

FACTORS INFLUENCING WOMEN'S PURSUIT OF A COLLEGE SCIENCE MAJOR OR SCIENCE CAREER: AN EVALUATION OF THE WOMEN IN SCIENCE PROJECT (WISP)

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This paper reports the results of a formative evaluation of the Women in Science Project (WISP) at Dartmouth College. Through paid research internships for freshmen, peer mentoring, career workshops, industrial site-visits, seminars with women scientists, study rooms, and an electronic newsletter, WISP aims to increase the number of first-year women students enrolling in, majoring in, or pursuing a career in science and engineering fields. Particularly unique to Dartmouth's program is the paid scientific research internship for freshmen. This is a highly unusual approach to undergraduate instruction in scientific research; research experiences are usually reserved for upperclass science majors, most often seniors, and tend to be focused on preparation for graduate study.

EVALUATION OVERVIEW

The multimethod evaluation of WISP collected quantitative and qualitative data from questionnaires, interviews, focus groups, Dartmouth College Records, and biweekly journals. Data from two freshmen classes, rising juniors, and seniors was used to assess the impact of the WISP program and distill some of the crucial decisions and factors affecting women's choice and pursuit of a science major. This paper focuses on the internship experience of the participants in 1995; more specifically, it reports findings from one data source, an internship journal.¹ As Sheila Tobias' work has demonstrated, student journals can provide in-depth documentation of participants' attitudes and experiences. The journals not only served as an evaluation tool, they also encouraged interns to reflect further upon science and their internship. Biweekly throughout the two terms of the internship in 1995, the evaluator e-mailed the 100 interns nine open-ended reflective journal questions that focused on: 1) Initial impressions 2) Internship responsibilities 3) Communication in the lab 4) Sources of frustration 5) Non-scientific understandings gained from the internship 6) Issue of women in science 7) "Culture" of science 8) Influence on personal views about science and scientific abilities 9) Review of highs and lows of the internship experience. All 900 of the journal entries were read and coded using thematic categories. The entries were analyzed on two levels, by question and by student.

FINDINGS

Six major themes emerged from the interns' responses—themes that pervaded the questionnaire and interview data as well. The topics address characteristics of science and science teaching that encourage and discourage women's interest in science. Journal responses offer convincing testimony of the role an internship experience can play in helping women more accurately understand what scientific research entails, in increasing women's

¹ A more extensive report of these findings, and those from the evaluation are available. Requests should be directed to Christine Cunningham, 111 Kennedy Hall, Cornell University, Ithaca, NY 14853 e-mail: cmc3@cornell.edu

confidence in their scientific abilities, and in influencing women's continuation in (or in some cases, departure from) science.

1) CONFIDENCE

WISP does a great job of trying to help alleviate the sexism and the psychological constraints women in science have to confront. So many times, the difference between a woman majoring in science or in a field of the humanities is sheer lack of confidence.

In their journals, interns vividly described the impact that their research experience had on their confidence in their scientific abilities. Initially many of the interns wrote that they felt overwhelmed by their internship and the background knowledge that they lacked; however, by the end, the experience had "taken away the mystery of the lab" and convinced them that they are capable of doing science and scientific research. For many interns, success in "real science" counterbalanced their doubts about their scientific aptitude that their "low" grades in their science courses raised and encouraged them to continue in science. "The encouragement and experience of my internship made me feel like I can make it (in the scientific world) even though I may not always feel that way as a result of my science classes."

The experience students gained in their internships promoted confidence that affected their coursework. Exposure to science techniques and content made them more comfortable in their classes and helped them perform better. Interns explained how actual hands-on experience helped make classes easier because it made theoretical learning more relevant.

I am able to see that the stuff we learn in class, which oftentimes seems rather irrelevant to the real world, really is used. My confidence in my scientific abilities has definately {sic} increased since first term.

The internship also increased their confidence in working, "with other people, and on group projects, as well as communicating with professors about problems."

A first research experience can open the door to future experiences in scientific research. Some women who had laboratory experiences in high school came to Dartmouth seeking more; the internship experience had a similar effect on many of its participants. Students wrote that their internship helped them develop the desire and the confidence in their science abilities to apply for summer jobs and additional lab experiences; about 60% of the interns indicated that they hoped to seek another research position.

The responsibility that the mentors gave interns was one factor that contributed to students' increased confidence in themselves. Interns were surprised by their mentors' trust in their abilities and the freedom that they were allowed to pursue their own ideas and make their own decisions. The confidence that the mentors displayed in the interns often rubbed off on the interns themselves. The fact that sponsors solicited interns' opinions and valued their input boosted students' confidence.

I'm starting to give more value to my own opinions. No one can tell me exactly what I am supposed to do, so when my prof asks me what I think it is not just an empty gesture, but a genuine request, because I am the one most familiar with the data

Some of the interns found the unfamiliar lack of guidance and structure stressful. Many women feared "messing things up" or making mistakes. Women described how answers in science classes and labs are either right or wrong and leave little room for revision or second chances—students strive to attain a known outcome. Interns enjoyed real research because the pressure associated with making a mistake was removed; a "failed" experiment no longer translated into feeling like a failure.

My internship...has changed my view of myself in relation to science. I was very timid at first in the lab, I felt like I know {sic} nothing and it bothered me a little. But now I realize that it's ok to not know, that the whole thing is about learning, about trying different things to get things to work, about experimenting. And it doesn't always work, but that doesn't mean that you should lose confidence in yourself.

During their internship, participants came "to understand that there is no failure in science--maybe things don't work out, but you can just do it again!" and that there are many questions that don't have answers. Hearing graduate students and faculty discuss their own frustrations, failures, and lack of knowledge seemed to reassure freshwomen that their own such feelings did not signal incompetence, but rather were inherent in the practice of science.

2) PERSONAL CONTACT AND TEAMWORK

The close, personal contact with people in science that the internship experience fosters is the most valued, important aspect of a WISP internship. Throughout the journals, interns cited their interaction and work with peers and lab members as an influential, necessary, and unique opportunity during their freshman year. Large introductory classes and impersonal departments turn women away from science majors—many miss the close interactions they had with teachers in high school and are intimidated by the aura of professors. In their internship setting, interns came in contact with other members of the lab (graduate students, technicians, upperclassmen); these people offered them support, advice, career counseling, mentorship, and friendship. By exposing the human face of science, the internship contradicted stereotypes about science and made it more appealing:

WISP has made me realize that science just isn't the impossible, foreign world that it is so often made out to be. I suppose it has humanized the field. The lab I am involved with is full of people truly concerned with scientific problems. They all put so much energy into their research and they care so much about getting helpful results.

Women frequently mentioned their friendship and conversations with fellow researchers and were struck by their co-workers' willingness to help or answer questions about academics and research as well as career and personal lives. A highly valued aspect of the internship program was the opportunity that it afforded women to glimpse the life a researcher leads both inside and outside the lab. Many freshwomen wondered about balancing a career in science with a family and other personal interests; contact with lab members demonstrated that the two worlds are not incompatible. The internship provided an understanding into "not only the academic part of the 'scientist' lifestyle, but also an insight into what kind of life a scientist leads away from the laboratory."

Interns' informal interactions with faculty fostered different types of relationships and contact outside the classroom helped to make the professors and their departments approachable. Some internships spawned close mentor-mentee relationships and friendships; some of these will continue as interns solicit their sponsor to act as their academic or thesis advisors, continue to work in the labs, or who occasionally touch base.

I think it was a great opportunity for me to meet professors and other faculty members at the engineering school where I work. I now feel more comfortable asking a faculty member that I know there for help or opinions. It's nice to recognize faces when I go through the building to my classes.

The interns also had the opportunity to look to the people (especially women) in lab as role models. Interns found their co-workers' work inspirational and their enthusiasm contagious.

The women in the lab with whom I work all seem to be very intelligent, hard-working, dedicated individuals, and I find it very inspiring to work along side of them. They always offer me advice and try to encourage me when I start to question my abilities in science. I think that this environment has helped me a great deal. I am learning so much about science and research, and it is wonderful to use the women in my lab as models of what I can become with hard work.

Interns contrasted the support and encouragement of lab members with their experience in college laboratories. The competition that prevails in many science courses is one of the factors that interns cited as a major deterrent to a major in science. Interns imagined labs as intense, competitive workplaces. However, they discovered that this is not so. The relaxed, social atmosphere of the labs in which people "work hard and play hard" was attractive to the women. Many women regarded the internship as a social and support network.

It was obvious to me that they [lab members] respect each other and will help each other out when they can. The support network was very refreshing. I used to think that like



college, the scientific world was dominated by cut throat competition, however, that is not true.

Part of what made the experience so meaningful to the interns was their inclusion in their lab's research "team." Interns commented on the fact that they were treated as a valued member of their research group instead of an employee that did only grunt work. Having assigned space and materials, attending weekly lab meetings and social events, and working on their own research project that interfaced with other projects in the lab, communicated to students that they were accepted as equals and that their work was important.

Many students who regarded science as an isolated endeavor were pleasantly surprised by the community that existed between members of the lab, between labs at Dartmouth, and between researchers worldwide who investigated similar questions. "I realized science is about team work. I had always had a picture of the lone scientist conducting research in a quiet desolate lab, but it's not at all like this. That's good." Working with people, doing something for people, and doing something useful were considerations that students cited as important ones in choosing a career. Thus, realizing that scientists interact with their colleagues, might influence some students to consider research as a career.

3) THE BIGGER PICTURE

One characteristic of science classes that discouraged women was the lack of personal connection with or practical applications of the material they studied. Interns described the important role that the internship played in helping them to situate abstract course content in a larger context. Women contrasted the difference between "just sitting and listening to abstract concepts being explained" in class with doing "actual work to get tangible results" in their lab. But, the uniqueness of an internship experience stemmed from more than just having a hands-on experience; science course labs, too, permit students to work with materials. What set the internship apart was that it entailed doing science that interns perceived as worthwhile—it was not just a verification of an existing fact.

I feel like I am actually going somewhere with all this, as if I will be doing something hands on, for the first time in my life!... the research is really worth while, and it means a lot to me personally to be part of it. I think that I was expecting something a bit like the class room, where I was never integrated into what was REALLY happening.

The interns explained that their work was often important for other members of their research team. What they do, and how they do it "counted" not because they were getting a grade, but because their work and results will be used in the future: "It also excites me to know that the work I am doing will have meaning and could be useful to other people." Situating concepts and research in their larger context served to excite students about both lecture and lab science classes. The internship research helped students to see how and why their book knowledge is important and prompted some interns to take science classes to better understand their research project

The "bigger picture" about why they were conducting the research helped students put the details and work (which they realized is often quite tedious) in perspective. The realization that their work could potentially make an impact by generating information that might help solve a problem—intellectual, physical, medical, or social—motivated students to continue their work and their science studies.

I loved every minute of it, even the times when I thought I would collapse, because I kept thinking to myself that "this is the real world. This makes a difference. What goes on in this lab matters to the whole world."

4) CAREER PLANS

Many students participated in an internship because they felt it would help them make an informed decision about possible future careers. A vast majority of the women were considering medical careers. Their journal responses revealed some of the factors that drive

this decision: it is a familiar world, students know what it entails; women perceive it as one of the only fields in science where you come in contact with many people and can help people; and women hold misconceptions and lack of information about other science-based careers. The internship experience broadened their understanding about the range of career options. Not only did internships expose students to new careers, but also to new scientific disciplines. Quite a few students wrote that, as a result of their internship, they plan to take a course in a previously-unconsidered scientific field; others were considering an internship-related field as a possible major. Many mentioned that they were beginning to contemplate a science career outside of medicine based on their experiences.

5) UNDERSTANDINGS ABOUT SCIENTIFIC RESEARCH

Regardless of whether or not an intern planned to pursue a career in science, students enthusiastically characterized their internship as a worthwhile experience that taught them much about how science really operates. Interns finished the experience with a much greater appreciation for the difficulties and joys of research.

Interns were surprised by the slow progress of scientific research, and the amount of work it took to understand even one small piece in the puzzle. They enjoyed researching new problems without predetermined answers, however, at the same time they grew frustrated with the unpredictability of science, their inability to get the results they wanted, and the lack of a definite "answer."

One thing that seems surprising to me about working in a lab is that it really is so much trial and error. I'm so used to having labs for class in which the results are known beforehand. Now, we are trying ideas as they come up. It's interesting to see the results, but there are so many areas that could be causing difficulties in the experiments that it's hard to make any definitive conclusions. I guess what I'm trying to say is that although I always liked science because it seemed to have an answer, I realized that there are so many unknown areas.

The journals expressed interns' new understandings about the patience, dedication, and perseverance that the researchers in the labs possessed, as interns came to recognize research as hard work. Contrary to the stereotypes in society, interns learned that scientists do not possess inordinate amounts of intelligence, just lots of motivation—an insight that could make a career in research seem much more accessible:

It has also made me realize what working as a scientist really means. I think before I began the internship, I looked on science as something glamorous, that only really brilliant people could be a part of. Now I know that is not true. Science includes a lot of drudge work that can be done by anyone, but if someone works long enough on one experiment, than [sic] they will be able to form ideas of their own about the subject, no matter how brilliant or not brilliant they are.

Through their work, interns realized that science is not built on "discoveries" but rather is constructed piecemeal through many unexciting trials. The complexities inherent in designing and conducting experiments; the messiness of data; the stamina needed for tolerating the mundane, tedious details of the work; and the myriad of variables that needed to be taken into account gave them a new understanding of science and respect for its practitioners.

Because they were immersed in a scientific setting, the interns also learned about other important forces that shaped scientific work. Interns had not realized the influence of grants, and the importance and time devoted to procuring funding. The role of publications, communications, and conferences; the organization and hierarchy of a laboratory; and the business and diplomacy that accompany research were described as new understandings about science.

Such glimpses into the innards of science, the lives of scientists, and the culture of science, caused students to reshape their views about science and their own abilities to understand and

conduct scientific research. Students described their new appreciation of not only the products or outcomes of science, but also the process of science:

I have already learned an incredible amount about the scientific process as it is really used, and it's great to know that there is much more to science than what I'm learning now in my classes.

The increased awareness, appreciation, and skepticism of scientific facts was an important effect of the internship program. Science is a powerful tool in our society, inspiring fear and awe, often because its findings and mechanisms are misrepresented. By participating in research, interns developed a more complex understanding of the workings of science. Regardless of whether or not they continue in science, interns valued this newly acquired knowledge.

6) THE ISSUE OF WOMEN IN SCIENCE

WISP and its existence was a topic of campus controversy at Dartmouth. In their journals some freshmen related that they had never experienced sexism in science. However, as their entries often later revealed, many had faced difficulties or isolation in high school, they just had not classified it as such. Interestingly, interviews with seniors evidenced that over their college career, women in science become much more aware of the issues and challenges that face women in the field. Educating women, especially freshmen, about the issues that women in science often confront and explaining the rationale behind WISP was an important, necessary, and well-received role of the newsletter. Other freshmen talked about the sexism and isolation they had already perceived in science and the important role that WISP could play. Some mentioned the lack of female science and math professors at Dartmouth, the decreasing number of women in their classes, and the differences between male and female questioning and interaction in science, math, and engineering classes. The lack of role models was another issue that women often wrote about when they expressed their appreciation for the support that WISP could provide. For example, one freshman wrote:

I find gender issues to be very confusing. I still feel that there aren't nearly enough female role models. Growing up, I always felt disadvantaged because I was female and all the heroes, all the doers, and all the role models were male. I thought that I was excluded from all those roles because of my sex. WISP is a step into showing me that the world is not a males only club. I feel like I can put my foot in the door and break into something that interests me.

CONCLUSION

The course sequencing and logistics of a science major necessitate that students seriously consider science as a possible major in their first two years of college—without the foundational courses completed it is almost impossible to transfer into a science major in the junior year. However, these same introductory science courses are the reason that many students leave science—the large, impersonal lectures, the competition, the dearth of hands-on experiences and open-ended questions, all drive students away. By allowing students access to scientific research their freshman year, WISP internship experiences expose students to the real face of science at the beginning of their college career. The interns' journals reveal that the confidence that the internship builds, the contact with people in science, and the opportunity to situate their science study in its larger context are very important components that encourage women to continue in science. The interns appreciated learning about the lives and “the mentality of a scientist” (how they approached problems) and were inspired by the mentors with whom they worked. All interns were grateful for the experience, even those who decided that a research career in science was not attractive to them. For other interns, the internship allowed them to realize that they were capable of doing research science and motivated them to continue to pursue science coursework and careers:

WISP has greatly influenced my view on science. Science is no longer a dream, a far-out-there wish that I think I could participate in. Science is a reality. I actively work in the fields of science and engineering, and my work has given me every confidence that I can go on to get my PhD and really make an impact in science.

