

## **THE IMPACT OF UNDERGRADUATE RESEARCH IN SEM PERSISTENCE: A RETROSPECTIVE STUDY OF DARTMOUTH COLLEGE SCIENCE ALUMNAE**

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In 1997, the Women in Science Project (WISP) embarked on a major research effort, the Dartmouth College Women in Science Alumnae Survey, as part of a broader Alumnae Connections initiative with grant support from the AT&T Foundation. The study was inspired by Wellesley's 1993 landmark Pathways Report<sup>3</sup> which discovered 36% attrition from science by Wellesley alumnae, and coincided with the 25<sup>th</sup> anniversary of coeducation at Dartmouth. The focus of the study was on women in the twenty-four graduating classes of 1973 through 1996 who majored in science, math, and engineering while at Dartmouth. The three major research questions were:

- Did these women continue in the sciences after graduating from Dartmouth?
- What factors in their college experience encouraged or discouraged them in their pursuit of careers and advanced studies in the sciences?
- What recommendations do alumnae have to best prepare women in science?

In August 1998, the five-page survey containing both multiple choice and open-ended questions was mailed to 1308 Dartmouth alumnae. In addition, respondents were notified that an electronic version of the survey was available on the web. A total of 724 women responded to the survey (43% electronically) for a 55% response rate. Of these respondents, 43% were students graduating during the 1990's, 43% were students from the 1980's, and 14% were students from the 1970's. Biology was the most frequently mentioned major of respondents (40%), engineering majors and math majors were the next most common (14%), followed by chemistry (10%), computer science (8%), physics (6%), and earth sciences (4%). Three percent of respondents reported that they had been double science majors.

### **Highlights of Findings from *Looking Back: A Retrospective Study of Dartmouth Science Alumnae 1973-1996*<sup>2</sup>**

- A substantial majority of respondents (80%) self-reported that their current or most recent job was in the sciences, while 20% reported employment in the nonsciences. Most were in health care and medicine (31%), followed by math and computer science (17%), and life sciences (13%). Almost one-half (45%) of the respondents felt that their current or most recent job related very much to their undergraduate training in the sciences.
- 81% of respondents were currently employed.

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- 72% of respondents went on to receive postgraduate degrees. Of those, 39% obtained doctoral degrees, while 33% attained masters' degrees as their highest level of graduate training.
- 28% of respondents offered reasons why they did not pursue careers in the sciences or were strongly considering leaving the field. Over one-half of these women graduated in the 1980's (i.e., out of college for 9–19 years). Their reasons for leaving science careers included: 1) the advantages of nonscience careers and/or concerns with science careers, 2) the sense of one's own interests and abilities, and 3) the formative experiences in college, graduate school or the workplace.

Most areas of women's undergraduate experiences were seen as positive influences on their interest and/or desire to pursue a career in the sciences. Undergraduate research was rated as one of the most positive influences. Other areas rated as *most positive* included: upper level science course content and instruction, preprofessional work/internships, four of the five WISP activities (research internships, peer mentoring program, industrial electronic mentoring program, and special events), informal peer support, and relationships with faculty. Areas rated as *somewhat negative* influences were pre-major advising and career counseling.

### **Impact of Undergraduate Research**

Using survey data, WISP conducted an in-depth analysis of the impact of undergraduate research and produced a special report, *WISP Alumnae Connections Survey Report on Undergraduate Research*<sup>1</sup>. Findings in this report addressed two questions:

- What is the quality of the undergraduates' experiences in the opportunities that currently exist and how might their quality be enhanced?
- Do such opportunities change the undergraduates' academic experience at Dartmouth, and if so, how?

To examine the value of research opportunities for undergraduates, seven main items from the survey were explored in depth.

The main quantitative data are obtained from the following questions:

- *How would you rate undergraduate research opportunities, in influencing your interest and/or desire to pursue a career in the sciences?*
- *How would you rate first-year WISP research internships, in influencing your interest and/or desire to pursue a career in the sciences?*
- *During your undergraduate years, did you have someone whom you considered a mentor in the sciences?*

The main qualitative data are obtained from the following questions:

- *What do you consider, if any, the most significant aspects of your entire Dartmouth undergraduate experience, in enhancing your interest and/or desire to pursue further studies or a career in the sciences?*
- *What do you consider, if any, the most significant aspects of your entire Dartmouth undergraduate experience, in diminishing your interest and/or desire to pursue further studies or a career in the sciences?*
- *Based on your experience both in school and in the work place, what one recommendation would you make to Dartmouth College to best prepare their female undergraduates for a career in the sciences?*
- *Describe their role and the nature of your relationship (if respondent mentioned that she had a mentor).*

A text search for the words or phrases: “research,” “internships,” “WISP,” and “women in science” was done on all responses to these four open-ended questions. Printouts were generated of all responses that included these terms, which were hand-coded by researchers.

In addition to these seven primary items, data were also analyzed using four background/demographic variables (class year, undergraduate major, perceived likelihood that would major in science, racial/ethnic identification), and three post-graduate variables (advanced degrees, current employment, field most closely defining respondents’ current employment).

The report focused on two groups of respondents: those who participated in undergraduate research opportunities and those who participated in a WISP first year internship. It should be noted that there is some overlap between these two categories because, as will be described later, many WISP participants also participated in other undergraduate research.

### **Major Findings on the Impact of Undergraduate Research**

*A sizable proportion of respondents reported participation in undergraduate research opportunities.* Of the 724 women who responded to the survey, 53% reported that they had participated in research opportunities as an undergraduate; 51% of these women were from the classes of 1990–96. Fifty-two women reported being a WISP intern (33% of respondents from the classes of ’94–’96, the only classes in this study in which WISP first year internships were available). Reflecting the predominance of biology majors in the total survey sample, 49% of those who participated in research opportunities majored in biology, followed by chemistry and engineering majors (12%), physics majors (8%), earth sciences and mathematics majors (6%), computer science majors (3%) and double science majors (2%).

*The vast majority of women who either reported research opportunities or WISP research internships were those who reported that upon entering college, they already thought it was highly likely that they would major in the sciences. Of the women who participated in research, 82% reported that they thought it was very likely that they would major in the sciences and 11% reported that they had felt it was somewhat likely. Six percent felt it was only possible or not at all likely.*

*Many women regarded research experiences as positively influencing their interest and desire to pursue a career in the sciences. Respondents rated their undergraduate research opportunities quite favorably, with perceived levels of positive influence increasing gradually over the last three decades of Dartmouth classes. Using a five-point rating scale (1 = very negative to 5 = very positive), respondents rated their undergraduate research experiences. Participants from the 1970's and 1980's reported that their experiences were somewhat positive (Means = 4.04 and 4.06, respectively). Respondents from the 1990's reported somewhat higher evaluations of their research experiences (Mean = 4.3). Evaluations of the respondents who participated in WISP internships were similarly positive.*

*Twenty-four percent of respondents listed undergraduate research opportunities as one of the most significant aspects of their Dartmouth undergraduate experience, in enhancing their interest and/or desire to pursue further studies or a career in the sciences. Women discussed the value of apprenticing with a faculty member as a research assistant/intern, as well as of conducting one's own independent research, such as doing a senior thesis. Women described a range of benefits received from engaging in research opportunities, such as acquiring an interest in and commitment to doing research, increased understanding of the real world applications of science, and a sense of belonging to a scientific community. These responses were coded into five general categories: affective/attitudinal benefits (37%), graduate school & career development (22%), increased knowledge/understanding (17%), having a mentor/role model (16%), and skills development (6%).*

*A small number of women regarded research opportunities, or lack thereof, as having an adverse effect on their interest and desire to pursue a career in the sciences.*

Approximately 5% listed undergraduate research opportunities, or lack thereof, as one of the most significant aspects in *diminishing* their interest and/or desire to pursue further studies or a career in science. Almost half of these responses indicated the positive value of a research experience. Respondents described how their science focus was redirected or expressed a desire for more research opportunities. More critical responses concerned women's view that the process of obtaining a research opportunity was too highly selective and competitive, expressing disappointment of having been rejected as a research intern or assistant. Others felt that the range of research opportunities had been too narrow and heavily skewed towards academic research and medicine.

*Women who participated in WISP first year internships were more likely to report having participated in other research opportunities ( $r = 0.24, p < 0.001$ ). Of the 52 women who reported taking part in WISP internships, 50 reported general research opportunities as well. A number of women described how they continued to conduct research with their WISP sponsor beyond their first year, or how the WISP internship was the first of a number of different research opportunities in which they participated.*

*Women who participated in undergraduate research opportunities were more likely to report having a mentor in science while in college. Women who participated in undergraduate research opportunities were more likely to report having a mentor in science while at Dartmouth than their peers who did not participate in research ( $r = 0.39, p < 0.001$ ). Similarly, women who participated in WISP research internships were also more likely to report having a mentor in science while at Dartmouth ( $r = 0.13, p < 0.001$ ). Respondents described many specific ways they felt mentors had offered support and guidance, such as overseeing their thesis work, providing encouragement and advice, helping with professional networking, providing positive role models, and recognizing potential in their students.*

*Women who participated in undergraduate research opportunities were more likely to go on and obtain doctoral degrees than their counterparts who did not participate in undergraduate research opportunities ( $r = 0.13, p < 0.001$ ).*

*Women who participated in undergraduate research opportunities were more likely to remain in a career in the sciences ( $r = 0.17, p < 0.001$ ). Of the 469 women who reported current/most recent employment in the science field, almost 60% had participated in undergraduate research opportunities. For the women who are not currently employed in a science field, about 35% had participated in undergraduate research opportunities.*

*Undergraduate research opportunities were cited by women as one of the most important program initiatives for Dartmouth to prepare their undergraduate women for a career in the sciences. When asked for the **one** recommendation they would make to Dartmouth College to best prepare their female undergraduates for a career in the sciences, 12% specifically mentioned the provision of undergraduate research. More specifically, women recommended that:*

- It is essential to provide undergraduate research opportunities to students interested in careers in the sciences, to afford a realistic sense of future fields and positions, and to build skills, knowledge and experience that are critical to graduate study and future careers in science.
- Research opportunities should be available early on in one's undergraduate career. At the same time, research opportunities should be made available throughout various points in one's college years, either to build upon previous research experiences, or to newly enter the research field.

- Having a mentoring relationship with a faculty member and feeling part of a scientific research community constitute important parts of research opportunities.
- The types of research opportunities available should be expanded beyond academic scientific research and positions in medicine, into positions in industry, business, education and other fields.

## Conclusion

Data from the Dartmouth College Women in Science Alumnae Survey clearly support the value of providing research opportunities to undergraduates. Alumnae majoring in the sciences rated such experiences as positively enhancing their interest and desire to pursue a career in the sciences, and described many of the benefits they felt they received through these experiences, particularly by acquiring a strong mentoring relationship with a faculty member. These views were further supported by the statistically significant relationship that undergraduate research opportunities increased the likelihood of obtaining an advanced doctoral degree, as well as increasing the likelihood that they would remain in careers in the field of science.

Given the clear benefits of research experiences, these findings suggest that colleges should consider ways to increase the numbers and kinds of research opportunities that might be made available, and the range of students served. Formal faculty research internships should be considered as part of the larger array of other out-of-classroom learning opportunities and internships, in greater coordination with academic advising and career counseling and placement. In this way, greater numbers and kinds of students can best be served, so that research and other out-of-classroom learning opportunities are not reserved for the “best and brightest.” Rather, such opportunities should be made widely available to all interested undergraduates, introducing them to interesting and diverse ways of thinking, learning, and working with colleagues, and serving as important avenues to exciting future careers.

## References

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3. Rayman, P. and B. Brett. 1993. *Pathways for Women in the Sciences, The Wellesley Report Part I*. Wellesley College Center for Research on Women.