

*The feature of university life which most inspired me in my first year as an undergraduate was the realization that the people who were now teaching me were active scientists who had directly contributed to the subject they were teaching through their research and that their research was stuff from which they still got a kick.*

—Philip Rea, Professor of Biology, from “Talk About Teaching and Learning,” *Almanac*, March 24, 2009, Volume 55, No. 26

## **Chapter 6: Undergraduate Research**

### **Introduction**

A great research university ought to engage undergraduate students in the excitement and possibilities of original research, teaching intellectual habits and practical skills that will last throughout their lives. Research in this way exemplifies Penn’s defining emphasis on combining the theoretical with the practical, as first defined by our founder Benjamin Franklin. Research is the ultimate step in a learning process that helps students become proficient in fundamental skills. By allowing students to move beyond the traditional classroom experience—in which they may often encounter pre-packaged problems and scenarios with known solutions and outcomes—research forces them to carefully consider how to identify an important or relevant problem, formulate a question or hypothesis, gather evidence, develop a paradigm for evaluating and understanding a major problem within that discipline, and work toward a potential solution.

Undergraduate research is in these ways integral to the principles of the Penn Compact. Undergraduates participating in research learn how knowledge is integrated across disciplines while engaging with both local partners and a world-wide community of scholars. Providing research opportunities to undergraduates from all backgrounds epitomizes the Compact’s emphasis on increasing access to education to all members of our community. Undergraduate research serves as a valuable experience for all students, regardless of their career goals, and is part of Penn’s core mission.

Our commitment to infusing research into undergraduate education has been markedly strengthened in recent years, so that about 70 percent of Penn seniors now report having engaged in at least one significant research activity during their undergraduate experience. In particular, we have expanded the Center for Undergraduate Research and Fellowships (CURF), including its signature Penn Undergraduate Research Mentoring Program, which gives rising sophomores and juniors life-changing opportunities to work directly with faculty members on hands-on research projects.

### **Working Group Charge and Process**

The charge to the Undergraduate Research Working Group was to evaluate the undergraduate research experiences provided by departments and programs, as well as the programs offered through CURF. The group was asked to articulate what is important about Penn’s current undergraduate research efforts and how those efforts could be improved, within the framework of the MSCHE Standards of Excellence, especially Standards 7, 11, and 14.

The Undergraduate Research Working Group gathered institutional data, information from department and school leaders, and survey and anecdotal data from faculty. Institutional data were obtained from

the Office of Institutional Research and Analysis, drawing on curricular, grant funding, and survey data of both faculty and undergraduates. These data were examined with an eye toward determining the extent of undergraduate research at Penn, as well as whether students from different schools, disciplines, and socioeconomic, racial, ethnic, and gender backgrounds participate equally.

Some of the key questions that guided this inquiry were:

- What is the role of undergraduate research at a research university like Penn?
- How does the Penn community understand the relation of undergraduate research to teaching and learning?
- How does undergraduate research help students in their career pursuits? Are we making our students more competitive job candidates by fostering undergraduate research?
- What data and information about undergraduate research at Penn will help us determine whether our initiatives are effective?
- Beyond specific benchmarks and data, what are some of the most valuable qualitative judgments, strategic thoughts, and recommendations about the future of undergraduate research at Penn?

## Definitions

The Working Group held extensive discussions about whether a uniform definition of “research” could or should be articulated, particularly given the variations among the disciplines at Penn. In seeking a shared definition, the group focused on the approaches, expertise, skills, and process-related activities in which undergraduate researchers were found to engage. Broadly defined, research runs the gamut from scientific experiments to creative works of art. Through their engagement in research, students learn how to gather evidence, formulate a question or hypothesis, answer that question or test that hypothesis, and interpret and communicate the findings or culmination of that work. Such a process is as intrinsic to a creative work as it is to a scientific experiment. Given the breadth of disciplines featured at a research university like Penn, we define research to entail one or more of the following:

- Employing the methodology of a discipline
- Learning from a mentor in the context of the mentor’s research project
- Confronting a problem or question of interest to practitioners in the field
- Thinking beyond the questions and problems explored in the classroom
- Documenting the process and results of one’s work

In considering this definition, it is important to keep in mind the distinction between *activities* that provide students the tools necessary to conduct advanced research (such as research methods courses) and the *active work* that embodies advanced research and leads to the production of scholarly knowledge. Due to Penn’s diversity and the wide range of faculty involvement in undergraduate life, it is difficult to characterize a “typical” undergraduate’s access to and involvement in undergraduate research. This list attempts to capture the breadth of undergraduate engagement in research:

- Archival research
- Conduct experiments
- Data analysis
- Data management
- Literature review
- Oral presentation of research results and progress
- Research design
- Synthesis of literature
- Attend lab meetings
- Create and/or document a work of art
- Data gathering
- Hypothesis formulation
- Manuscript preparation
- Prove a theorem
- Seminar attendance

### **Undergraduate Research at Penn: An Extension of Learning**

Undergraduate research contributes to Penn’s mission as a premier research institution by promoting and supporting undergraduates who are pushing the boundaries of knowledge under the guidance of Penn faculty. To a great extent, undergraduates are taking advantage of opportunities for research. Penn undergraduates should have the opportunity to engage in academic research in a meaningful way at some point in their academic careers. Although requiring each student to complete a senior thesis is unworkable given Penn’s range of disciplines and programs, we believe undergraduates should be strongly encouraged to participate at each of three increasingly complex levels of engagement.

At the most basic level, each undergraduate should be encouraged to assist with a faculty member’s research project. As a leading research university and in keeping with the goal of the Penn Compact to increase access to education, the University should pay particular attention to supporting and engaging students who are underrepresented in their fields or may not have previously had access to research opportunities. Similarly, students who have shown clear interest or promise as potential contributors to their disciplines should be enthusiastically encouraged and supported.

Students who advance to a deeper level of research engagement should be encouraged and supported by a standing faculty member in their chosen field to launch an independent research project under the faculty member’s guidance. Those students who are underrepresented in academic research—students from underrepresented minority groups or low socioeconomic backgrounds, and women in the sciences—should be particularly encouraged and supported in this endeavor.

At the most advanced level, Penn undergraduates who are doing well in their chosen fields should be encouraged and provided the opportunity to delve deeply into a topic in their discipline, through a senior thesis, independent study, or some form of hands-on, semi-autonomous project guided by a member of Penn’s standing faculty. Each Penn undergraduate who has successfully committed her/himself to ongoing research should have the opportunity to perform advanced work enhanced with central support (which could mean receiving research funding, academic credit, engagement in a research seminar, presentation of their work, or other forms) under the close supervision of a Penn faculty member.

Penn offers many informal and formal opportunities for research, including research assistantships and lab positions, informal faculty mentorships and research colloquia, senior theses and capstone courses and experiences, funded summer programs, competitive fellowship programs, and long-term scholars

programs. For a complete list of these substantial resources, see Appendix 6.1: Research Programs and Internships. The “Roadmap to Research” for incoming undergraduates drafted by the Student Committee on Undergraduate Education (Appendix 6.2) is a thoughtful effort to help students navigate Penn’s varied resources and illustrates how an engaged group of undergraduates perceives student opportunities to become engaged in research.

### Survey Findings

Student surveys indicate that large numbers of Penn undergraduates participate in research activities. Analysis of these responses plays a key role in assessing student engagement in and satisfaction with research, although the responses do not address the academic quality of student experiences. When interpreting student responses, it is important to distinguish between formalized research participation and the acquisition of research-related skills/activities, as well as student opportunities, participation, and satisfaction. It is furthermore difficult to determine from student survey comments which activities are being referenced in comments regarding skills related to research, as well as whether those activities occurred in or out of the classroom. With such caveats in mind, if the goal is to have Penn students engage in research activities and to use that experience to position themselves for success after graduation, then Penn is very successful.

Based on 2012 Senior Survey data, we estimate that approximately 70 percent of Penn seniors engage in one or more research activities during their undergraduate years at Penn. In addition, we can say that these students are overwhelmingly satisfied with their research experiences (Figure 6.1). Research with a faculty member was the only question asked specifically in previous senior surveys, and Penn students’ 87 percent satisfaction rate in 2012 rose substantially from 76 percent in both the 2006 and 2010 Senior Surveys.

**Figure 6.1**  
Selected 2012 Senior Survey Responses by Undergraduate School/Discipline

	Research with a Faculty Member		Other Research Experiences		Independent Study		Published or Presented Paper Off-Campus	
	Participation	Very or Generally Satisfied	Participation	Very or Generally Satisfied	Participation	Very or Generally Satisfied	Participation	Very or Generally Satisfied
Comparison SPIs	53%	N/A*	41%	N/A*	36%	N/A*	15%	N/A*
ALL Penn	46%	87%	41%	90%	34%	89%	14%	97%
SAS-Natural Sciences	77%	90%	58%	92%	53%	92%	29%	97%
SAS-Social Sciences	41%	82%	40%	95%	39%	85%	5%	75%
SAS-Humanities	36%	91%	53%	86%	38%	89%	11%	100%
Nursing	38%	84%	38%	84%	3%	100%	15%	100%
SEAS	58%	84%	38%	90%	32%	88%	21%	94%
Wharton	27%	92%	22%	88%	21%	92%	7%	100%

\* Comparison SPI percentages not provided; overall Penn student population reports satisfaction rates similar to Comparison SPIs

Overall 2012 Senior Survey Penn Response rate: 39.1%

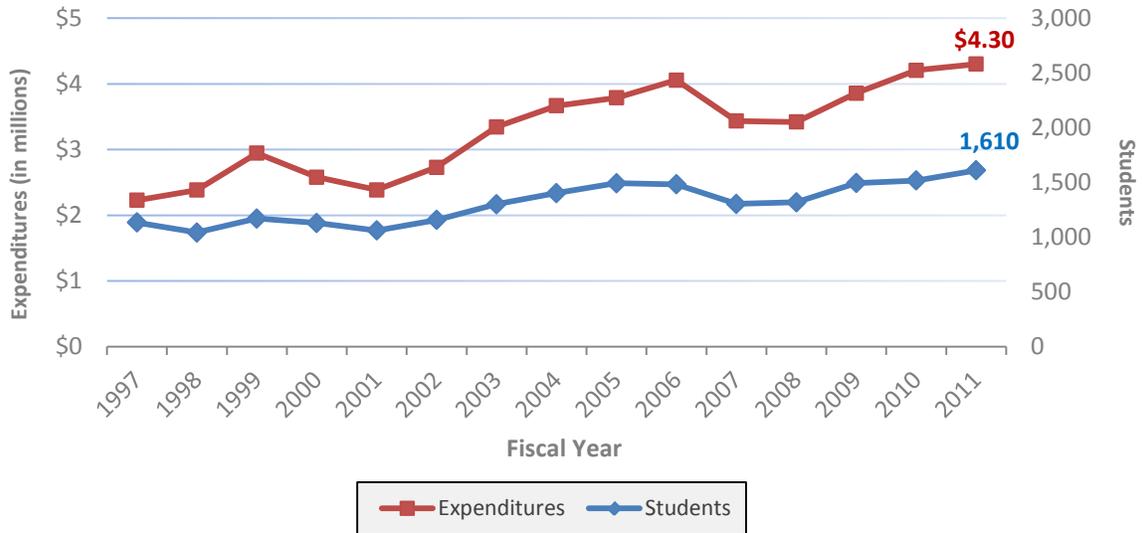
Student participation in these activities clearly varies across schools and disciplines. Fifty-eight percent of Engineering students report participating in research with a faculty member, while only 38 percent of Nursing students report having done so. The Nursing student responses are surprising, since the School's Senior Inquiry requirement should have generated a 100 percent response. Wharton students reported the lowest involvement in research activities other than independent study. In the School of Arts and Sciences, disciplinary background (as determined by the student's primary major) also appears strongly related to engagement in research. Twenty-nine percent of students majoring in the natural sciences report publishing or presenting their work off-campus, compared with 14 percent of the overall student population.

A wide range of ancillary data has been collected and examined to understand how initial involvement in undergraduate research might influence students' ongoing commitments to research. Continuing to monitor the number of Penn undergraduates who earn PhDs or are awarded NSF graduate fellowships may indicate the role undergraduate research involvement can and does play in meeting Penn's goal of integrating knowledge. However, it should be noted that two of Penn's schools, Nursing and Wharton, have not typically expected large numbers of their students to pursue the PhD. Given the large number of professional programs at Penn, enrollment in and completion of a graduate degree are not necessarily useful markers of the influence of research on undergraduates.

### **Research Programs and Internships**

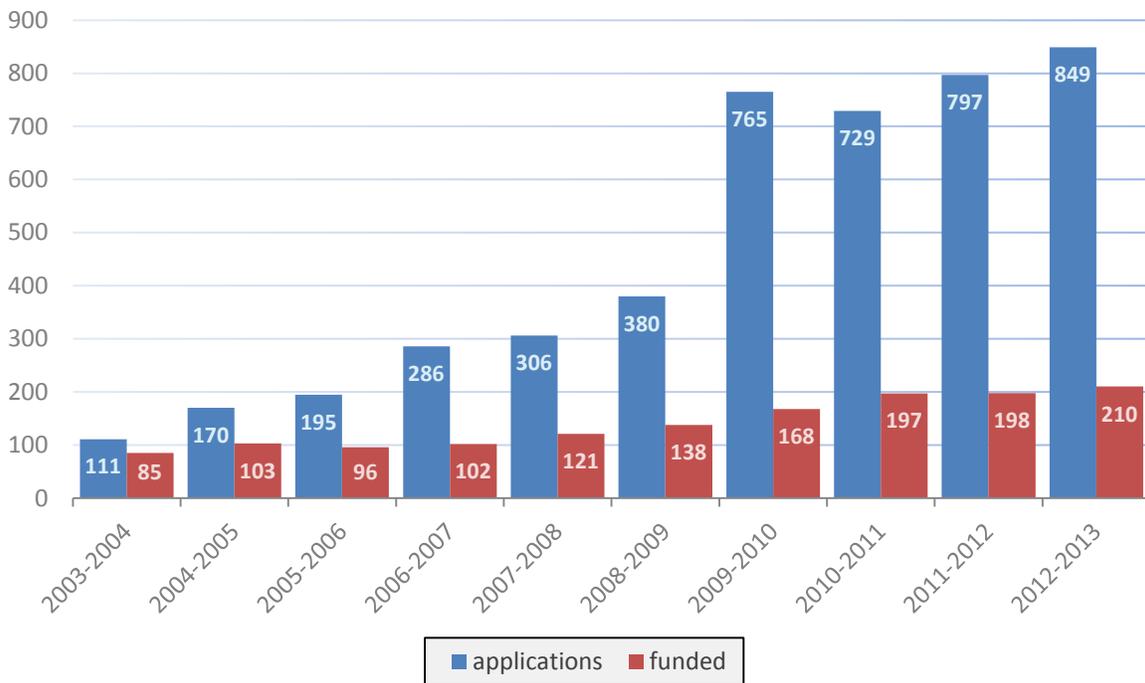
The [Center for Undergraduate Research and Fellowships](#) (CURF) is the central resource to help students find opportunities at Penn, as well as a key resource in connecting faculty with students seeking opportunities. Founded in 2001, primarily as a launching pad for students applying for international fellowships, CURF has played an increasingly important role in advancing undergraduate research among students, faculty, and staff, enhancing its outreach efforts to connect students with faculty researchers. CURF's comprehensive, up-to-date, and user-friendly website also provides students an access point to grants, fellowships, and internships at the University and elsewhere. CURF distributed \$468,000 in grant funding in 2012-2013, up from \$193,000 in 2003-2004. When combined with funding distributed to undergraduates from the research accounts of principal investigators at Penn who support undergraduates, this increase demonstrates that Penn's investment in research funding directed to undergraduates over the past decade and a half continues to rise (Figure 6.2).

**Figure 6.2**  
 Research Expenditures and Students Supported by Penn Principal Investigators and CURF  
 FY 1997 through FY 2011



During this same period, student interest in research as measured by applications to research programs coordinated by CURF has grown considerably (Figure 6.3).

**Figure 6.3**  
 Research Applications Coordinated by CURF  
 2003-2013



CURF's flagship outreach program is the [Penn Undergraduate Research Mentoring](#) (PURM) program. PURM provides rising sophomores and a few rising juniors with opportunities to work directly on a Penn faculty member's research project, as a paid summer assistant. It originally offered a \$4,000 student stipend and \$3,500 faculty research fund; to broaden participation, it now offers a \$3,000 student stipend and \$2,500 faculty research fund. PURM has proven extremely popular among both faculty and students and attracts far more faculty and student applicants than can be supported with current funding. As of summer 2013, more than 200 faculty members have mentored more than 300 students through PURM, growing from 18 faculty-student pairs in 2007 to 63 pairs in 2013. The program has benefited each year from increased support from the President, the Provost, and donors.

Since 2007, CURF's outreach efforts have increased substantially, showcasing Penn's vibrant research culture in such accessible formats and venues as Penn Previews and New Student Orientation, College House programs, targeted outreach to research courses, programs such as PennCAP and the Mellon Mays Undergraduate Fellowship Program, and twice-annual campus-wide research poster expos. CURF has incorporated undergraduates into its efforts by forming an Undergraduate Advisory Board and engaging juniors and seniors conducting advanced research as research peer advisors. While CURF is an important resource, research advising must emanate most fundamentally from the faculty. CURF plays an integrative role in connecting students with potential mentors and educating faculty and students about central resources. Actively engaging and empowering faculty in this process—including soliciting faculty input on research needs and resource allocation and providing willing faculty with necessary resources—is crucial to making undergraduate research an even more central activity for as many undergraduates as are capable and eager to engage in it.

### **The Role of the Faculty**

Many faculty members see undergraduate research as a natural extension of their own teaching and research. They see undergraduate research as a combination of teaching particular skills; providing students with guidance as they design their research programs; mentoring them about educational, professional and career opportunities; and pushing them to understand the differences between completing tasks in a classroom and producing original knowledge. However, research opportunities differ across disciplines. Mentorship in a science lab may mean integrating undergraduates into an existing team of researchers, with daily supervision provided by a post-doctoral fellow, graduate student, or lab manager. Similarly, social science research may engage students in extensive data gathering and analysis, field work, and literature reviews overseen by a research project manager, post-doctoral fellow, or graduate student. In both cases, direct student contact may vary by the size of the lab and the principal investigator's time, funding constraints, and openness to student engagement. External research funding may result in a reduced course load for these faculty members, thus freeing time for research activity including working with undergraduates (while lessening the faculty member's presence in the classroom).

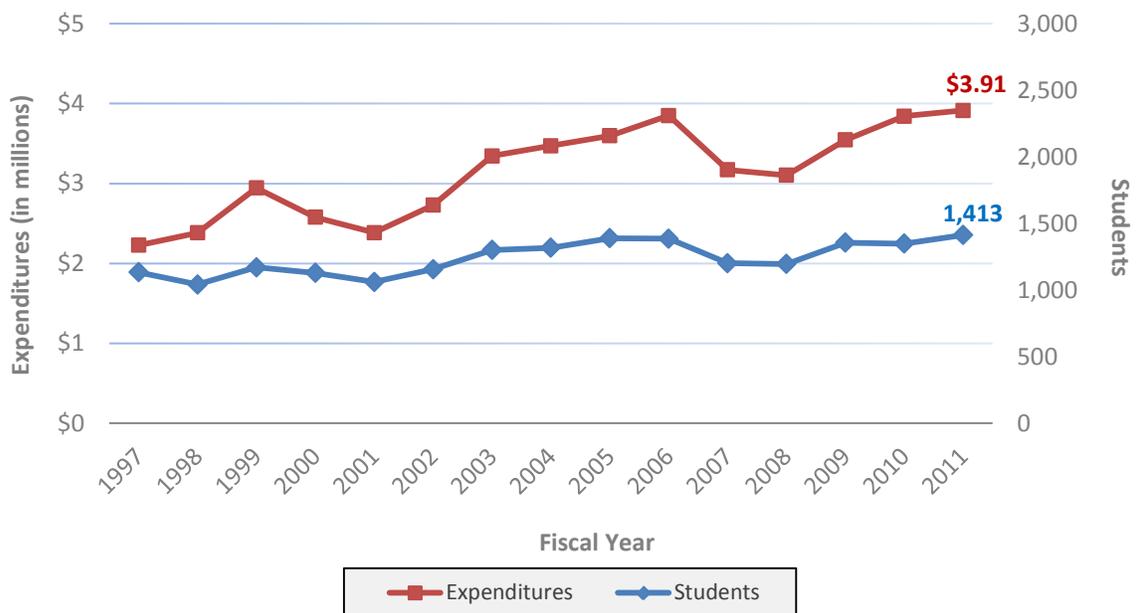
Penn undergraduates are often paid on faculty research grants. Student salaries paid in FY 2011 from research grants reached nearly \$4 million in Penn funds, an amount that significantly understates total

payments to students since it excludes the matching share of salaries for students paid through the Federal Work-Study Program. From 1997 to 2007 participation in research activities was stable.

- those paid by research funding in a single fiscal year ranged from 12 percent to 15 percent;
- those who completed a research course in a single academic year ranged from 16 percent to 21 percent; and
- those who participated in both of these research activities during a single year ranged from 3 percent to 4 percent.

While the trend in student payments via research grants has been generally upward, the declines in FY2007 and FY2008 reflect the leveling of federal funding awards that began in 2005, as the impact of such declines is generally felt one to two years after they are announced. Stimulus funding likely accounts for the increases in paid research participation from FY2009 through FY2011 (Figure 6.4). Looking forward, the downward trend in federal research funding to universities may result in a decrease in paid undergraduate research at Penn.

**Figure 6.4**  
 Research Expenditures and Students Supported by Penn Principal Investigators  
 FY1997 through FY2011

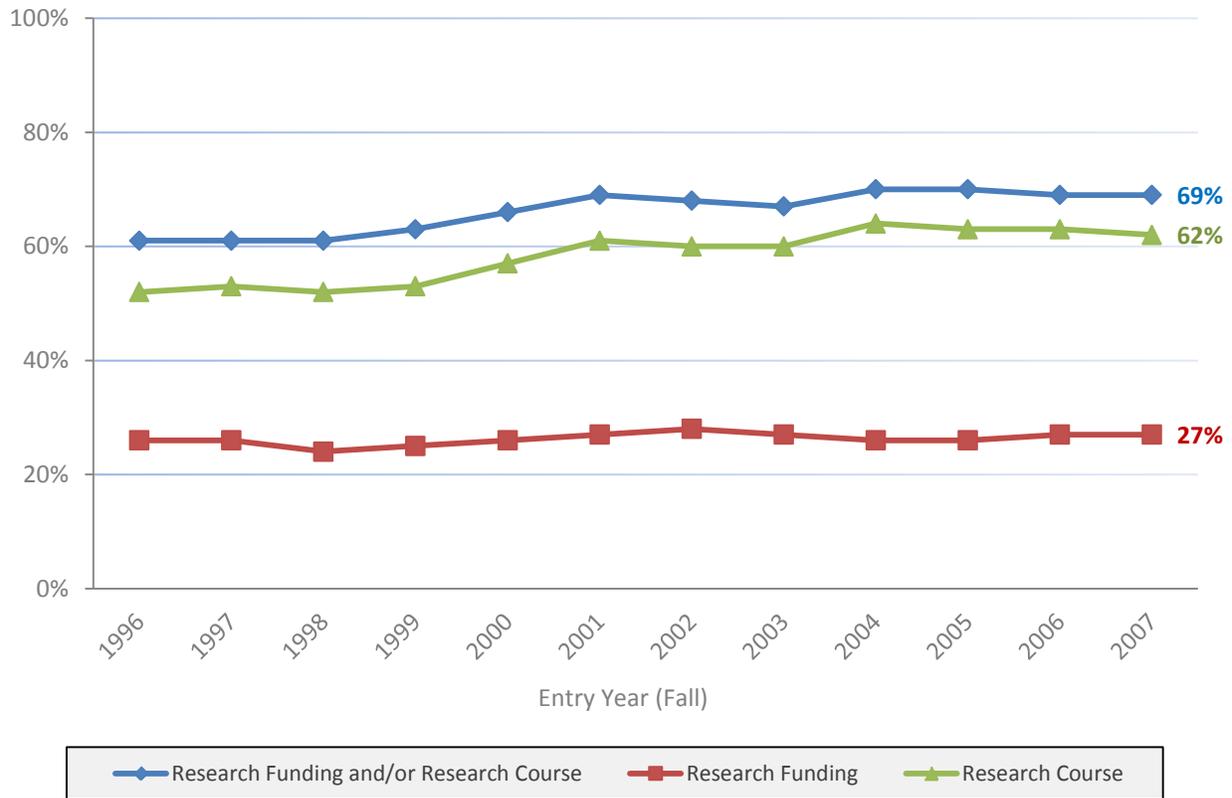


Grant funding is usually not as accessible to humanities faculty, thus eliminating or greatly reducing the likelihood that faculty members will hire undergraduates as paid research assistants. However, students in the humanities, like those in other fields, participate in research through independent study and other coursework. Thus, a combination of paid opportunities and course enrollments represents perhaps the best way to account for the participation of undergraduates in research.

### **Participation Data and Differences Among Schools**

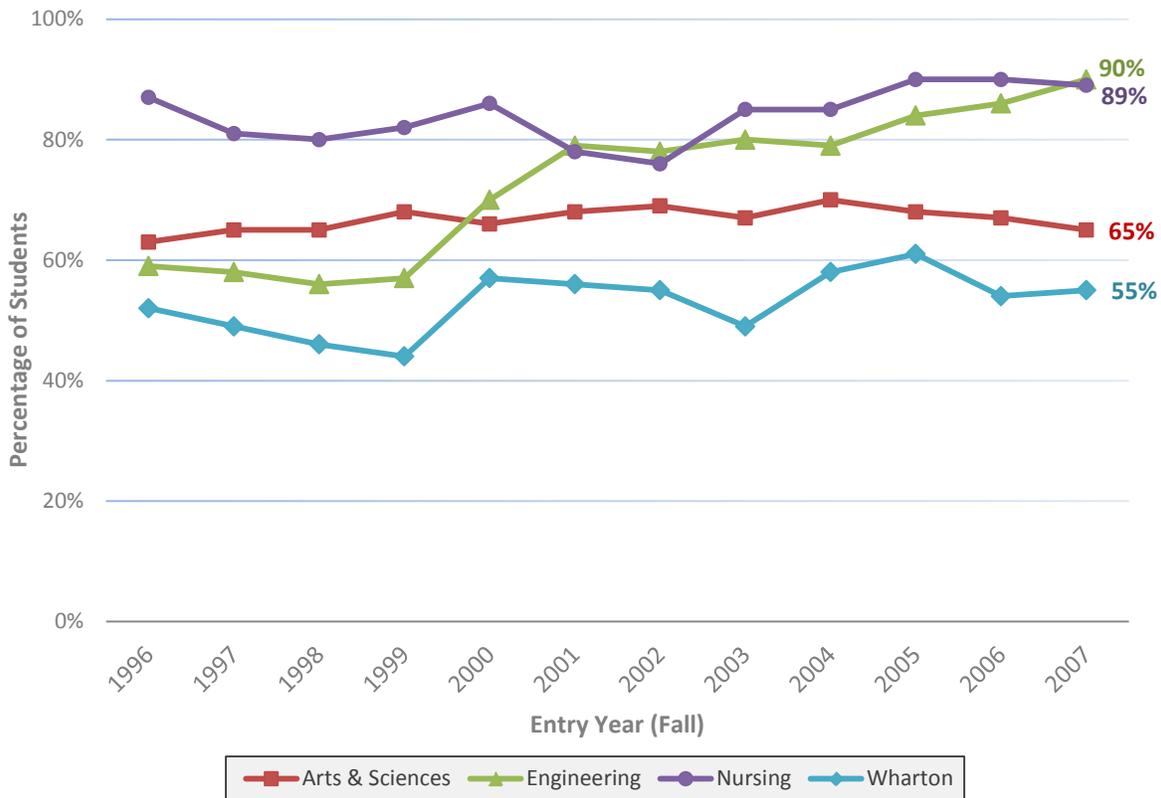
Data in the following figures reflect research grant payments and course enrollments for traditional undergraduate cohorts entering Penn as first-year students from fall of 1996 through fall of 2007, the last cohort for whom comprehensive four-year data are available. Like the data describing participation in research activities in a single year, the data for entering cohorts' participation in research during their undergraduate experience suggest a gradual upward trend in research engagement as measured by both research funding paid directly to undergraduates and enrollment in research courses. It is impossible to determine the exact number of students who engage in paid research during their undergraduate years. For the purposes of this review, "research funding" refers to the amount of funding paid to students from research grant accounts. While the extent of grant payments via research funding was determined using a precise—though incomplete—objective standard, research courses were identified by each school. In this context, a "research course" is defined as a course in which a student actually conducts research rather than simply learns research methods. Therefore, findings that rely on "research courses" should be considered preliminary. Since the early 2000s, the percentage of students who received research funding or enrolled in at least one research course (or both) has risen from 61 percent for the fall of 1996 entering cohort to 69 percent for the fall of 2007 entering cohort (Figure 6.5).

**Figure 6.5**  
 Percentage of Traditional Undergraduate Cohorts Paid by Research Funding  
 and/or Completing a Research Course during Undergraduate Years



The full implementation of a Senior Design requirement in all accredited Engineering programs during this period, which incorporated research activities, resulted in a dramatic increase in the percentage of traditional undergraduate Engineering students completing courses each year that could be classified as “research.” The School of Nursing has also required a Senior Inquiry course for all cohorts since 1987. While Nursing faculty see the work they expect of graduating seniors as research (suggesting that 100 percent of Nursing seniors should indicate that they have completed research with a faculty member), only 38 percent of graduating Nursing seniors responding to the 2012 Senior Survey indicated that they had indeed engaged in “research with a faculty member.” Nursing is currently revising its curriculum, including changing its Senior Inquiry requirement to “Senior Research” to promote more universal student engagement in faculty research and better align faculty and student perceptions. These examples underscore the challenges, even within specific schools and disciplines, of developing a definition of “undergraduate research” that is comprehensible and accessible to undergraduates, as well as rigorous enough to meet faculty expectations and disciplinary standards. These definitional challenges do not obscure the important fact that by multiple measures—survey results, paid research work, and registration in research courses—it is clear that approximately 70 percent of Penn undergraduates have a research experience.

**Figure 6.6**  
 Percentage of Traditional Undergraduate Cohorts Paid by Research Funding  
 and/or Completing a Research Course during Undergraduate Years



Analysis of the 2007 cohort’s research activities by school (Figure 6.6) suggests several notable trends:

- The highest level of research engagement is demonstrated by Engineering and Nursing seniors. As previously noted, this is likely due to the research requirements in the curricula of those schools.
- Students in Engineering and Nursing are the most likely to receive research funding at some time during their undergraduate career.
- Research funding by class year peaks during junior year in all schools except Wharton, which peaks during sophomore year.
- Wharton students exhibit the lowest level of research course completion during their senior years. However, Wharton students exhibit the highest level of research course completion during their junior years (21% vs. 18% for all Penn students).

## Equity in Undergraduate Research Opportunities

Among the most important issues the Self-Study explored was whether access to undergraduate research opportunities is shared equitably across student demographic groups. According to course and grant funding data and the 2012 Student Survey, women appear more likely to participate in research than men. Female students report “participating in research activities” more or equally as frequently as males; “research with a faculty member” is equal at 46 percent; “other research experiences” is higher for females (47%) than for males (33%); more females complete independent studies than males (36% vs. 31%); and slightly more publish their work (15% vs. 13%). Females are more likely than males to report more than one acceptance to graduate school, and more females than males (65% vs. 50%) report that they will be attending their first choice institution. Despite these differences, self-reported skill acquisition does not appear to differ by gender.

Students from underrepresented minority groups seem somewhat less likely to participate in research, perhaps driven by lower enrollment in courses identified as “research” in our analysis (53% for the FY 2007 cohort vs. 62% for all Penn students). Although very small numbers of underrepresented minority students responded to the 2012 Senior Survey, these students reported less engagement in “research with a faculty member” (33% vs. 46% for majority students), particularly among African American students (16% vs. 48% for non-African American students). Encouragingly, underrepresented minority students (particularly African Americans) reported consistently high levels of satisfaction with their faculty research experiences (88% of underrepresented students and 100% of African American students).

Students having high need for financial aid are roughly twice as likely to be paid by research funding (39%) as students with no financial need (21%), perhaps reflecting the important influence of the Federal Work-Study Program on research engagement. The data from the Senior Survey for high need students are mixed when compared to other students. Fewer of these students reported participating in research with a faculty member (37% vs. 47%), but more participated in “other research experiences” (45% vs. 41%) and independent study (40% vs. 33%) and most report high levels of satisfaction with their faculty research experiences (96%). These differences may reflect the fact that more high need students are engaged in research experiences as part of work study activities, but that would not explain lower participation in independent study.

High need students report no differences from other students in most specific skill and knowledge areas. However, their responses to a question about the contribution of their education to the acquisition of analytical and logical thinking skills suggest less of a contribution than responses from students with no financial need. The data on graduate/professional school plans are mixed—fewer high need students have more than one acceptance, but more will attend their first choice school—though these are very small response groups (17 and 11 students, respectively), which may suggest that we need to provide more high need students with the skills and experiences necessary to apply to graduate school.

Finally, international students report significantly more engagement in “research with a faculty member” (63% as compared to 44% for non-international students) and “independent study” (48% as compared to 32%) than non-international students.

In sum, student demographic groups showed slightly different patterns of engagement with undergraduate research. All groups showed consistently high levels of satisfaction with their research experiences. Survey results are of limited utility because it is impossible to determine exactly why students respond to specific Senior Survey questions as they do. Given the challenges of understanding the role of these factors in influencing undergraduate engagement in research at Penn, it could prove useful to track data on both undergraduate research experiences and post-graduate plans. Ongoing data collection could shed light on whether Penn's increased emphasis on undergraduate research affects the number of alumni pursuing graduate and professional degrees and applying for and receiving national fellowships.

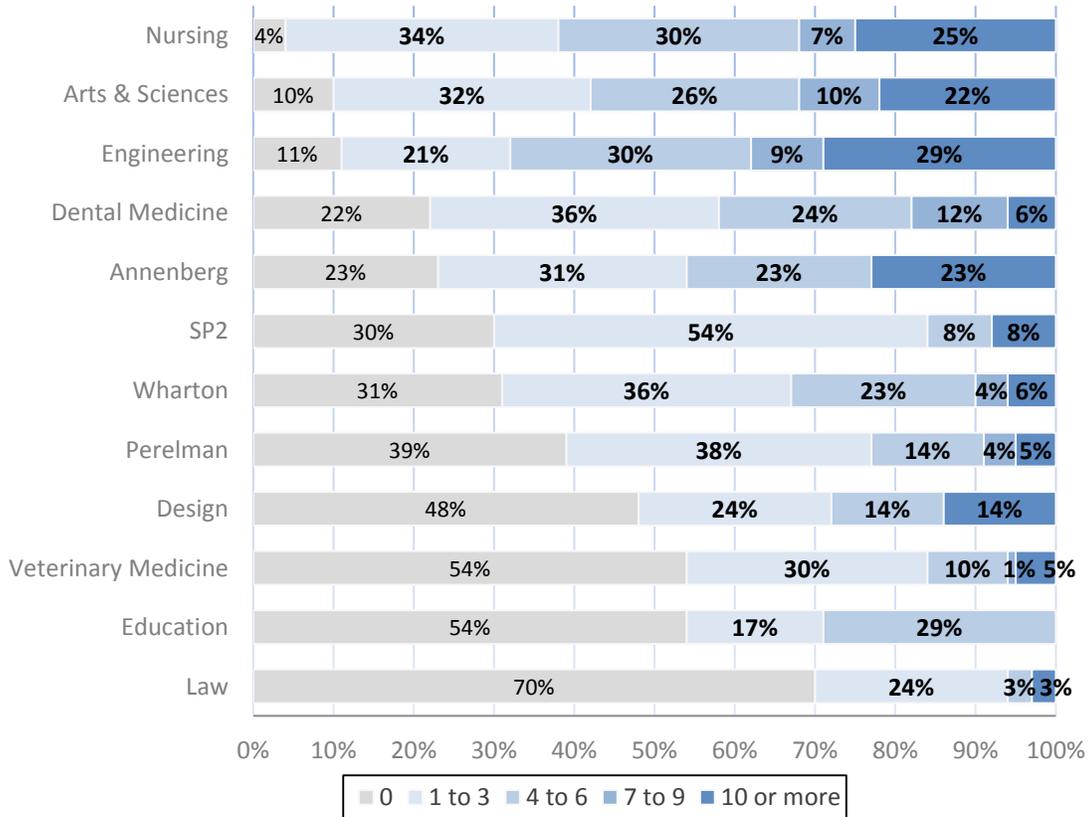
### **Faculty Survey Findings**

A comprehensive Faculty Survey conducted in the fall of 2011 with a 74 percent response rate among standing faculty (1,854 standing faculty respondents) demonstrated the broad engagement of Penn faculty in undergraduate research (Figure 6.7).

Approximately nine out of 10 standing faculty members in Arts and Sciences, Engineering, and Nursing report regularly mentoring undergraduates in research, as do more than three-quarters of the faculty in Dental Medicine and the Annenberg School for Communication, more than two-thirds in Wharton and Social Policy and Practice, more than 60 percent in Medicine, nearly half in Education and Veterinary Medicine, and nearly one-third in Law. Faculty involvement in research mentoring appears to include significant involvement among a core of faculty in all graduate and professional schools. Across the schools, there are a large number of faculty deeply engaged in mentoring undergraduates, and a larger number who take on a smaller number of undergraduates. In each graduate-only Penn school, a small number of faculty appears to rarely engage undergraduates in research, whether by virtue of the nature of their research, lack of information about support for engaging undergraduates, their institutional role, or limited interest. The broad involvement in undergraduate research of faculty from a wide range of research fields is a testament to importance of undergraduate education to the entire University.

**Figure 6.7**

Responses by School to the Fall 2011 Faculty Survey Question: “Over the past three years, how many undergraduates have had significant research experience\* under your direction or oversight?”



Faculty members responding to a spring 2013 survey on practices in undergraduate research were asked to identify the types of research activities in which undergraduates engaged. Among the 264 faculty respondents drawn from all faculty ranks at Penn, data gathering and literature reviews were the most common areas of undergraduate involvement. Tasks requiring relatively sophisticated thinking—such as research design, hypothesis formulation, data management, synthesis of literature, and synthesis of data—were also commonly associated with undergraduate research. Significant numbers of faculty reported student engagement in manuscript preparation, archival research, and seminar attendance, while science faculty emphasized undergraduates’ role in conducting experiments and attending lab meetings.

Identifying the contours of faculty involvement in undergraduate research highlights several trends:

- Broad involvement in undergraduate research mentorship among a significant segment of Penn’s faculty;
- Sharp school-based and disciplinary differences in faculty involvement;

- Different levels of undergraduate mentorship among faculty, even within schools and departments;
- A wide range of influences on faculty willingness to engage undergraduate researchers;
- General agreement on the kinds of research activities in which undergraduates are most commonly engaged;
- Consensus among a significant segment of faculty engaged in undergraduate research that enhanced funding for students and/or faculty, such as that institutionalized in the PURM model, would likely increase engagement in undergraduate research.

### **Strategic Considerations**

All undergraduates interested in a research experience outside the context of a course ought to have the opportunity to work with faculty or post-doctoral supervision. Deeply engaged students should be provided the support and faculty mentoring necessary to excel in their disciplines, positioning them to compete successfully in their academic pursuits (e.g., entry to top-tier PhD and other graduate degree programs); to earn external recognition (e.g., NSF Graduate Awards and other competitive graduate research fellowships); or to pursue careers in which they are opinion leaders. With these goals in mind, Penn might explore creating a summer research program for incoming underrepresented students, expanding PURM to fund more projects, and increasing funding for undergraduates to present their research at off-campus academic conferences.

To advance our understanding of student and faculty research engagement, CURF could develop a research project registration system for undergraduate researchers, with faculty verification of student research activities. More generally, Penn could enhance institutional data by monitoring the distribution of opportunities across and within departments for independent research projects—for example, a measure of total undergraduate research funding across the University that includes funds disbursed by programs, individual faculty, and research grants. Finally, the number of Penn undergraduates who earn PhDs and NSF graduate fellowships upon and after graduation could be tracked and reported. Since the dividends of engaging in research may not be fully realized until years after graduation—in such forms as publications, pursuit of graduate education, and career choices—the impact of undergraduate research involvement could be tracked beyond graduation through alumni surveys. Faculty research engagement with undergraduates should also be regularly reexamined, through periodic reviews of departmental and school data and faculty surveys.

### **Recommendation**

Penn students are regularly and quite successfully accessing a wide range of research opportunities at Penn. To maximize the scope, reach, and educational value of undergraduate research, the University could further strengthen the coordination of these opportunities. To this end, the Provost should create a faculty working group, convened jointly by the Vice Provost for Education and the Vice Provost for Research, which would extend our methods of collecting and analyzing information about undergraduate research and coordinate cross-school efforts to promote undergraduate research to students and faculty, especially in the graduate and professional schools.