Some Patterns of PhDs in Mathematics Awarded Annually by Institutions of Higher Education in the United States over the Last Two Decades

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Over the years, the *Notices* has provided data related to new doctorates in mathematics. This includes the names of graduates, their dissertation titles, and the institutions awarding the degree [1]. There are also reports providing profiles and data characterizing new doctorates [2].

This article provides a different perspective on new PhDs in mathematics and the institutions that produced them. In addition to reporting the annual number of PhDs in mathematics over the last 20 years, we report institutions producing the most PhDs overall and in specific fields, such as applied mathematics and number theory.

All data are from the Survey of Earned Doctorates (SED). Prior research on doctorates in mathematics education has reported some issues regarding the validity of the SED data [3]. Nevertheless, the SED is the most comprehensive report of earned doctorates available in the USA. It has been reporting annual summaries of doctorates from accredited institutions of higher education in the USA since 1920. The SED is currently a joint effort of the National Science Foundation (NSF), National Institute of Health (NIH), Department of Education (DoE), and the National Endowment for the Humanities (NEH). It reports doctorates awarded over a 12-month academic year. For example, the report for 2019 includes doctorates awarded from July 1, 2018, to June 30, 2019. Figure 1 shows the annual number of PhDs in mathematics awarded from 2000 to 2019.
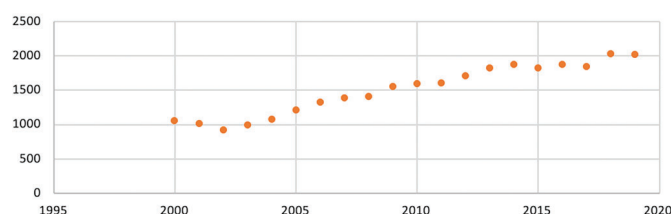
Figure 1. SED data reporting the number of PhDs in mathematics awarded annually from 2000 to 2019.

Over the last 20 years the number of PhDs awarded in mathematics has nearly doubled, from 1050 in 2000 to over 2000 in 2019. During this period, PhDs in mathematics were awarded by nearly 250 different institutions of higher education, with over 60% awarded by the 54 institutions in Table 1.

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Institution	Number of PhDs awarded	Range of number of graduates per year	Institution	Number of PhDs awarded	Range of number of graduates per year
University of California, Berkeley	709	25 to 49	University of Iowa	324	9 to 28
North Carolina State University	683	19 to 52	Brown University	314	9 to 23
University of California, Los Angeles	570	13 to 44	University of North Carolina	305	5 to 24
University of Wisconsin	555	14 to 39	University of California, San Diego	296	9 to 22
Stanford University	539	14 to 50	University of Florida	296	3 to 27
University of Michigan	534	13 to 39	Michigan State University	291	8 to 26
University of Illinois, Urbana-Champaign	520	13 to 48	Rice University	291	9 to 21
Purdue University	498	10 to 40	Northwestern University	274	8 to 20
Massachusetts Institute of Technology	491	16 to 40	University of Pennsylvania	264	6 to 31
Stony Brook University	489	12 to 34	University of Illinois, Chicago	272	3 to 23
University of Maryland	470	12 to 40	Carnegie Mellon University	271	5 to 24
University of Washington	447	11 to 37	University of Pennsylvania	264	6 to 31
Cornell University	429	9 to 31	University of Colorado	258	7 to 26
Ohio State University	429	7 to 34	University of Pittsburgh	255	5 to 22
Texas A & M University	410	8 to 30	Duke University	254	3 to 25
University of Minnesota	408	9 to 39	Indiana University	249	5 to19
University of Chicago	403	9 to 26	Virginia Polytechnic Institute & State University	249	3 to 21
Penn State University	387	10 to 30	Georgia Institute of Technology	243	5 to 22
Columbia University	381	8 to 27	University of Connecticut, Storrs	237	4 to 21
Princeton University	380	9 to 27	University of California, Santa Barbara	230	5 to 20
University of Texas, Austin	377	8 to 30	University of Missouri	229	3 to 17
Harvard University	368	10 to 29	University of Arizona	226	5 to 17
Rutgers University	368	9 to 27	University of California, Irvine	225	2 to 21
Iowa State University	366	5 to 38	University of Kentucky	224	4 to 21
New York University	366	10 to 32	University of Georgia	221	5 to 17
University of California, Davis	348	8 to 29	University of Nebraska	211	2 to 20
Florida State University	342	3 to 43	Arizona State University	205	3 to 22

Table 1. Institutions awarding a total of at least 200 doctorates in mathematics from 2000 to 2019.

What Institutions are Producing the Most PhDs in Mathematics?

From 2000 to 2019, a total of 30,076 doctorates in mathematics were awarded. Table 1 shows the 54 institutions that awarded at least 200 doctorates during this period and provides the range of the number of graduates per year for each institution. Two institutions, UC Berkeley and North Carolina State University, produced over 600 graduates, with a consistently large number each year. In fact, only in the years 2010, 2012, and 2017 did UC Berkeley graduate fewer than 30 PhDs per year. The minimum annual number from UC Berkeley (25) is greater than the maximum annual number from more than 200 institutions.

There is considerable variability in the annual number of graduates, with Florida State University having the greatest range of 3 to 43. During the 20-year period, 43 institutions awarded 100–199 PhDs, 48 awarded 50–99, and 100 awarded fewer than 50. Of the latter group, 36 awarded only 1–2.

Table 2 gives the top 20 institutions in each decade. The two lists share 16 institutions, with Berkeley and North Carolina State topping the list in each decade. Also, there are significant increases for these common institutions across decades. Another indicator of growth is that the minimum number of graduates in the top 20 producers was 157 for 2000–09 and 227 for 2010–19.

Institution	# graduated 2000−09	Institution	# graduated 2010−19
University of California, Berkeley	355	North Carolina State University	401
North Carolina State University	282	University of California, Berkeley	354
University of Wisconsin	246	University of California, Los Angeles	341
Massachusetts Institute of Technology	234	University of Michigan	315
Stanford University	230	Stanford University	309
University of California, Los Angeles	229	University of Wisconsin	309
University of Michigan	219	University of Illinois, Urbana-Champaign	306
University of Illinois, Urbana-Champaign	214	Purdue University	298
University of Maryland	214	Stony Brook University	296
Purdue University	200	University of Washington	279
University of Chicago	199	Florida State University	260
Cornell University	197	Ohio State University	258
Stony Brook University	193	Massachusetts Institute of Technology	257
University of Minnesota	179	University of Maryland	256
Ohio State University	171	Texas A & M University	247
New York University	168	Iowa State University	246
University of Washington	168	Penn State University	237
Texas A & M University	163	Cornell University	232
Harvard University	158	University of Minnesota	229
Princeton University	157	University of Texas	227

Table 2. The 20 institutions graduating the most doctorates in mathematics over two decades according to the SED.

How Many PhDs Were Awarded in Specific Fields?

The SED asks respondents to choose one field from the list in Table 3 that "best matches the primary field of study for your research doctoral degree." The totals at the bottom of the table show a more than 50% increase between the first decade and the next, from 11,920 during 2000–2009 to 18,156 during 2010-19. Applied mathematics (SED 420) was the biggest field in both decades, accounting for nearly one-quarter of the PhDs in mathematics. Except for Logic, all fields produced more graduates during 2010–19 than during 2000–09. The number of PhDs in "Mathematics, General" (code 499) more than doubled over the two decades, while fields (Applied Mathematics and Statistics) each showed significant increases of about 40 percent from one decade to the next. There is also an increase in the number of institutions awarding degrees in every field except logic.

SED field code number	SED field code description	# graduates 2000–09	# of institutions producing graduates 2000–09	# graduates 2010–19	# of institutions producing graduates 2010–19	Total # of graduates 2000–19
420	Applied Mathematics[1]	2880	178	4511	196	7391
425	Algebra[1]	980	135	1303	144	2283
430	Analysis & Functional Analysis[2]	1000	151	1227	152	2227
435	Geometry & Geometric Analysis[3]	757	112	948	122	1705
440	Logic[1]	224	49	200	39	424
445	Number Theory[1]	499	76	681	103	1180
450	Statistics[4]	2563	142	3587	165	6150
455	Topology/Foundations[5]	561	111	662	119	1223
460	Computing Theory & Practice[6]	158	75	167	78	325
461	Computational Mathematics[7]	No data	No data	186	78	186
465	Operations Research[8]	236	60	326	78	562
498	Mathematics, General[9]	1339	167	3569	186	4908
499	Mathematics/Statistics, Other[10]	723	152	857	154	1512
	Total	**11,920**	**215**	**18,156**	**230**	**30,076**

Table 3. SED field codes for 30,076 PhDs awarded in mathematics from 2000 to 2019.

[1]*Denotes fields constant since 1958.*

[2]*Denotes field constant since 1968.*

[3]*Denotes field constant since 2004—previously Geometry.*

[4]*Denotes field constant since 2003—previously Statistics, Math Probability & Statistics and Mathematical Statistics.*

[5]*Denotes field constant since 2004—previously Topology.*

[6]*Denotes field constant since 1960.*

[7]*Denotes field started in 2018.*

[8]*Denotes field constant since 1974.*

[9]*Denotes field constant since 2004.*

[10]*Denotes field constant since 2004—previously Mathematics, Other.*

The footnotes to Table 3 indicate when and how the titles of various fields provided by the SED for PhDs in mathematics have changed over the past twenty years. For example, prior to 2004 SED 435 was labeled "Geometry" while after that time it was labeled "Geometry and Geometric Analysis." The remainder of this article will focus only on the fields in Table 3 that had at least 1000 graduates over the two decades. Below we give tables for each field, showing the 20 institutions producing the most PhDs in that field.

What Institutions Are Producing the Most PhD Graduates in Applied Mathematics?

Applied Mathematics (SED 420) grew from 2880 graduates at 178 different institutions during 2000–09 to 4511 at 196 institutions during 2010–18, a nearly 60% increase in the number of graduates.

The top five institutions are the same in both decades, but in a different order, with North Carolina State University showing the greatest growth. Twelve institutions were common to both decades, each showing an increase. Another indicator of growth is that an institution graduating 40 was in the top 20 in 2000–09, while it took 56 graduates during the next decade to be included in Table 4.

What Institutions Are Producing the Most PhD Graduates in Statistics?

The SED has two different codes for statistics, Statistics (SED 450), and Mathematics/Statistics Other (SED 499). The footnotes to Table 3 show that while these fields have evolved over time, they have remained unchanged since 2004. Statistics (SED 450) was the second largest field with 6150 graduates over two decades, growing from 2563 at 142 institutions in 2000–2009 to 3587 at 165 institutions in 2010–2019, a more than 75% increase in graduates and 15% increase in the number of institutions.

Table 5 for SED 450 shows that the top three producers of PhDs in 2000–09 are among the top four in 2010–19, and nine of the top ten in 2000–09 remain there in 2010–19. Overall, 15 institutions are common to both decades.

Institution	# graduated 2000−09	Institution	# graduated 2010−19
Brown University	91	North Carolina State University	123
University of Maryland	87	Stony Brook University	115
New York University	83	University of Maryland	115
North Carolina State University	81	New York University	95
Stony Brook University	78	Brown University	93
Cornell University	66	University of California, Los Angeles	87
University of California, Los Angeles	58	Florida State University	84
University of Southern California	56	University of Colorado	81
University of Arizona	55	Arizona State University	73
Northwestern University	52	Cornell University	69
University of Colorado	52	University of Washington	68
University of California, Davis	50	University of California, Irvine	63
California Institute of Technology	46	University of Michigan	62
University of Texas	45	University of Houston	62
Massachusetts Institute of Technology	44	University of Arizona	61
University of Washington	42	Purdue University	60
Michigan State University	41	University of Texas	57
Princeton University	41	Rensselaer Polytechnic Institute, Troy	57
Rice University	41	University of California, Davis	57
University of Minnesota	40	Texas A & M University	56

Table 4. The 20 institutions reported by the SED to graduate the most PhDs in Applied Mathematics (420).

Institution	# graduated 2000−09	Institution	# graduated 2010−19
North Carolina State University	124	North Carolina State University	134
University of Wisconsin	100	Iowa State University	121
Stanford University	74	University of Wisconsin	101
University of California, Berkeley	73	Stanford University	98
Texas A & M University	67	Penn State University	86
Iowa State University	64	Ohio State University	82
Purdue University	60	Purdue University	82
Ohio State University	59	Texas A & M University	82
Penn State University	59	University of Michigan	82
University of Michigan	54	Florida State University	79
University of Minnesota	53	Duke University	75
University of North Carolina	51	University of California, Los Angeles	72
University of Washington	49	Harvard University	67
University of Florida	47	University of Washington	66
University of Chicago	46	Carnegie Mellon University	60
University of California, Davis	45	University of North Carolina	60
Rice University	42	University of California, Berkeley	58
University of California, Los Angeles	42	University of Florida	58
Virginia Polytechnic Institute & State University	42	Columbia University	57
Columbia University	41	University of Connecticut, Storrs	56

Table 5. The 20 institutions reported by the SED to graduate the most mathematics PhDs in Statistics (450).

Institution	#graduated 2000-09	Institution	# graduated 2010-19
University of California, San Diego	24	Auburn University	29
Carnegie Mellon University	18	University of California, San Diego	25
Emory University	17	University of Illinois, Urbana-Champaign	25
University of California, Los Angeles	17	Florida State University	21
Georgia Institute of Technology	16	Georgia Institute of Technology	17
Massachusetts Institute of Technology	16	University of Nebraska	17
Auburn University	15	University of Washington	16
University of California, Berkeley	15	Iowa State University	16
University of Illinois, Urbana-Champaign	15	Rutgers University	15
University of Washington	14	University of Connecticut, Storrs	15
Ohio State University	13	University of California, Davis	14
Cornell University	12	Louisiana State University	14
Rutgers University	12	University of Pennsylvania	14
North Carolina State University	11	Ohio State University	13
University of Memphis	11	Carnegie Mellon University	12
University of Wisconsin	11	University of Memphis	12
Boston University	10	University of Michigan	12
New York University	9	Arizona State University	11
Stanford University	9	University of California, Santa Barbara	11
University of Michigan	9	New York University	10
University of Minnesota	9	University of Mississippi	10
		Princeton University	10

Table 6. The 20 institutions reported by the SED to graduate the most mathematics PhDs in Mathematics/Statistics/Other (499).

Table 6 for SED 499 shows 11 institutions were common to both decades. The number of graduates in Table 6 pales in comparison to Table 5. The two tables have six institutions in common in the second decade. It would be interesting to learn how the graduates from these six institutions decided to choose SED 499 vs. SED 450.

What Institutions Are Producing the Most PhD Graduates in Algebra?

Algebra PhDs grew from 980 at 135 institutions in 2000–09 to 1303 at 144 institutions in 2010–19, which is about a one-third increase in the number of PhDs and a slight increase in the number of institutions. As Table 7 shows,

UC Berkeley was the top producer in both decades. Overall, there were more graduates in 2010–19, although generally this institutional growth was modest. One exception is the University of Michigan, which grew 40%. Another exception is Northeastern University, which was not in the top 20 in 2000–09 but made a dramatic change from 8 in that decade to 22 in 2010–19. On the other hand, the University of Chicago had a noticeable decline from 43 to 25 between the two decades.

Institution	# graduated 2000–09	Institution	# graduated 2010–19
University of California, Berkeley	55	University of California, Berkeley	50
University of Chicago	43	North Carolina State University	46
University of Michigan	31	University of Michigan	46
University of Oregon	29	University of Nebraska	32
North Carolina State University	27	University of Wisconsin	28
University of Wisconsin	27	University of Chicago	25
Massachusetts Institute of Technology	26	University of Washington	25
University of Kentucky	24	Texas A & M University	23
Purdue University	22	Northeastern University	22
Graduate Center, City University of New York	21	University of Iowa	22
Yale University	21	University of California, Riverside	21
University of Iowa	20	University of Illinois, Urbana-Champaign	21
University of Virginia	18	Rutgers University	20
Cornell University	17	University of Virginia	20
University of Illinois, Urbana-Champaign	17	Massachusetts Institute of Technology	19
University of Nebraska	17	University of Oregon	19
Iowa State University	15	Cornell University	18
Northwestern University	15	University of California, Los Angeles	18
Rutgers University	15	Louisiana State University	18
University of Pennsylvania	15	University of Kentucky	17
		Purdue University	17
		University of Pennsylvania	17
		Yale University	17

Table 7. The 20 institutions reported by the SED to graduate the most mathematics PhDs in Algebra (425).

What Institutions Are Producing the Most PhD Graduates in Analysis and Functional Analysis?

Table 3 shows a more than 20 percent increase in PhDs in Analysis and Functional Analysis between the two decades. Table 8 shows four institutions common to the top five in both decades, and twelve institutions common to the top 20 in both decades.

During 2010–19 the 22 institutions in Table 8 produced over 40 percent of the PhDs in the field. Out of the 152 institutions producing PhDs in the field in 2010–19, over 100 produced fewer than 10, and 25 graduated a total of one during the entire decade.

What Institutions Are Producing the Most PhD Graduates in Geometry and Geometric Analysis?

Table 3 shows the number of graduates in Geometry and Geometric Analysis increased about 25% between the two decades. Table 9 shows that 15 institutions were common to both decades, but only Stony Brook University was common among the top five producers. Four of the top five institutions from 2000–09 produced fewer PhDs in 2010–19 than they did in 2000–09. During 2010–19 the institutions listed in Table 9 produced about one-half of the PhDs overall in Geometry and Geometric Analysis. An examination of other institutions revealed that 65 institutions produced less than a total of ten graduates in Geometry and Geometric Analysis during 2010–19, and 20 institutions produced only one graduate in Geometry and Geometric Analysis during the last decade.

Most institutions in Table 9 reflected modest changes over the two decades. Two exceptions were the University of Chicago that went from 33 graduates in 2000–09 to 13 the next decade and consequently appeared only once in Table 9, while the University of Michigan more than doubled the number of their graduates over these two decades.

Institution	# graduated 2000−09	Institution	# graduated 2010−19
University of California, Berkeley	38	Purdue University	40
University of California, Los Angeles	32	University of California, Los Angeles	37
University of Illinois, Urbana-Champaign	30	New York University	33
University of Missouri	30	University of Illinois, Urbana-Champaign	33
Purdue University	24	University of California, Berkeley	32
University of Iowa	23	Princeton University	26
New York University	22	University of Houston	26
University of Minnesota	22	Texas A & M University	24
Texas A & M University	21	University of Missouri	22
University of Maryland	20	University of Washington	20
University of Wisconsin	20	University of Texas	19
Washington University, St. Louis	18	Indiana University	18
Cornell University	17	University of Iowa	18
Kent State University	17	University of Nebraska	18
Rutgers University	17	University of Wisconsin	18
Princeton University	16	Vanderbilt University	18
University of Michigan	16	University of Chicago	17
Louisiana State University	15	University of Kentucky	17
Indiana University	14	Georgia Institute of Technology	16
Penn State University	14	Ohio State University	16
		Penn State University	16
		University of Virginia	16

Table 8. The 20 institutions reported by the SED to graduate the most mathematics PhDs in Analysis and Functional Analysis (430).

Institution	# graduated 2000−09	Institution	# graduated 2010−19
Massachusetts Institute of Technology	36	Stony Brook University	38
Stony Brook University	36	University of Michigan	37
Stanford University	34	University of California, Berkeley	32
University of Chicago	33	University of Illinois, Urbana-Champaign	28
Harvard University	28	Columbia University	27
University of California, Berkeley	28	Princeton University	25
Columbia University	27	University of Pennsylvania	23
Penn State University	24	Harvard University	22
University of Washington	21	Penn State University	22
Princeton University	20	University of Texas	22
University of Pennsylvania	19	University of Wisconsin	22
University of Illinois, Urbana-Champaign	18	Stanford University	19
University of Michigan	17	Massachusetts Institute of Technology	19
Rice University	15	University of California, San Diego	18
University of Texas	14	New York University	16
University of Wisconsin	14	Purdue University	16
University of California, Los Angeles	13	Rutgers University	16
University of Illinois, Chicago	13	University of California, Riverside	16
New York University	11	Cornell University	15
University of Maryland	11	Graduate Center, City University of New York	15
		University of Washington	15

Table 9. The 20 institutions reported by the SED to graduate the most PhDs in Geometry and Geometric Analysis (435).

Institution	# graduated 2000–09	Institution	# graduated 2010–19
Stanford University	21	University of Chicago	23
University of California, Berkeley	21	University of Texas	23
Massachusetts Institute of Technology	18	University of California, Santa Barbara	22
University of Chicago	16	University of Iowa	20
Stony Brook University	14	Louisiana State University	17
University of California, Davis	14	Stanford University	17
Binghamton University, SUNY	13	Michigan State University	16
Columbia University	12	University of Illinois, Urbana-Champaign	16
Princeton University	12	Ohio State University	15
University of California, Santa Barbara	12	Princeton University	15
University of Iowa	12	University of Virginia	15
University of Texas	12	Columbia University	14
Rice University	11	Massachusetts Institute of Technology	13
University of California, Los Angeles	11	Rice University	13
Indiana University	10	University of California, Davis	13
University of Michigan	10	Graduate Center, City University of New York	12
Graduate Center, City University of New York	9	Auburn University	11
Northwestern University	9	Stony Brook University	11
Notre Dame University	9	University of California, Berkeley	11
Auburn University	8	University of Illinois, Chicago	11
George Washington University	8	University of Tennessee	11
Michigan State University	8		
University of California, San Diego	8		
University of Illinois, Urbana-Champaign	8		
University of Oregon	8		

Table 10. The 20 institutions reported by the SED to graduate the most PhDs in Topology/Foundations (455).

What Institutions Are Producing the Most PhD Graduates in Topology/Foundations?

Table 3 shows nearly a 20 percent growth in the total number of PhD graduates in Topology/Foundations over the two decades. About three-fourths of the institutions shown in Table 10 are common to both decades, but there was shuffling among the larger producing institutions from 2000–09 to 2010–19. For example, Michigan State, UC Santa Barbara, UIUC, and Texas about doubled their number of graduates in Topology/Foundations.

The institutions in Table 10 graduated about one-half of the PhDs in Topology/Foundations each decade. Over half the 116 institutions producing PhDs in this field graduated fewer than five in 2010–19, and over 20 had a total of one for the decade.

What Institutions Are Producing the Most PhD Graduates in Number Theory?

Table 3 shows a more than one-third increase over the two decades. Table 11 shows that UIUC was the largest producer of PhDs in Number Theory each decade and there was consistency across the decades with eight of the top ten producers in 2000–09 also in the top ten in 2010–19. About one-half of the institutions showed growth, with Princeton and Purdue showing the greatest growth, from 17 to 30 and 11 to 19, respectively.

The top 20 in 2000–09 graduated almost two-thirds of the PhDs in Number Theory, and the top 20 in 2010–19 graduated about 60 percent. While the number of institutions increased dramatically from 76 to 103, most institutions graduated only a few PhDs over each decade, 24 graduating a total of one each decade.

What Institutions Are Producing the Most PhD Graduates in Mathematics/General (498)?

Table 3 shows more than twice as many graduates identified Mathematics/General as their research field during the second decade. Table 12 shows there are 12 institutions common to both two decades, with 18 institutions increasing their production. Many institutions, including MIT, Minnesota, and Texas A & M, doubled their numbers, while Stanford University more than tripled. Another growth indicator is that 18 was the minimum number of graduates to be listed in 2000–09 compared to 44 graduates to be in the top 20 in 2010–19.

Institution	# graduated 2000−09	Institution	# graduated 2010−19
University of Illinois, Urbana-Champaign	43	University of Illinois, Urbana-Champaign	38
Harvard University	31	Princeton University	30
University of California, Berkeley	31	Columbia University	27
Brown University	21	University of Wisconsin	26
Columbia University	21	Harvard University	25
University of Wisconsin	20	Purdue University	19
University of California, Los Angeles	18	University of Michigan	19
Princeton University	17	University of California, Los Angeles	18
University of Michigan	16	Brown University	17
University of Texas	15	Ohio State University	17
California Institute of Technology	13	Stanford University	17
University of Pennsylvania	13	University of Chicago	17
Dartmouth College	11	Graduate Center, City University of New York	16
Purdue University	11	University of Arizona	16
University of Maryland	11	Penn State University	15
Brandeis University	10	Rutgers University	13
Ohio State University	10	University of California, Irvine	13
Stanford University	9	University of Washington	13
University of Arizona	9	University of California, Berkeley	12
University of Georgia	9	University of Texas	12
		California Institute of Technology	11
		University of Maryland	11

Table 11. The 20 institutions reported by the SED to graduate the most PhDs in Number Theory (445).

Institution	# graduated 2000−09	Institution	# graduated 2010−19
Ohio State University	46	Massachusetts Institute of Technology	116
Massachusetts Institute of Technology	40	University of California, Berkeley	74
Purdue University	37	University of Minnesota	73
University of Maryland	37	Stanford University	73
University of California, Berkeley	30	University of California, Los Angeles	70
University of Minnesota	30	University of Illinois, Urbana-Champaign	60
Princeton University	29	North Carolina State University	60
University of Texas	29	Indiana University	57
Indiana University	28	Texas Tech University	56
University of Michigan	28	University of Wisconsin	56
New York University	26	Ohio State University	53
University of California, San Diego	25	University of Maryland	53
University of Chicago	25	University of Texas	51
University of Georgia	24	Purdue University	49
University of Illinois, Chicago	23	Iowa State University	47
Johns Hopkins University	21	Stony Brook University	45
Stanford University	21	Texas A & M University	45
Cornell University	19	University of Utah	45
Texas A & M University	19	Cornell University	44
Michigan State University	18	University of Illinois, Chicago	44

Table 12. The 20 institutions reported by the SED to graduate the most PhDs in Mathematics/General (498).

Some Observations on the Overall Growth of PhDs in Mathematics

Here are some issues of particular interest to discuss and explore further.

- Almost 250 institutions of higher education have graduated one or more doctorates in mathematics since 2000. It would be interesting to examine the nature of these PhD programs. Do graduates from different peer institutions complete similar courses? If so, what are those core courses? How does the depth and variety of the research done for their PhD in mathematics differ among the more than 200 different institutions?

- Table 2 showed some consistency of program production, such as the University of California, Berkeley, and North Carolina State University. Forty institutions graduated over one-half of all PhDs awarded in mathematics. Yet over 100 institutions graduated a total of 25 or fewer doctorates in mathematics over this 20-year period. In fact, over 20 institutions graduated only one PhD over 20 years. An examination of the coursework patterns for these large and smaller producers of PhDs in mathematics would be interesting.

- While over 100 different institutions produced PhDs in each of the specific codes addressed in this paper, about 20 institutions produced the lion's share of PhDs in these fields. More specifically, the top 20 producers graduated between one-third and two-thirds of the PhDs in each field from 2000 to 2019. On the other hand, many institutions graduated fewer than a total of 25 PhDs in a given field over two decades. Furthermore, there were typically 15 to 25 institutions that graduated a total of one PhD in a given field. While some of these programs are new and getting established, those with only a few graduates over 20 years raise some questions. Does the large number of institutions that graduate only a few PhDs in a given field over several decades raise questions or concerns? Does a quality PhD program in mathematics require a critical mass of annual graduates in at least a few fields? If so, what is the critical mass?

- Most institutions graduating the greatest number of PhDs in a field from 2000–09 also graduated the most PhDs in that field during 2010–19. While there were changes among the top producers across the two decades in every field, the fact that most institutions remained common documents consistency of these programs over time. In three research fields, Algebra (UC Berkeley), Number Theory (UIUC), and Statistics (NC State), the institution producing the most PhDs in that field remained constant over two decades. Their consistency in being the largest producer of these PhDs is impressive and likely provides an advantage in the recruitment of new faculty members as well as future doctoral students interested in pursuing a PhD in mathematics with a particular area of specialization. It would be interesting to learn more about the evolution of these fields or niches at these institutions.

- There is always some variability in the annual production of doctoral graduates at an institution. However, a look at Table 1 shows that several institutions, such as Florida State, Purdue, Stanford, and UIUC, had ranges of 30 or more graduates a year during the last two decades. It would be interesting to learn what factors contributed to this wide variance.

- To learn more about ways departments of mathematics have grown their PhD programs in mathematics we contacted chairs of several mathematics departments that have experienced significant growth [4], [5]. Here are some of the things they and some other mathematicians reported doing that helped increase their graduation of PhDs in mathematics.
  - Conducted a self-examination of their doctoral program and initiated new emphasis areas in the changing discipline of mathematics. For example, changing from a focus on pure mathematics to include more interdisciplinary areas such as bio-mathematics.
  - Lobbied successfully for additional internal financial support to hire new faculty members with specific expertise.
  - Established a track record of success in securing external funding that helped support faculty research as well as fund doctoral students.
  - Improved methods to track the progress of PhD students more closely by the graduate director and provided annual feedback to each student.
  - Organized mentoring of PhD students by faculty members that began upon admission and was maintained throughout the duration of their program.
  - Shortened the time typically required to complete the PhD.
  - Strengthened their Master's degree program, which had a positive impact on the PhD program as more Masters students decided to enter the PhD program.
  - Intensified efforts to help place PhD graduates in jobs that were aligned with their career goals.

While no two departments followed the same path, each of them implemented some of the above initiatives to strengthen and grow their PhD program in mathematics.

- The SED provided different field codes to identify special areas of mathematics. Some fields, such as Algebra and Number Theory, are clearly identified. However, other field codes, such as SED code 498, Mathematics, General, seem much less clear. Is there such a thing as a PhD in Mathematics, General? Would this field code only be used by PhD graduates in mathematics that did not find any other field code appropriate? The fact

that over one thousand PhD graduates in mathematics selected this option in 2000–09 and then the number more than doubled to over 3500 in 2010–19 documents that this is a popular field code. Further investigation to identify more clearly what constitutes SED code 498 Mathematics, General in the minds of recent PhD graduates seems appropriate.

Hopefully this report provides information that stimulates thinking and promotes discussion among mathematicians, faculty members in PhD programs in mathematics, as well as potential doctoral students. The latter group may find this information useful in considering institutions where they might pursue a PhD in a given field.

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Credits

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