STEM at American Institutes for Research

Broadening Participation in **STEM Graduate Education**

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The United States is at a critical juncture in its ability to remain internationally competitive in science, technology, engineering, and mathematics (STEM). At present, too few people from diverse populations, including women, participate in the STEM academic and workforce communities. This series of issue briefs is produced by American Institutes for Research (AIR) to promote research, policy, and practice related to broadening the participation of traditionally underrepresented groups in STEM doctoral education and the workforce.

AIR supports the national effort to prepare more students for educational and career success in STEM by improving teaching and providing all students with 21st century skills needed to thrive in the global economy; meeting the diverse needs of all students—especially those from underrepresented groups; and using technology, evidence, and innovative practice to support continuous improvement and accountability.

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Exploring Gender Imbalance Among STEM Doctoral Degree Recipients

Overview

Gender imbalance in doctoral education in science, technology, engineering, and mathematics (STEM) fields raises important questions about the extent to which women experience differential access, encouragement, and opportunity for academic advancement. Previous research suggests a leaky pipeline in the academic pathways of women in STEM fields (Hill, Corbett, & St. Rose, 2010; Jesse, 2006; Mastekaasa & Smeby, 2008; Modi, Schoenberg, & Salmond, 2012). Such leaks occur at many points along the pathway, with the first leak appearing in the middle and high school years. Through primary school and middle school, girls and boys typically indicate an equal interest and demonstrate equivalent levels of achievement on several science and mathematical indicators, but girls' interest in pursuing scientific degrees and careers wanes by high school (Jesse, 2006; Modi et al., 2012).

The transition from high school into undergraduate programs of study is another critical juncture in the academic pathway. A number of factors may contribute to whether an individual pursues an undergraduate degree in any field, among them labor market demands and opportunities, loss of interest in the field, and growth in interest in another field. In the STEM fields, the leaky pipeline for historically underrepresented groups of individuals, including underrepresented minorities and women of all races and ethnicities, has been attributed to factors that include financial barriers, inadequate preparation or academic skills to move to the next level, a lack of role models, inadequate social or academic integration into a field, an inability to identify with a field of study, and experiences of social and academic isolation and marginalization because of the individual's race, ethnicity, gender, or a combination (American Institutes for Research, 2012; Stout, Dasgupta, Hunsinger, & McManus, 2011). These same factors also can affect whether a student decides to pursue a doctoral degree, and then once in a doctoral degree program, whether the student persists to degree completion (Hill, Corbett, & St. Rose, 2010; Ong, 2005; Poirier, Tanenbaum, Storey, Kirshstein, & Rodriguez, 2009). These many factors often lead to the continual underrepresentation of females among doctorate recipients, especially in traditionally male-dominated fields, like many STEM fields (Hill et al., 2010; Ong, 2005).

PRIMARY SOURCE OF DATA AND STUDY SAMPLE

Primary Source of Data

The U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS) Completions surveys from 2002-2007 and 2010-2012 served as the source of data on degree recipients for this paper.

Academic Field of Study and STEM Classifications

We used the U.S. Department of Education's Classification of Instructional Programs (CIP) system to define academic fields. Every degree awarded is assigned a CIP code of two to six digits. CIP codes are structured as broad families of academic fields by four- and two-digit CIP codes. For instance, degrees in agricultural animal breeding are assigned the six-digit CIP code of 01.0902, which falls under the four-digit CIP code of 01.09 (animal sciences), which falls under the two-digit CIP code 01 (agriculture, agriculture operations, and related sciences). We focused on four-digit CIP codes, striking a balance between offering finer detail and ensuring sufficient observations per group.[1] In this brief, the identified academic fields are based on these four-digit CIP code classifications.

We used the STEM-Designated Degree Program List for 2012 from the U.S. Immigration and Customs Enforcement agency to further classify academic fields as STEM or non-STEM and included all four-digit CIP code academic field classifications (split into STEM and non-STEM portions when necessary[2]) with (a) sufficient data[3] and (b) an average of at least 100 bachelor's degrees and 30 doctoral degrees awarded per year.[4] This resulted in 135 academic fields for analysis (55 STEM fields and 80 non-STEM fields).

Research Doctoral Degree Focus

Beginning in the 2007–08 academic year, the Department of Education started classifying most advanced degrees higher than the master's level as a doctoral degree. For example, a law degree was previously classified as a "professional degree" but is now considered a "doctor's degree—professional practice." Because STEM degrees are predominantly classified as "doctor's degree—research/scholarship," we largely restricted our analysis to this type of doctoral degree. The main impact of this focus is to exclude from the analysis many professional practice degrees in law and health, though the law and health degrees that are classified as "Doctor's degree—research/scholarship" are still included.

Accurately identifying the nature of the imbalance is an important first step in addressing it. The most effective methods for correcting gender imbalances in the pool of potentially eligible students for doctoral program study may be different from the most effective methods for correcting gender imbalances that occur after enrollment as a result of doctoral program attrition (that is, enrollments are gender-balanced, but completions are not).

Simply comparing the number of doctoral degrees awarded to women and men can be a misleading gauge of gender imbalance. This brief uses an alternate method to account for the gender breakdown among undergraduate degree recipients and provides a more reliable gauge of gender imbalance at the doctoral level. Key results from using this alternate method are

- *Men are overrepresented in about three quarters of academic fields and women are overrepresented in about one quarter of academic fields.*
- *STEM fields are slightly more gender-balanced than non-STEM fields.*
- *Among STEM fields, and often in contrast to conventional wisdom, biological and biomedical sciences and the physical sciences show the greatest overrepresentation of males and engineering was roughly gender-balanced.*

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[1] The four-digit CIP code is a compromise between the six-digit CIP codes, which offers much finer detail (1,400+ groups) but often very few observations per group (many degrees have fewer than 10 doctoral degrees per year), and the two-digit CIP code, which has fewer groups (only 47 groups) but many observations per group.

[2] Some four-digit CIP codes do not universally contain STEM or non-STEM fields. For example, CIP code 03.05 (forestry), contains some six-digit CIP codes that are classified as STEM fields (03.0502 forest sciences and biology; 03.0508 urban forestry; and 03.0509 wood science and wood products/pulp and paper technology) and other six-digit CIP codes that are classified as non-STEM fields (03.0501 forestry, general; 03.0506 forest management/forest resources management; 03.0510 forest resources production and management; 03.0511 forest technology/technician; 03.0599 forestry, other). In these cases, we split the four-digit CIP code into the STEM and non-STEM components, resulting in two groups: 03.05 (STEM) and 03.05 (non-STEM).

[3] Sufficient data in this case means that the four-digit CIP code field awarded both doctoral and bachelor's degrees. Sixty-six fields do not have any doctoral degree recipients from the years 2010–2012, and another 30 did not have any bachelor's degree recipients from the years 2002–2007. These 96 fields were therefore dropped from the analysis.

[4] There were many four-digit CIP code fields with very few degrees awarded. For example, CIP code 16.10 (American Indian/Native American languages, literatures, and linguistics) had just two doctoral degrees awarded from the years 2010–2012 and just 16 bachelor's degrees awarded from the years 2002–2007. Because a small number of cases can lead to volatility and unreliability, fields with fewer than an average of 30 doctoral and 100 bachelor's degrees awarded per year were dropped from the analysis.

Assessing Gender Imbalance in STEM Doctoral Education

In theory, simply comparing the number of degrees awarded to women with the number awarded to men in a specific degree program would provide a reasonably accurate measure of whether there is gender imbalance within an academic field. After all, men and women are fairly evenly distributed in the population (the U.S. population is 50.8% female[5]). But this approach works only if the actual enrollment of men and women in a degree program is equally split. If, for example, more women than men are interested in pursuing doctoral education in a field, we would expect to see a higher number of doctoral degrees awarded to women than men. A comparison of the number of doctoral degrees awarded to men and women would provide a skewed impression of the gender balance within a field.

To illustrate how aggregated totals of doctoral degree production can be a misleading gauge of gender imbalance, consider the STEM field of animal sciences.[6] From 2010 to 2012, an average of 70 women and 71 men per year received doctoral degrees in this academic field. On the surface, this might lead us to conclude that there is virtually no gender imbalance in doctoral degree production in animal sciences. Yet these figures do not account for the *available pool* of men and women who could enroll in and receive doctoral degrees in this academic field. An average of 1,003 men and 2,398 women received a bachelor's degree in animal sciences each year between 2002 and 2007 (the time period within which we would expect most 2010–2012 PhD recipients to have earned their bachelor's degrees if they entered graduate school within one to three years after earning their bachelor's degrees).[7] Using the number of bachelor's degrees awarded in animal sciences as a proxy for academic interest and preparation for an advanced degree program in the field, we might expect women to outnumber men by more than two to one among those who earned a doctoral degree in animal sciences. Yet the average number of doctoral degrees awarded to men and women was essentially equal (71 in comparison with 70). Thus, even though the absolute number of doctorates awarded to men and women is similar, men are significantly *overrepresented* among doctoral degree recipients relative to the available pool of candidates.

The primary argument in this paper is that accounting for differences in the number of female and male students who are academically prepared for and interested in pursuing a doctoral degree provides a more accurate measure of gender imbalance in doctoral education. Because there are no direct measures of the number of female and male students who are academically prepared and interested in a field, we use a proxy measure, the number of students from each gender who earn a bachelor's degree in each academic field. Although a bachelor's degree in a particular field is not a requirement for doctoral study in that field, our argument is that a gender imbalance in the bachelor's degrees awarded within a field is representative of the gender imbalance in the number of students in the field who are academically prepared and interested in doctoral-level study in that field. By controlling for gender imbalance at the bachelor's-degree level, this approach isolates any gender imbalance that emerges at the doctoral level.

Specifically, this brief took the following analytic approach. First, we calculated the number of doctoral degrees per 100 bachelor's degrees. To smooth over yearly volatility, we averaged multiple years together, and to account for the delay between finishing a bachelor's degree and finishing a PhD, we staggered the relevant years. Thus, the number of bachelor's degrees earned was calculated as the yearly average between 2002 and 2007, and the number of doctoral degrees was calculated as the yearly average between 2010 and 2012. Continuing to use animal sciences as an example, the number of doctoral degrees earned per 100 bachelor's degrees earned for men is 7.15 (71.67/1,002.67*100 = 7.15) and for women it is 2.95 (70.67/2,398*100 = 2.95). The rate for women is then expressed as a percentage of the rate for men. For animal sciences, this would be 41 percent (the rate for women [2.95] is 41 percent of the rate for men [7.15]).

5 United States Census, State & County QuickFacts: USA, http://quickfacts.census.gov/qfd/states/00000.html

6 The STEM fields with a four-digit CIP code of 01.09.

7 The median time to completion in STEM fields is approximately seven years (Zeiser & Berger, 2012).

Presenting the rate for women as a percentage of the rate for men has two primary advantages. First, it is easier to interpret. A value of 100 percent indicates perfect gender balance, meaning that men and women have the same number of doctoral degrees per 100 bachelor's degrees (or equivalently, that the same ratio of female to male degree recipients was observed at the bachelor's- and doctoral-degree levels). A value less than 100 percent indicates that women are underrepresented. This was the case for animal science—the value of 41 percent indicated that many fewer women were earning a doctoral degree in the field than we would anticipate from the number of men earning doctoral degrees and the gender breakdown of bachelor's degree recipients. Conversely, a value greater than 100 percent indicates that women are overrepresented in an academic field (or equivalently, that men are underrepresented).

The second advantage of converting the rate for women into a percentage of the rate for men is that it enables comparisons across academic fields. Not every academic field has similar magnitudes for the number of doctoral degrees per 100 bachelor's degrees. For example, cognitive science[8] had higher figures for doctoral degrees per 100 bachelor's degrees than animal sciences did, 11.4 for men and 8.4 for women. These differences in underlying rates make it difficult to compare the gender imbalances in the two academic fields. But by converting the rate for women into a percentage of the rate for men, we can easily compare the gender imbalances in the two fields. For animal sciences, we saw a value of 41 percent. For cognitive science, the value was 74 percent (8.4 is 74 percent of 11.4). Because 41 percent is further away from 100 percent (the gender-balanced value) than 74 percent, it is clear that animal sciences has a greater gender imbalance than cognitive science—women are more underrepresented in animal sciences than they are in cognitive science.

Results

GENDER IMBALANCES IN DOCTORAL COMPLETION ACROSS ACADEMIC FIELDS

With respect to doctoral degree completion, men are overrepresented in about three quarters of academic fields. Women are overrepresented in about one quarter of academic fields. Figure 1 displays women's doctoral degrees per 100 bachelor's degrees as a percentage of men's doctoral degrees per 100 bachelor's degrees. A value of 100 indicates that there is no gender imbalance (the number of doctoral degrees per 100 bachelor's degrees is equal for women and men). A value less than 100 indicates that men are overrepresented in the academic field and a value greater than 100 indicates that women are overrepresented in the field.

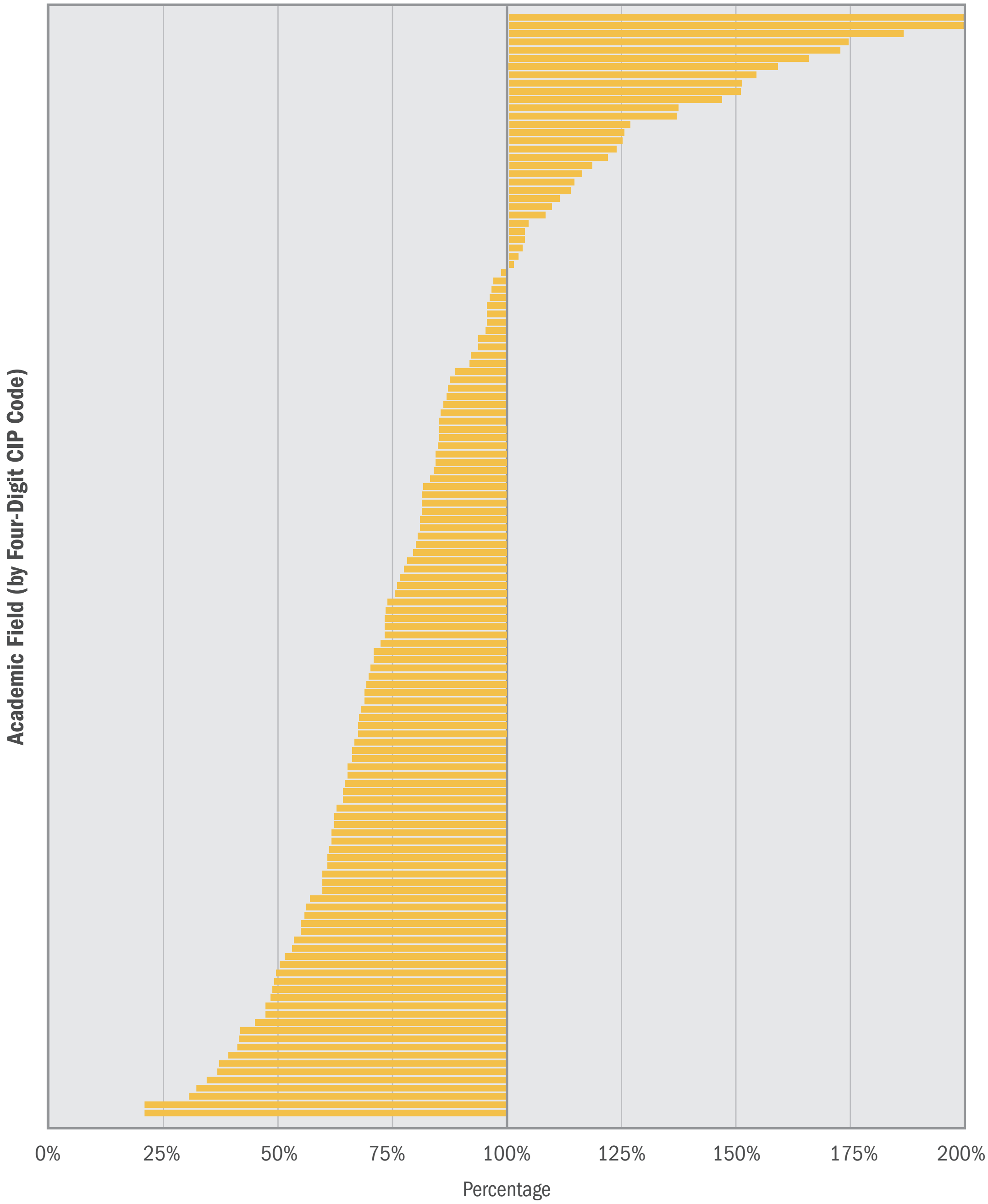
With respect to doctoral degree completion, men are overrepresented in about three quarters of academic fields. Women are overrepresented in about one quarter of academic fields.

Among the 135 academic fields in this analysis, men are overrepresented in about three quarters of the fields (103 fields, or 76 percent) and women are overrepresented in about one quarter of the academic fields (32 fields, or 24 percent). The degree of gender imbalance ranges considerably across the examined fields, from 21 percent to 223 percent.

In 56 academic fields, a ratio near gender balance was observed (a ratio of women's to men's doctoral degrees per 100 bachelor's degrees between 75 percent and 125 percent). The remaining 79 academic fields show a decided gender imbalance, with men overrepresented in 63 fields (80 percent), and women overrepresented in 16 (19 percent).

[8] The STEM fields with a four-digit CIP code of 30.25.

Figure 1. Women's Doctoral Degrees per 100 Bachelor's Degrees as a Percentage of Men's Doctoral Degrees per 100 Bachelor Degrees



Source: American Institutes for Research
Note: A value of 100 indicates that there is no gender imbalance (the number of doctoral degrees per 100 bachelor's degrees is equal for women and men). A value less than 100 indicates that men are overrepresented in the field and a value greater than 100 indicates that women are overrepresented in the field.

Table 1 presents the top 10 academic fields in which men are most overrepresented among doctoral degree recipients. Eight of these 10 fields are non-STEM fields; two are STEM fields.

In some fields on this top 10 list, the overrepresentation of men at the doctoral level highlights a widening of a gender imbalance that already existed at the bachelor's-degree level. In mathematics, for example, women earned an average of 6,102 bachelor's degrees per year, and men earned an average of 7,521. We therefore would expect men to receive slightly more doctoral degrees in mathematics than women. Yet men earned almost three times as many doctoral degrees in mathematics (2,341 vs. 788). Men earned 10.4 doctoral degrees for every 100 bachelor's degrees, whereas women earned just 4.3 doctoral degrees per 100 bachelor's degrees. This implies that men are overrepresented among doctoral degree recipients in mathematics relative to what we would expect on the basis of bachelor's degree recipients.

Other academic fields on this list indicate a different gender imbalance, one in which the average number of doctoral degrees awarded to women exceeds the average number awarded to men, but by less than what would have been expected on the basis of the composition of the available pool. For example, communication disorders sciences and services is the academic field that has the greatest underrepresentation of men. Women outnumber male doctoral degree recipients by almost five to one (210 vs. 44), but the number of bachelor's degree recipients in the field would lead us to expect women to outnumber men by even more—women outnumber men among bachelor's degree recipients in communication disorders sciences and services by more than 23 to one.[9] This result indicates a different type of imbalance but still reveals a "point of loss" in which a disproportionate number of women relative to the number of men are not pursuing or completing advanced degree pathways.

Table 1. Top 10 Academic Fields in Which Men Are Overrepresented Among Doctoral Degree Recipients

Academic Field	Doctoral Degrees per 100 Undergraduate Degrees (Men)	Doctoral Degrees per 100 Undergraduate Degrees (Women)	Women's Doctoral Degrees per 100 Undergraduate Degrees as a Percentage of Men's
Communication Disorders Sciences and Services	17.6	3.6	20.7
Missions/Missionary Studies and Missiology	18.3	3.8	20.8
Law	32.4	9.9	30.5
Family and Consumer Sciences/Human Sciences, General	4.2	1.4	32.3
Teacher Education and Professional Development, Specific Levels and Methods	1.3	0.5	34.6
Bible/Biblical Studies	1.2	0.5	36.8
Health Services/Allied Health/Health Sciences, General	8.9	3.3	37.3
Public Administration and Social Service Professions, Other	16.1	6.3	39.1
Animal Sciences	7.1	2.9	41.2
Mathematics	10.4	4.3	41.5

Note: STEM fields are shaded.

[9] This result nicely illustrates a possible story in which the key assumption in this paper—that the gender breakdown among bachelor's degree recipients represents the gender breakdown among students who are academically prepared for and interested in doctoral level study in a field—breaks down. Because majoring in communication disorders sciences and services is so uncommon among men at the bachelor's level, an argument could be made that those students are intensely interested in the field, and therefore we should expect a higher rate of doctoral completion per 100 bachelor's degrees among men than we would for women. Without data measuring student interest by field, there is no way to determine whether this is the case.

Table 2 presents the top 10 academic fields in which women are overrepresented among doctoral degree recipients. Five of the academic fields are non-STEM and five are STEM. The overrepresentation of women in some of these 10 fields reveals a slight widening of an overrepresentation of women that originated at the bachelor-degree level. For example, in the field of teacher education and professional development, specific subject areas, women earned an average of 403 doctoral degrees a year and 18,155 bachelor's degrees. Men earned an average of 209 doctoral degrees and 14,196 bachelor's degrees. Thus, women earned 2.2 doctoral degrees for every 100 bachelor's degrees, but men earned only 1.5 doctoral degrees for every 100 bachelor's degrees, suggesting that the transition from undergraduate to graduate degree study represents a disproportionate point of loss among men in this academic field.

Women are overrepresented among computer engineering doctoral degree recipients, but in a different way (note this is a different field from computer science). Men received an average of 5,588 bachelor's degrees and 270 doctoral degrees per year in computer engineering, or 4.8 doctoral degrees per 100 bachelor's degrees. In comparison, women earned considerably fewer bachelor's and doctoral degrees per year—just 760 bachelor's degrees and 58 doctoral degrees, or 7.7 doctoral degrees per 100 bachelor's degrees. Thus, even though more men than women received a doctoral degree in computer engineering, women are overrepresented relative to what would be expected from the pool of undergraduates who demonstrated interest in the academic field. This type of result might suggest that efforts to correct the gender gap in the field of computer engineering may best be corrected at lower levels of the academic pathway as women, once through an undergraduate program in this field, appear more likely than their male peers to complete a doctorate.

Table 2. Top 10 Academic Fields Where Women Are Overrepresented Among Doctoral Degree Recipients

Academic Field	Doctoral Degrees per 100 Undergraduate Degrees (Men)	Doctoral Degrees per 100 Undergraduate Degrees (Women)	Women's Doctoral Degrees per 100 Undergraduate Degrees as a Percentage of Men's
Forestry (Non-STEM)	9.1	20.3	222.9
Slavic, Baltic and Albanian Languages, Literatures, and Linguistics	4.7	9.6	205.7
Forestry (STEM)	14.2	26.5	187.2
Fine and Studio Arts	0.5	0.9	175.3
Information Science/Studies	1.3	2.2	173.7
Engineering-Related Fields	11.5	19.1	166.6
Computer Engineering	4.8	7.7	158.7
Engineering Physics	12.1	18.6	153.8
Teacher Education and Professional Development, Specific Subject Areas	1.5	2.2	151.0
City/Urban, Community and Regional Planning	10.5	15.8	150.6

Note: STEM fields are shaded.

GENDER IMBALANCES IN STEM AND NON-STEM FIELDS

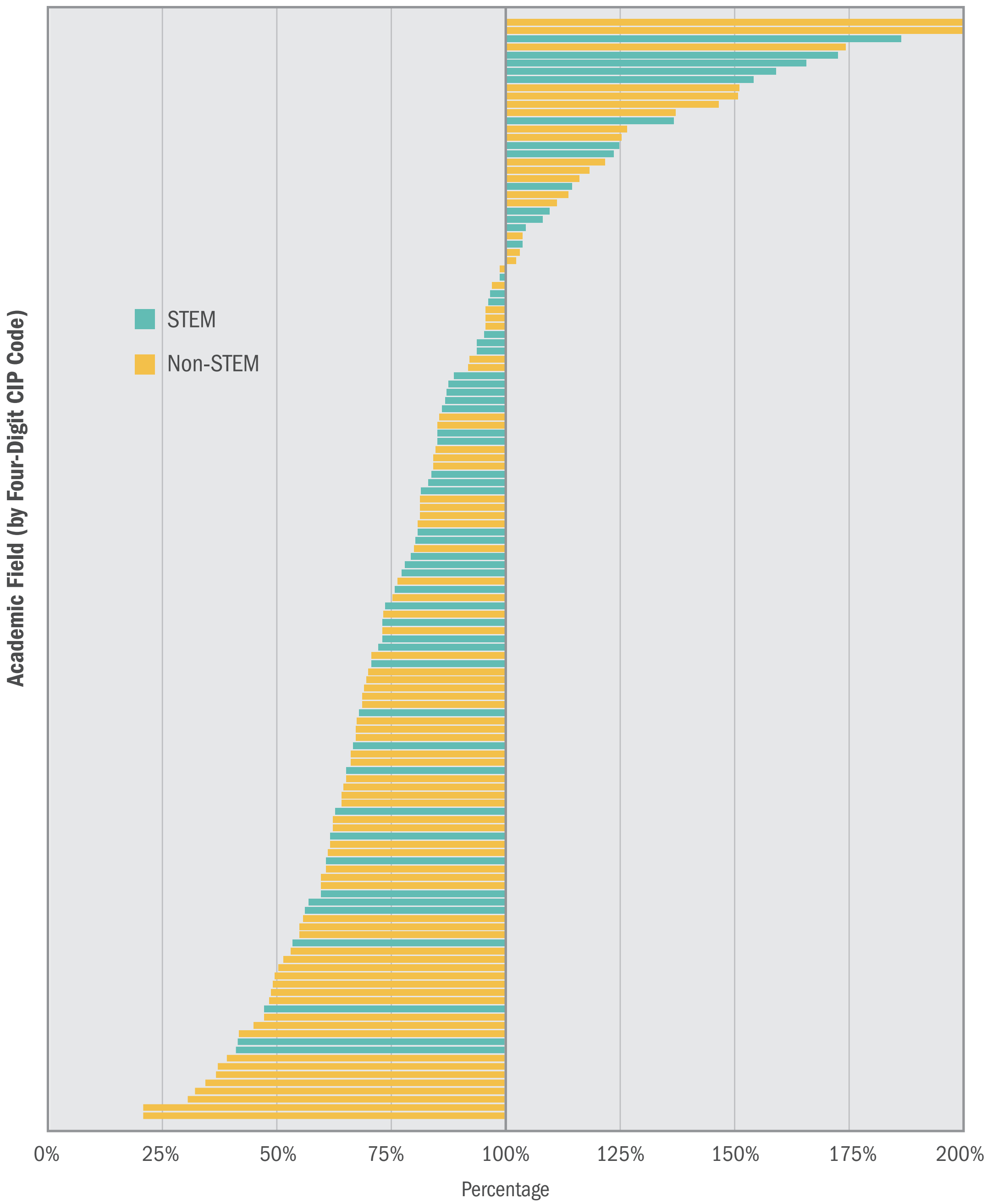
Figure 2 reproduces Figure 1 but distinguishes between STEM and non-STEM fields.

At the doctoral level, STEM fields are slightly less gender-imbalanced than non-STEM fields. In the 80 non-STEM fields analyzed, men are overrepresented in 62 (77.5 percent) and women are overrepresented in 18 (22.5 percent). In the 55 STEM academic fields analyzed, men are overrepresented in 41 (74.5 percent) and women are overrepresented in 14 (25.5 percent). In other words, STEM academic fields are slightly less likely than non-STEM fields to have an underrepresentation of women among doctoral degree recipients.

At the doctoral level, STEM fields are slightly less gender-imbalanced than non-STEM fields.

This finding is further supported by the magnitude of the gender imbalance across academic fields. The average value among STEM academic fields in Figure 2 was 90.4 percent, and the average among non-STEM fields was 80.1 percent. Because a value of 100 indicates gender balance, this indicates that on average, STEM academic fields are somewhat less gender-imbalanced than non-STEM fields at the doctoral level. This finding suggests that women who earn undergraduate degrees in STEM complete doctoral education at rates more comparable to rates among men than their counterparts in non-STEM fields. Thus, to address the inequities in the absolute number of doctoral degrees earned by women and men in STEM, efforts should be made earlier on the academic pathway—such as the undergraduate level.

Figure 2. Women's Doctoral Degrees per 100 Bachelor Degrees as a Percentage of Men's Doctoral Degrees per 100 Bachelor Degrees



Source: American Institutes for Research

Note: A value of 100 indicates that there is no gender imbalance (the number of doctoral degrees per 100 bachelor's degrees is equal for women and men). A value less than 100 indicates that men are overrepresented in the field and a value greater than 100 indicates that women are overrepresented in the field.

Among STEM fields, men are more likely to be overrepresented in the biological and biomedical sciences and the physical sciences, and engineering was roughly gender-balanced. Although there are no broad STEM fields where women tend to be overrepresented, there are some that stand out as being particularly prone to male overrepresentation (Table 3). One such broad academic field is the biological and biomedical sciences.[10] This is a somewhat counterintuitive result because women received more doctoral degrees in these academic fields than men did—an average of 3,675 a year for women and 3,243 for men. But these aggregate figures do not account for the fact that many more women were prepared and interested in those fields than men were—an average of 40,655 women received bachelor's degrees in the biological and biomedical fields each year but only 25,411 men did. Thus, men received 13 doctoral degrees for every 100 bachelor's degrees, but women received only nine doctoral degrees for every 100 bachelor's degrees, indicating that men are overrepresented among doctoral degree recipients in the biological and biomedical sciences. This general pattern of male overrepresentation held in 10 of the 11 biological and biomedical sciences academic fields that were analyzed.[11] Among the biological and biomedical fields, pharmacology and toxicology was the most gender-balanced. Five other fields had a ratio greater than 75 percent.

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Physical sciences was another broad academic field where men were more likely to be overrepresented. Of the five physical sciences academic fields that were analyzed,[12] men were overrepresented in four; atmospheric sciences and meteorology was the only physical sciences academic field that showed only a slight overrepresentation of women.

Engineering stood out as being roughly gender-balanced. This result also is counterintuitive because men outnumber women among doctoral degree recipients in engineering by more than three to one. Yet men outnumber women among bachelor's degree recipients in engineering by four to one. Within the broader field of engineering, the agricultural engineering academic field nicely illustrates the larger story of gender balance in engineering. Men outnumber women among doctoral degree recipients 80 to 36. But men also outnumber women among bachelor's degree recipients 471 to 214. Thus, in agricultural engineering, both men and women earn 17 doctoral degrees for every 100 bachelor's degrees, indicating a gender balance in doctoral degree completion. This pattern held in many of the other engineering academic fields. Of the 21 engineering academic fields analyzed,[13] 13 exhibited rough gender equality (defined as women's doctoral degrees per 100 bachelor's degrees of between 75 and 125 percent of men's). Of the eight remaining academic fields in engineering that showed marked gender imbalance, women were overrepresented in three and men were overrepresented in five.

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[10] STEM fields within CIP code 26.

[11] Biology, general; biochemistry, biophysics and molecular biology; botany/plant biology; cell/cellular biology and anatomical sciences; microbiological sciences and immunology; zoology/animal biology; genetics; physiology, pathology and related sciences; pharmacology and toxicology; ecology, evolution, systematics, and population biology; biological and biomedical sciences, other.

[12] Astronomy and astrophysics; atmospheric sciences and meteorology; chemistry; geological and earth sciences/geosciences; and physics.

[13] Engineering, general; aerospace, aeronautical and astronautical engineering; agricultural engineering; biomedical/medical engineering; chemical engineering; civil engineering; computer engineering; electrical, electronics and communications engineering; engineering mechanics; engineering physics; engineering science; environmental/environmental health engineering; materials engineering; mechanical engineering; nuclear engineering; petroleum engineering; systems engineering; textile sciences and engineering; Industrial engineering; operations research; and engineering, other.

Table 3. Gender Imbalance in STEM Doctoral Education by Academic Field

Academic Field	Doctoral Degrees per 100 Undergraduate Degrees (Men)	Doctoral Degrees per 100 Undergraduate Degrees (Women)	Women's Doctoral Degrees per 100 Undergraduate Degrees as a Percentage of Men's
Forestry	14.2	26.5	187.2
Information Science/Studies	1.3	2.2	173.7
Engineering-Related Fields	11.5	19.1	166.6
Computer Engineering	4.8	7.7	158.7
Engineering Physics	12.1	18.6	153.8
Public Health	30.0	41.4	137.7
Engineering, Other	10.9	13.7	125.5
Electrical, Electronics and Communications Engineering	13.7	17.1	124.1
Civil Engineering	8.5	9.7	114.5
Plant Sciences	11.5	12.5	109.3
Mechanical Engineering	7.3	7.9	108.1
Natural Resources Conservation and Research	5.0	5.2	104.1
Atmospheric Sciences and Meteorology	18.4	19.0	103.1
Pharmacology and Toxicology	341.2	341.4	100.0
Agricultural Engineering	17.0	17.0	99.8
Petroleum Engineering	17.5	17.1	97.4
Systems Engineering	17.2	16.6	96.6
Wildlife and Wildlands Science and Management	4.4	4.2	95.8
Geological and Earth Sciences/Geosciences	18.3	17.2	94.3
Computer Science	7.2	6.8	94.3
Engineering, General	19.7	17.6	89.1
Ecology, Evolution, Systematics, and Population Biology	39.0	34.4	88.1
Nuclear Engineering	44.5	39.0	87.6
Statistics	64.1	56.0	87.4
Cell/Cellular Biology and Anatomical Sciences	39.5	34.3	86.8
Physics	37.0	31.7	85.7
Microbiological Sciences and Immunology	37.5	32.1	85.7
Computer and Information Sciences, General	2.8	2.4	84.4
Biomedical/Medical Engineering	37.0	31.0	83.7
Genetics	127.5	104.8	82.2

Academic Field	Doctoral Degrees per 100 Undergraduate Degrees (Men)	Doctoral Degrees per 100 Undergraduate Degrees (Women)	Women's Doctoral Degrees per 100 Undergraduate Degrees as a Percentage of Men's
Astronomy and Astrophysics	54.0	44.1	81.7
Environmental/Environmental Health Engineering	30.3	24.7	81.3
Aerospace, Aeronautical and Astronautical Engineering	11.0	8.9	81.1
Biochemistry, Biophysics and Molecular Biology	23.4	18.7	80.0
Physiology, Pathology and Related Sciences	81.4	64.1	78.7
Industrial Engineering	13.2	10.3	77.7
Chemical Engineering	18.7	14.2	76.2
Biological and Biomedical Sciences, Other	19.9	14.8	74.2
Cognitive Science	11.4	8.4	73.7
Applied Mathematics	22.9	16.9	73.5
Food Science and Technology	24.7	18.0	72.8
Materials Engineering	97.7	69.4	71.0
Biology, General	3.5	2.4	68.4
Engineering Mechanics	49.8	33.3	66.9
Engineering Science	41.1	26.9	65.5
Botany/Plant Biology	102.6	64.5	62.8
Textile Sciences and Engineering	24.1	14.9	62.0
Chemistry	29.9	18.3	61.2
Biological and Physical Sciences	3.6	2.1	59.8
Nutrition Sciences	40.2	23.0	57.2
Operations Research	21.3	12.0	56.4
Zoology/Animal Biology	14.4	7.7	53.5
Pharmacy, Pharmaceutical Sciences, and Administration	199.6	94.9	47.6
Mathematics	10.4	4.3	41.5
Animal Sciences	7.1	2.9	41.2

Conclusion

In this brief, we used an alternative approach to examine gender imbalance in STEM doctoral degree production that considers the potential pool of available doctoral students. We found that men are overrepresented in roughly three quarters of academic fields and women are overrepresented in roughly one quarter of academic fields. We also found that doctoral education in STEM academic fields is slightly more gender-balanced than in non-STEM fields once the number of students who are prepared for and interested in advanced study in an academic field is taken into account. With respect to specific fields, we found that among STEM fields, men tended to be overrepresented in academic fields included in the biological and biomedical sciences academic fields and in the physical sciences academic fields, suggesting that more efforts are needed in these fields of study to recruit and retain women in doctoral education. In contrast, engineering academic fields were, overall, roughly gender-balanced when the proxy of bachelor's degree recipients was used to gauge expected gender breakdown in doctoral degree production. Nevertheless, the absolute counts of women earning engineering degrees suggest that more intensive actions are needed at the predoctoral level to engage females in engineering academic pathways.

Our approach illustrates that there is considerable loss of women candidates between the bachelor's and doctoral degrees. One implication of this analysis is that if gender equity in STEM is the desired result, efforts need to be made earlier in students' academic pathways. Such efforts, however, need to be sustained all the way through doctoral education to help ensure equitable access and opportunities for women to advance in traditionally male-dominated fields (and, in some instances, for men to advance in female-dominated fields). These efforts need to be research-based and may benefit from a more qualitative understanding of student experiences. Identifying the leaks can support more informed efforts about where to target resources and support. To improve gender-equitable access to and opportunity in postsecondary STEM education pathways in practice, however, a greater qualitative understanding of both the institutional and external forces is essential. This includes the forces that influence students' decisions to pursue graduate degrees at the identified leakage points in a given field and the forces that affect institutions' decisions to recruit or accept particular students into their doctoral programs.

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