time doctorate faculty at the assistant professor level or above.

TABLE 5

	I	II	III	M	B
Tenured - Fall 1973	70.7%	68.0%	61.5%	61.1%	51.6%
Tenured - Fall 1974	72.8%	70.5%	64.3%	63.9%	54.0%
Nontenured but expected to be retained indefinitely, Fall 1974	3.5%	5.1%	12.2%	16.0%	26.0%
TOTAL 1974 (Rows 2 and 3)	76.3%	75.6%	76.5%	79.9%	80.0%

The figures are from the AMS faculty mobility survey and show a slightly lesser increase in tenured faculty than do the annual salary survey figures. The Ph. D. producing departments I, II, and III have about 5,500 total faculty (5,100 with doctorates), the masters' level departments also have about 5,500 (3,900 with doctorates), and the bachelors' level about 4,500 (2,700 with doctorates) according to 1974 projections. The situation is probably more rigid than the numbers indicate since some (or many) new, or recent, department members will be retained even though not yet identified as expected to be retained indefinitely. Also, as reported above, at least 95% of the nondoctorate faculty above the instructor level in the masters' and bachelors' departments are tenured or are expected to be retained indefinitely.

THE EMPLOYMENT POSSIBILITIES FOR NONRETAINED FACULTY

As the Faculty Flow Diagram shows, there were about 170 nonretained doctorate-holding faculty members not yet employed as of July. This was an improvement over the comparable number, 210, for July 1973. This summer the AMS collected specific further information on hiring patterns of new faculty. For example, all 438 masters' and bachelors' level departments reporting hired not a single new faculty member with tenure. Indeed these departments hired only thirteen people who had their degrees seven years or longer and were from U. S. academia. In the same departments only twenty-seven people who had their degrees from three to six years were hired from U. S. academia. Projections from the

sample to the total number of such departments indicate that only about 80-90 mathematicians who had their degrees more than three years were hired from U. S. academia for 1974. Furthermore, projections to all 156 Ph.D. producing mathematics departments (in classes I, II and III), show the total number of hirings from U. S. academia of people out more than three years to be about 45-50, of whom about fifteen were hired with tenure.

It would appear that for each n , $4 \leq n \leq 7$, there were only about thirty doctorates out n years who left their academic positions and found jobs in four-year college and university mathematics departments, and this figure includes those who moved voluntarily or got temporary positions.

With, for each such n , an average of perhaps 500 pure mathematicians out n years and

now in academia and with many in positions that will not be permanent, we are clearly headed into a most difficult time for such nonretained people. As higher percentages of the national faculty become tenured, the situation for those who must move gets more and more severe. A complicating factor is that most available positions appear to be at or near the beginning level, thus creating financial problems even for the nonretained who do get academic positions.

The AMS and the Committee on Employment and Educational Policy welcome suggestions as to how they may be helpful to those who are not retained in academia and do not find positions in academia. Efforts by CEEP to locate sources of funds for potential training of such people in contemporary applications of mathematics have been discouragingly unsuccessful so far.

The results of the Eighteenth Annual AMS Survey were published in two parts, in the October and November issue of the Notices of the American Mathematical Society. A copy of the other part is available upon request.

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