

INTRODUCTION

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American colleges and universities are simultaneously facing large numbers of faculty retirements and expanding enrollments. Budget constraints, especially those at public higher education institutions, have led colleges and universities to substitute part-time and full-time non-tenure-track faculty for tenure-track faculty. Although this substitution will reduce the demand for new full-time tenure-track faculty, the demand for faculty members will likely be high in the decade ahead.

This heightened demand is coming at a time when the share of American college graduates who go on for PhD study is far below its historic high. Moreover, groups that historically have been underrepresented in PhD study, women and people of color, are composing a growing share of the pool of college graduates. Although the female share of PhD holders has increased substantially in many fields, these increased shares have not translated into equal increases in female representation in tenure-track faculty positions at major research universities. The share of PhDs going to U.S. citizens of color has increased at a much slower rate than that going to women, and both the shares of new American PhDs and faculty positions at American colleges and universities that go to people of color are still way below what would be

predicted based on the number of American college graduates who are women or people of color.

The declining interest of American students in going on to PhD study is undoubtedly due to a number of factors. These include better labor market opportunities associated with professional degree programs, such as those in law, medicine, and business; long completion times to degree and low completion rates in PhD programs; how doctoral education is financed; the lengthy apprenticeship needed for doctoral study, which makes it difficult for students to complete degrees in a timely fashion; the need for (often multiple) postdoctoral appointments before PhD holders in many science and engineering fields can even contemplate a permanent academic position; the decline in the share of faculty positions that are tenured or on tenure track; and the failure of many PhD programs to adequately prepare their students for nonacademic employment opportunities.

At the same time, the share of PhDs earned in the United States by foreign students has substantially increased over the last thirty-five years, especially in key science and engineering fields. Many of these foreign PhD holders have remained employed in the United States. Through their roles as research assistants during their graduate study, postdoctoral researchers, and doctoral degree holders in academic and nonacademic employment, they have contributed substantially to our nation's scientific progress and to our college and university teaching programs.

Concern has been expressed, however, that the growing enrollment of foreign students in American PhD programs "crowds out" potential American citizen PhD holders and discourages them from pursuing PhD study. On the other hand, the aftermath of 9/11, the growth of research infrastructure and research support in other nations, and the growth of other nations' higher education systems all cast doubt on the ability of the United States to continue to rely on foreign PhD holders to meet our nation's need for scientific researchers and to fill future faculty positions.

Given all of these issues, in October 2006 the Cornell Higher Education Research Institute brought together a group of researchers from a wide number of science and social science fields, academic administrators, and policymakers for the conference "Doctoral Education and the Faculty of the Future." The sessions at the conference focused on efforts to increase and improve the supply of future faculty, and covered topics ranging from increasing undergraduate interest in doctoral study to improving the doctoral experience and the representation of underrepresented groups in doctoral education. The chapters in this book are revisions of the papers presented at that conference.¹

IMPROVING DOCTORAL EDUCATION

The first section of *Doctoral Education* consists of five chapters concerned with ways to better understand and improve the processes of doctoral education. Numerous private foundations, government agencies, individual researchers, and universities have worried over the last two decades about how to improve doctoral education, and the chapters in this section summarize some of the major efforts and their findings. Each paper reports conclusions based on substantive empirical research.

In 1991 the Andrew W. Mellon Foundation launched the Graduate Education Initiative (GEI), a major intervention toward improving the structure and organization of PhD programs in the humanities and related social sciences, with the dual goals of improving the general quality of doctoral education and reducing high rates of student attrition that accompany long completion times to degree completion. In contrast to earlier programs, which had provided grant aid to individual students or to graduate schools to distribute as they saw fit, the focus of the GEI was at the departmental level. The program ran for ten years and involved fifty-four departments at ten major universities, as well as a slightly smaller number of “comparison” departments. In all, the Mellon Foundation devoted almost \$85 million toward supporting the GEI.

In chapter 1, Ronald G. Ehrenberg, Harriet Zuckerman, Jeffrey Groen, and Sharon M. Brucker describe the GEI and the data collection efforts undertaken to help analyze the effectiveness of the GEI. It provides preliminary evidence of the program’s effect on a wide variety of outcomes, including attrition rates, times to degree, early-career job market success, and early-career publications. This is the first study of doctoral education that has traced the educational and job market experiences of students who dropped out of PhD programs, and it finds that a substantial proportion of the dropouts received PhDs from other PhD programs and/or received professional degrees. The chapter concludes with a discussion of the more general lessons that the authors believe the GEI provides for improving graduate education.

Although the focus of the GEI was on the department, recently the Council of Graduate Schools has undertaken the PhD Completion Project, which stresses the important role of graduate schools and their deans in improving doctoral education. Begun in 2004 with support from Pfizer Inc. and the Ford Foundation, the PhD Completion Project now involves twenty-nine major research universities that are creating intervention strategies to improve doctoral education in science, engineering, and mathematics, evaluating the impact of pilot projects designed to implement these strategies and then disseminating best

practice findings to graduate deans around the nation. An additional fifteen universities are participating in various aspects of the project.

In chapter 2, Daniel Deneke, Helen S. Frasier, and Kenneth Redd provide a progress report on the PhD Completion Project as of late 2006. They discuss the background of the project and the institutional factors that are believed to influence completion and attrition, including selection and admissions, mentoring and advising, financial support and structure, program environment, students' research experiences, and curricular processes and procedures. After providing background data on the nature of PhD programs and student outcomes, they summarize the directions in which the project is going.

At the turn of the twenty-first century, the Carnegie Foundation for the Advancement of Teaching sponsored the Carnegie Initiative on the Doctorate (CID). The CID was an action and research program that involved eighty-four participating departments from six disciplines (chemistry, education, English, history, mathematics, and neuroscience) in forty-four universities. The CID was designed to support departmental efforts to examine their doctoral programs.

In chapter 3, Chris M. Golde, Andrea Conklin Busche, Laura Jones, and George E. Walker summarize the nature of the CID and the two major themes that have emerged from the project as central to the foundation's thinking. The first is the important role of apprenticeship in the pedagogy of doctoral education and what the key characteristics of successful apprenticeship systems are. The second is the importance of a healthy and vibrant intellectual community for effective doctoral education. The authors elaborate on these two themes and how they interact to create outstanding doctoral programs.

Michael T. Nettles and Catherine Millett published an important book, *Three Magic Letters: Getting to the PhD*, in 2006. Based on a stratified sample of doctoral students in eleven fields at twenty-one doctoral-granting universities who had completed at least their first year of doctoral study in 1996, Nettles and Millett focused on how students navigate their doctoral experience, including the progress they are making toward completing their degrees. In chapter 4, Millett and Nettles summarize their analyses and findings. Their discussion focuses on racial/ethnic and gender differences in doctoral students' rates of progress and on the personal and program characteristics that influence students' degree completion and the amount of time that takes.

In chapter 5, the final study in the section, Maresi Nerad, director of the Center for Research and Innovation in Graduate Education at the University of Washington, confronts five common assumptions that faculty members and higher-education policymakers often have in mind when they think about doctoral education: (1) all students studying for

PhDs want to become professors; (2) professorial positions are highly desirable, and only the best students succeed in becoming professors; (3) career paths are linear, and new PhD recipients move directly into tenure-track academic positions after short delays due to postdoctoral fellowships; (4) successful PhD holders choose the very best job offer, unconstrained by relationship and family concerns; and (5) professors are more highly satisfied with their jobs than those with PhDs in non-academic employment. Using data from three national longitudinal studies that she and her colleagues conducted of the early career experiences of new doctoral recipients, Nerad shows that each of these assumptions is false. With that as a background, Nerad provides prescriptions for how doctoral programs should change in the future to meet the needs of students as well as the needs of the employers of new doctoral degree recipients.

ATTRACTING UNDERGRADUATES TO PHD STUDY

Our nation's private liberal arts colleges educate only a small percentage of American college students. However, the likelihood that their graduates will go on to earn PhDs is much higher than the likelihood that graduates of major U.S. research universities (where PhD education takes place) will do so. People often attribute the better performance of the liberal arts colleges to faculty at research universities being preoccupied with their graduate students and having neither the time nor the incentive to mentor undergraduates in research and/or encourage them to undertake PhD study.

Even among the most selective private liberal arts colleges, the share of students going on to PhD programs varies widely. If one is concerned about increasing the number of students going on to pursue PhDs, it is important to understand which characteristics of liberal arts colleges are associated with large numbers of their graduates receiving PhDs. In chapter 6, Robert Lemke addresses this issue. He finds that characteristics of the faculty (such as their research performance) and of their students (such as test scores and gender) clearly matter. But these factors do not tell the whole story. Through interviews with deans at colleges with large proportions of graduates going on for PhDs, Lemke concludes that providing a serious curriculum, encouraging students to take on challenges, and developing a campus environment that respects intellectual curiosity all appear to be factors that facilitate student interest in pursuing PhDs.

One aspect of the undergraduate experience that Lemke is unable to examine is the role of providing undergraduate research experiences for

students. A number of federal and foundation programs have supported such efforts in the hope that these experiences will encourage our best undergraduates to pursue careers in the science and engineering fields and to consider going on to PhD study.

In chapter 7, Myles Boylan critically reviews the evaluations that have been made of undergraduate research experience programs in the science, technology, engineering, and mathematics (STEM) fields. There are numerous methodological issues that one must face when trying to summarize the lessons of the evaluations. For example, some of these programs target for participation high-achieving undergraduates who already are oriented toward graduate school; most evaluations do not include control or comparison groups of students who did not go through the programs; many evaluations lack information on long-term outcomes; and results may be discipline specific. Nonetheless, Boylan finds that the empirical findings of the studies are broadly consistent and that research experience programs do appear to increase the likelihood that students who were not in the highest achieving cohorts at their undergraduate institutions will go on to graduate study. Paradoxically, however, he finds that the increased knowledge of career opportunities that these programs provide may also be associated with increased student uncertainty about career plans.

INCREASING THE REPRESENTATION OF PEOPLE OF COLOR IN THE PHD POOL

The chapters in this section discuss alternative approaches to achieving increased representation of people of color among PhD recipients. They are written by individuals who have all played important, active roles in seeking to achieve this objective.

In chapter 8, Richard Tapia, an applied mathematician at Rice University and mentor of a large number of underrepresented minority PhD holders in the STEM fields, and his colleague Cynthia Johnson discuss the factors that they believe are responsible for the underrepresentation of minority students in the STEM fields. They argue that there is a serious need for universities to make substantial changes in the ways they interact with minority populations and that focusing on the nature of PhD programs and the support minority students receive in these programs is too limited. Put simply, minority students cannot be successful in their undergraduate studies without a good elementary and secondary background; they cannot be successful in graduate school without good undergraduate preparation; and they cannot realistically be candidates for academic jobs in the STEM fields at major American universities

unless their PhDs come from top-ranked graduate programs. Hence, serious interventions at all stages of the pipeline are important if we are to substantially increase the number of underrepresented minorities in academic positions in the STEM fields at major American universities.

Carlos Castillo-Chavez, another applied mathematician and mentor for numerous minority STEM PhD recipients, and his colleague Carlos Castillo-Garsow echo Tapia and Johnson's concerns. However, while concerned about the problems that occur at all stages of the pipeline, they argue in chapter 9 that shifting the "blame" for the small number of minority PhD holders to the K–12 educational system and claiming that no progress can be made until improvements are made there ignores a history of successful long-term partnerships between federal agencies and universities. These partnerships have led to an increase in minority students receiving undergraduate degrees in the STEM fields and to a growing pool of these students ready to undertake graduate education in these fields. They describe their own very successful efforts to mentor undergraduate students for entry into STEM PhD programs, to successful completion of those programs, and on to productive careers. In their view, models such as their own program exist to greatly expand the production of minority PhD holders; the real problem is the lack of institutional and federal funding that would permit a large-scale expansion of such programs.

The American Economic Association has sponsored the Summer Minority Program to encourage and prepare minority undergraduate students to embark on doctoral study, receive PhDs, and move on to careers in both the academic and nonacademic sectors. As Charles Becker and Gregory Price describe in chapter 10, the program has evolved over time, been hosted by a variety of academic institutions, and is chronically underfunded. As a result, there have only been limited attempts to evaluate its effectiveness. Becker and Price describe a recent change in program design that has led to a natural experiment that allowed them to analyze the aspects of the program that are most likely to increase the likelihood that participants will proceed on to graduate study. They emphasize the range of outcomes that the program may influence, including improved interest in graduate study, improved performance in undergraduate courses, increased likelihood of admission to a top-ranked graduate program, and improved performance while in graduate school. Although their data do not permit them to analyze all of these outcomes, their findings about the program's effects are generally positive and they present an evaluation framework that can be usefully employed by other discipline-based groups.

In chapter 11, Cheryl Leggon and Willie Pearson Jr. analyze evaluations that have been undertaken in programs designed to improve the

participation of underrepresented racial/ethnic minorities in the STEM disciplines in the United States. They focus on evaluations of what appear to be the most effective and promising programs at the undergraduate, graduate, postdoctoral, and junior faculty levels. Their goal is to identify what is known and what needs to be known about programs that are effective in diversifying the STEM workforce, and how evaluations should be designed to assure that they provide information that is useful to decision makers.

INCREASING THE REPRESENTATION OF WOMEN IN ACADEMIA

M. R. C. Greenwood, chancellor emeritus of the University of California–Santa Cruz, provides an overview in chapter 12 of the status of women in the STEM fields in academia. Today, over half of all bachelor’s degrees in the STEM fields are granted to women, and their share of PhDs in most STEM fields is increasing. Although progress is most apparent in the life sciences and psychology, where over 50 percent of new PhD recipients are now women, it is evident in all fields. Data suggest, however, that women PhD holders in the STEM fields are much less likely than their male counterparts to wind up in tenure-track positions in major research universities, and the number of women in high-ranking academic or science and engineering policy positions is still rather small and fluctuating. Greenwood is particularly concerned about what she calls the “glass cliff”—a pattern of women moving into leadership positions in academia and then abruptly departing from them. She stresses that much additional work needs to be undertaken to remedy all of these inequities.

Jong-on Hahm spent a number of years as executive director of the National Research Council’s Committee on Women in Science and Engineering. Chapter 13 summarizes the work of the committee in its efforts to examine the challenges to the recruitment, retention, and advancement of women in faculty positions in the life sciences at major research universities. Unlike the physical sciences and engineering, there is a large pool of women PhD holders in the life sciences. The reason there are so few women doctorate holders in faculty positions in the life sciences at research universities must relate to the recruitment, retention, and promotion processes. Hahm’s chapter summarizes the departmental and institutional policies that can be pursued in order to increase the number of women applicants and the likelihood that recruited applicants will accept offers of employment, and discusses the retention of young female faculty and the likelihood of their promotion. She provides examples of specific policies pursued by individual institutions and

provides the addresses of websites at which the reader can learn more about these policies.

Unlike that of the life sciences, the new PhD pool in engineering fields tends to be heavily male. The School of Engineering at Tufts University has a significantly larger percentage of women among both its students and its faculty than is the national average. In chapter 14, Linda Abriola, the dean of the Tufts Engineering School, and Margery Davies, the director of the Office of Diversity Education and Development for several schools at Tufts, describe policies that have been pursued in order to help explain why Tufts has been so successful in recruiting and retaining women in engineering at all levels. These include positive efforts to integrate the engineering and liberal arts schools, administrative commitment and leadership on diversity efforts, targeted student recruitment and support programs, features of the curriculum and extracurricular programs, careful monitoring of faculty hiring, and structural support for faculty—particularly junior faculty.

THE INTERNATIONALIZATION OF DOCTORAL EDUCATION

The final section deals with the internationalization of doctoral education and the likely impact of current U.S. government policies on the flow of international students and faculty to the United States. In chapter 15, Liang Zhang addresses the concern that foreign doctoral students are “crowding out” doctoral students who are U.S. citizens. He sees no evidence that this is occurring in science and engineering but finds that outside these fields, increases in foreign doctoral student numbers are associated with decreases in the numbers of American doctoral students. Zhang also finds that male U.S. citizens who are potential PhD students exhibit strong female-avoidance behavior in a number of academic fields. Put simply, American men appear to opt out of PhD study as the share of new female entrants into these fields increases. Why this occurs is an open question, but the implication is that an increase in the number of women going on to PhD study in these fields does not lead to an equal increase in the number of students going on to PhD study in these fields.

In chapter 16, Emily Blanchard, John Bound, and Sarah Turner use detailed data on the countries of origin of foreign PhD students to understand the factors that have led to the dramatic growth of foreign enrollments in U.S. doctoral programs. Although some of this growth represents relatively continuous adjustments in the choices of students from countries with long-standing diplomatic and trade ties with the United States, another share represents responses associated with dramatic changes in

the political environment in foreign countries, such as the large increases in the number of Chinese students in the early 1980s and the number of Eastern European and former Soviet Union students in the early 1990s.

Blanchard, Bound, and Turner also caution that the flow of foreign PhD students to the United State does not always imply that these students desire to remain in the United States for employment after receiving their PhDs. Such decisions depend on the states of the labor and education markets for new PhDs in both the United States and the country of origin. An increase in the production of new PhDs from a given country at any point in time may be associated with the educational development of people who can staff the country's improving and growing university and technology sectors in the future, thus swelling the ranks of that country's students in the present but curtailing enrollments in the long run. They also analyze where foreign students go for doctoral study. Not surprisingly, foreign students from countries with well-developed higher education systems that include their own high-quality PhD programs only come to the United States for graduate study if they are accepted at our nation's most prestigious doctoral programs. In contrast, doctoral students from countries with few high-quality doctoral programs of their own often will be found enrolled in lower-ranked U.S. doctoral programs.

The enrollment of foreign students at U.S. universities, both at the doctoral and undergraduate levels, also depends on our government's policies toward foreign students. In chapter 17, Michael Olivas, a law professor who studies both higher education and immigration issues, describes what the "war on terror" has meant for U.S. colleges and universities. More specifically, he addresses how the United States regulates entry into its colleges and universities for international students, how antiterrorism laws have affected these practices, and how the changed ground rules associated with the so-called war on terror have affected the place of U.S. higher education in the world. Olivas finds that at the same time that we are making it more difficult for foreign students to study in the United States, a number of other countries in different parts of the world are moving in exactly the opposite direction. He worries about the implications for our nation's well-being; if fewer foreign students attend U.S. institutions this will have profound implications for the United States both because of its impact on the supply of highly trained STEM workers in our economy and because fewer foreign students will have experiences with American culture to take back to their home countries.

Olivas is also deeply concerned about the number of U.S. universities that are setting up branch campuses around the world. For example, Cornell University recently established a branch of its medical college

in Qatar, and Texas A&M University and three other major U.S. institutions also have branch campuses there. Although recognizing the importance of providing educational opportunities for citizens worldwide, Olivas worries about the implications of the expansion of American universities across the globe at the same time that there are underserved populations at home, especially in low-income and minority communities. He takes the position that public higher education institutions, in particular, need to have a very clear academic justification for operating overseas. This, at least implicitly, takes the reader back to chapter 8, and Tapia and Johnson's conclusion that American universities need to think much more seriously about how they relate, or don't relate, to underserved populations here in the United States.

CONCLUDING REMARKS

In the final essay we summarize the major lessons of the chapters of this book, talk briefly about some topics that were not discussed, and point out areas in which future research relating to doctoral education will be needed.